



City of Thornton

Water Pipeline Seg F2

**Construction Documents
Technical Specifications**

Issue for Bid

August 2026

City of Thornton Project 12-777XF2

HDR Project No. 10442825



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DIVISION 01

GENERAL REQUIREMENTS



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SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Location and description of Work and prior uses of the Site.
 - 2. Construction Contracts for this Project.
 - 3. Others retained by Owner for the Project.
 - 4. Work by others under Owner's control on other projects.
 - 5. Sequence and progress of Work.
 - 6. Contractor's use of the Site.
 - 7. Easements and rights-of-way.
 - 8. Utility owners.
- B. Related Requirements:
 - 1. Include, but are not limited to, the following:
 - a. Section 01 14 16 - Coordination with Owner's Operations.
 - b. Section 01 50 10 - Protection of the Existing Facilities.

1.2 LOCATION AND DESCRIPTION OF WORK

- A. The Work is located in Larimer and Weld Counties, and extends from Larimer County Road 54, west of I-25 to Weld County Road 88, east of Larimer County Road 1.
- B. Work to be performed under this Contract includes, but is not limited to, constructing a welded steel raw water pipeline 42 inches diameter. Included, but not limited to, are associated appurtenances, including air vacuum and air release valves, blow-off valves, drain valves, manways, temporary pipe bulkheads, a corrosion protection system, provisions for pressure testing and connecting to other segments, and fiber optic (FO) conduit with pull boxes. It also includes a pressure gauge and transmitter, including any required power supply and communications panel that will interface with the fiber optic communications system and all other Work required in accordance with the Contract Documents.
- C. Contracting Method: The Project will be constructed under a single prime construction Contract. Project will be contracted with Segment F.2 in a single contract, but Segment F.1 will be executed under separate Contract Documents by Others. Contractor is responsible for coordination of requirements at interface between F.1 and F.2.
- D. Hazardous Environmental Conditions:
 - 1. To the best of Owner's knowledge, information, and belief, the prior use of the Site included agriculture, irrigation, ROW, and open space.

1.3 CONSTRUCTION CONTRACTS FOR THIS PROJECT

- A. Single Prime Construction Contract: The Contract requires all the Work for the Project not expressly allocated to Owner or others in the Contract Documents, including coordination of all interfaces between Segments F.1 and F.2.

1.4 OTHERS RETAINED BY OWNER FOR THE PROJECT

- A. Construction Manager
 - 1. Owner's Construction Manager is Ditesco.
 - 2. Owner's Construction Manager's responsibilities for the Project, relative to Contractor, are indicated throughout the Contract Documents.

- B. Engineer:
1. Engineer for Segment F.2 is HDR Engineering, Inc. as identified in the Agreement.
 2. Engineer's responsibilities for the Project, relative to Contractor, are indicated throughout the Contract Documents.
- C. Environmental Consultant:
1. Environmental Consultant is ERO.
- D. Coordination and Approval Authority. For all Work under this Contract (Segments F.1 and F.2):
1. The Owner's Construction Manager is the Contractor's single point of contact for administrative routing and processing, including submittal routing, allowance authorizations, work-hour and extended-hours requests, and permit and DCP coordination.
 2. The Engineer for each segment retains responsibility for technical review and action on submittals and other design-related matters for that segment.
 3. Authorities Having Jurisdiction (AHJs), meaning the federal, state, county, and municipal agencies that issue permits or approvals for the Work (including Larimer County, Weld County, the Colorado Department of Public Health and Environment, and the Colorado Department of Transportation), retain sole authority over their permits and approvals. This paragraph allocates administrative routing only and does not modify the roles, responsibilities, or authorities established elsewhere in the Contract Documents. Terms retain the meanings given in the General Conditions and each segment's Specifications.
- E. Other Professional Services Contracted by Owner: Owner will retain services of the following entities to perform the services indicated relative to the Project. Contractor shall coordinate and schedule the Work with, and cooperate with, the entities performing the following services for Owner.
1. Geotechnical Special Inspector or Consultant:
 - a. Identification: Geotechnical special inspection and consulting services will be performed by Ditesco and RJH.

1.5 WORK BY OTHERS UNDER OWNER'S CONTROL - OTHER PROJECTS

- A. Other construction contracts have been or will be awarded by Owner that are in close proximity to or border on the Work of this Project. Work under these other contracts is briefly described in this Article.
1. Thornton Water Pipe, Segment E
 - a. Principal Work Location: East of project terminus, and adjacent areas.
 - b. Scope:
 - 1) Project involves: Continuation of Segment E of the Thornton Water Pipeline.
 - c. Substantial Completion for Segment E is May 7, 2027.
 2. Tree Replacements for Segment F.2
 - a. Principal Work Location: Along project alignment
 - b. Scope
 - 1) Replacing and planting trees to compensate for removed trees during construction

1.6 WORK BY OTHERS NOT UNDER OWNER'S CONTROL

- A. Work by Utility Owners:
1. Owner is aware of the work indicated below, to be performed at or adjacent to the Site, by utility owners (not under Owner's control).
 - a. Northern Water Parallel Waterline
 - 1) Principal Work Location: Parallel to project alignment.
 - 2) Scope:

- a) Project involves: Construction of a parallel raw waterline.
- 3) If construction work on this Project commences during active construction of the Segment F.2 Pipeline Project, Owner will notify Contractor no less than 30 days prior to start of Northern Water Parallel Waterline Construction.
 - a) If notified of active Northern Water Parallel Waterline Construction, contractor shall add Northern Water construction representative to Construction Progress Meetings, as defines in Section 01 31 19 – Project Meetings, for activity coordination within the construction corridor.

1.7 SEQUENCE AND PROGRESS OF WORK

- A. Sequencing:
 - 1. Incorporate sequencing of the Work into the Progress Schedule.
 - 2. Sequencing Requirements:
 - a. Schedule constraints to project sequencing are in Section 01 14 34 – Construction and Schedule Constraints and Section 01 35 13 – Project Special Procedures.
- B. Requirements for sequencing and coordinating with Owner's operations, including maintenance of facility operations during construction, and requirements for tie-ins and shutdowns, are in Section 01 14 16 - Coordination with Owner's Operations.

1.8 CONTRACTOR'S USE OF SITE

- A. Use of Site - General:
 - 1. Limits on Contractor's use of the Site are shown on the Drawings.

1.9 EASEMENTS AND RIGHTS-OF-WAY

- A. Easements and Rights-of-Way - General:
 - 1. Easements and rights-of-way required for the permanent improvements included in the Work will be provided by Owner in accordance with the General Conditions and Supplementary Conditions.
 - 2. Confine construction operations within Owner's property, public rights-of-way, easements obtained by Owner, and limits shown, and property for which Contractor has made arrangements directly with property owner(s).
 - a. Submit evidence of agreement when using property for which Contractor has made arrangements directly with property owner(s) to Owner's Construction Manager.
 - 1) Owner's Construction Manager will submit evidence of agreement to Larimer County for approval of use.
 - 2) Owner is not responsible for delays in review or approval timelines by Larimer County.
 - 3) Approval of use of property for which Contractor has made arrangements directly with property owner(s) is not guaranteed. Owner is not responsible for delays or financial impacts of denial by Larimer County.
 - 3. Use care in placing construction tools, machinery and equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
 - 4. Do not enter private property outside the construction limits without written permission from the owner of the property.
- B. Within Roadway Rights-of-Way:
 - 1. Permits required for the permanent facilities will be obtained by Contractor on behalf of Owner as described in Section 01 41 24 – Permit Requirements. Contractor shall obtain and pay for work permits and fees for safety and inspection forces to be furnished by the right-of-way owner.
 - 2. Work performed and Contractor's operations within rights-of-way, shall comply with requirements of right-of-way owner and owners of facilities thereon, and with applicable

permits obtained by Contractor as described in Section 01 41 24 – Permit Requirements, and orders of authorities having jurisdiction over right-of-way.

1.10 UTILITY OWNERS

- A. Utilities known to Engineer and that may have Underground Facilities or other facilities in the vicinity of the Work are:
1. AT&T:
 - a. Facilities: 3" Fiber (Polyethylene)
 - b. Location: As Identified on Drawing Sheet 00G007
 2. Northern Colorado Water Conservancy District:
 - a. Facilities: 8" Water (PVC), 2" Water (PVC), 8" Water (PVC), 8" Water (PVC), Unk. Water (Unk.)
 - b. Location: As Identified on Drawing Sheet 00G007
 3. Anheuser Busch
 - a. Facilities: Unk. Sanitary Sewer (Unk.), 24" Sanitary Sewer (DIP)
 - b. Location: As Identified on Drawing Sheet 00G007
 4. Century Link
 - a. Facilities: (2) ½" Fiber (Direct Bury), ½" Direct Bury Phone (Direct Bury), ¼" Fiber (Direct Bury)
 - b. Location: As Identified on Drawing Sheet 00G007
 5. Xcel Energy
 - a. Facilities: Unk. Electric (Unk.), 1" Direct Bury Electric (Direct Bury), 4" Gas (Polyethylene)
 - b. Location: As Identified on Drawing Sheet 00G007
 6. Magellan (formerly Oneok)
 - a. Facilities: 8" Gas (Steel)
 - b. Location: As Identified on Drawing Sheet 00G007
 7. Private
 - a. Facilities: Various Irrigation (8-12", PVC and Steel)
 - b. Location: As Identified on Drawing Sheet 00G007
 8. Unknown:
 - a. Facilities: 1" Unk. (Direct Bury), 2" Fiber (Polyethylene)
 - b. Location: As Identified on Drawing Sheet 00G007
 9. North Weld County Water District
 - a. Facilities: Unknown Water (Unable to Locate/Find)
 - b. Location: As identified on Drawing Sheet 00G007
 10. Poudre Valley REA
 - a. Facilities: Overhead Power
 - b. Location: As shown on Drawing Sheet 01C121
 11. Larimer County Canal:
 - a. Facilities: Larimer County Canal
 - b. Location: As shown on Drawing Sheet 01C113
 12. Anchor Aviation:
 - a. Facilities: Private Runway
 - b. Location: As shown on Drawing Sheet 01C108
- B. Utilities and their owners indicated in the Contract Documents are for Contractor's convenience. Neither Owner nor Engineer will be liable to Contractor or any utility owner for failure to indicate utility, its owner, or complete and correct contact information in the Contract Documents where

Contractor's reasonable and ordinarily-exercised diligence would reveal the presence of the utility and its owner. Nothing in the Contract mitigates Contractor's responsibilities under the General Conditions, Section 01 50 10 - Protection of Existing Facilities, and Laws and Regulations, including dialing 811 to identify locations of underground facilities in accordance with Colorado SB18-167 regulations.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 14 16
COORDINATION WITH OWNER'S OPERATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Requirements for coordinating with Owner's operations during the Project.
 - 2. Requirements for tie-ins necessary to complete the Work without impact on Owner's operations except as allowed in this Specifications section.
- B. Scope:
 - 1. Contractor shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with Owner's operations during the Work in accordance with this Specifications section.
- C. Related Requirements: Include but are not necessarily limited to:
 - 1. Section 01 11 00 - Summary of Work.
 - 2. Section 01 14 34 – Construction and Schedule Constraints

1.2 REFERENCES

- A. Terminology:
 - 1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Specifications section have the meaning indicated below:
 - a. The term "Owner" is used throughout this section. When the facility is operated or managed by an entity other than Owner, references in this section to "Owner" as the operator or manager of the facility will be interpreted as referring to the facility manager.
 - b. A "tie-in" is a connection of new Work to existing facilities, including connecting to existing conduits (including piping and ducting), electrical systems, structural elements, process/mechanical elements, and other physical connections. Some tie-ins may require that the tie-in be made without an associated shutdown.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Review construction procedures under other Specifications sections and coordinate Work that will be performed with or before the Work indicated in this Section.
- B. Sequencing and Scheduling:
 - 1. Refer to this Specifications sections articles on sequencing, tie-ins, and shutdowns.

1.4 GENERAL CONSTRAINTS

- A. New materials and equipment may be used by Owner after the specified field quality control activities are successfully completed and the materials or equipment are substantially complete in accordance with the Contract Documents.
- B. The following constraints apply to coordination with Owner's operations:
 - 1. Dead End Valves or Conduits:

- a. Provide blind flanges, watertight bulkheads, or valve at temporary and permanent terminuses of conduits, including piping and ducting.
 - b. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as necessary or as required by Engineer.
 - c. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of conduit, including piping or ducting, also provide on downstream side of valve a blind flange with drain/flushing connection.
2. Draining and Cleaning of Conduits, Tanks, and Basins:
 - a. Unless otherwise shown or indicated in the Contract Documents, Contractor shall dewater conduits (including piping) at beginning of each tie-in.
 - b. Contractor shall remove liquids and solids and dispose of them at appropriate location at the Site as directed by Owner's Construction Manager.

1.5 TIE-INS

- A. Table 01 14 16-A in this Specifications section lists connections by Contractor to existing facilities.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate preparations for removals and tie-ins with Owner's Construction Manager..

3.2 ATTACHMENTS

- A. The following, bound after this Specifications Section's "End of Section" designation, are part of this Specifications Section:
 1. Tables:
 - a. Table 01 14 16-A, Schedule of Tie-ins.

END OF SECTION

Table 01 14 16-A Schedule of Tie-Ins					
Tie-In No.	New Line Size and Service	Existing (Connecting) Line Size & Service	Tie-In Building/Location	Construction Stage	Remarks
1	42" Steel Raw Water	42" Steel Raw Water	Sta: 10+00	After Successful Pressure Test	Contractor to coordinate scope of materials supplied and sequencing of testing and final connection with Segment F1 Drawings and Specifications.
2	42" Steel Raw Water	42" Steel Raw Water	Sta: 252+3.70	After Successful Pressure Test	
3	Electrical Service	Xcel Overhead	Sta: 234+00	After water pipeline constructed, before system startup	Contractor to coordinate connection with Xcel.
4	Impressed Current Cathodic Protection	Seg E, Seg F.1	Sta: 10+00	Once CP system in place	

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SECTION 01 14 34

CONSTRUCTION AND SCHEDULE CONSTRAINTS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. The Contractor shall perform the Work within the specified Contract time. Critical events in the sequence of construction as described in this Section shall be utilized by the Contractor as a guideline. The construction constraints presented do not include all items affecting the completion of the Work, but are intended to describe the sequence of critical events necessary to minimize disruption to the Owner and other agency facilities, to properly coordinate between related contracts, and to ensure compliance with permit requirements. It shall be understood and agreed by the Contractor that the critical events described are not all inclusive and that additional items of work not described may be required to minimize disruption and ensure compliance with the Contract Documents and permit requirements. Deviation from or modification of these suggested sequences may be permitted if techniques and methods known to the Contractor will result in facilitating construction and in reducing facility disruption, and is accepted in advance by the Owner.
- B. The Contractor shall allow for construction and schedule constraints in preparing the construction schedules. The schedules shall include the Contractor's activities necessary to satisfy all constraints and permit requirements included and referenced in the Contract Documents.

1.2 CONTRACT TIME

- A. To meet the Owner's program goal, substantial completion is required by January 31, 2028.

1.3 WORK HOURS

- A. Normal work hours outside of road right-of-way shall be 7:00 a.m. to 7:00 p.m., Monday through Saturday, except legal holidays recognized by the applicable jurisdiction.
- B. Certain installations, connections, or other work may only be feasible at times other than normal working hours, such as nights, weekends, or holidays.
 - 1. Any work proposed between the hours of 7:00 pm to 7:00 am on any day, and at any time on Sundays or Holidays must be approved by both the Owner's Construction Manager and by Larimer County in accordance with Larimer County 1041 Permit Conditions of Approval #20 and #24. Written request for work in these periods must be given to the Owner's Construction Manager.
 - a. Evaluation of these requests must be evaluated and approved through Larimer County Departments including Health, Planning, and Engineering. Documents supporting a deviation must be provided to the County by the Owner's Construction Manager a minimum of two business days in advance.
 - 1) Owner does not have control over the Larimer County Review process or timelines, and approval delays or denials by Larimer County are not compensable. Work in these periods may not commence until written approval is granted by both Larimer County and the Owner's Construction Manager.

1.4 PERMITS

- A. Permits, approvals and agreements from various agencies are required for execution of the Work under this Contract. Refer to Section 01 41 24 – Permit Requirements for detailed permit requirements.
- B. Contractor shall allow adequate time in their schedule for the application, review, and approval of contractor-obtained permits.

1.5 PIPELINE CONSTRUCTION SCHEDULE AND SEQUENCING CONSTRAINTS

- A. Construction Schedule Constraints:

1. Habitat and Environmental Surveys

- a. A Habitat Assessment (HA) letter has been prepared by Owner's Environmental Consultant dated February 18, 2026. The HA letter presents a summary of potential habitat for federally threatened, endangered, and candidate species protected under the Endangered Species Act in the project. No habitat was identified for the federally listed species within the project area.
- b. Migratory Birds and Raptors
 - 1) To the extent possible, clearing of vegetation along the pipeline easement corridor should occur outside of the breeding season. Unless indicated otherwise, if vegetation is removed between March 15 and August 31 (within the primary nesting season), a nest survey will be completed within one (1) week prior to construction to confirm no active nests are within the construction limits. If active nests are found, any work that would destroy the nests would not be conducted until the birds have vacated the nests to comply with the Migratory Bird Treaty Act. Contact the Owner's Construction Manager two (2) weeks prior to vegetation removal to schedule the nest survey during those dates as required by Larimer County 1041 Permit Conditions of Approval #59, #60, and #73.
 - 2) Owner's Environmental Consultant performed raptor surveys to identify potential nesting habitat. No nests or nest buffer areas were identified within the work area. Owner's Environmental Consultant will perform raptor nest surveys and will review Colorado Parks and Wildlife (CPW) raptor nest data before the nesting season (September 1 through November 30) to identify raptor nests before construction activities begin. If nests are identified and construction activities are scheduled to take place within the nesting season, Owner's Environmental Consultant will coordinate with CPW to develop measures acceptable to CPW to minimize impacts to nesting raptors.
 - 3) No prairie dog burrows were found during the design phase of the project. If prairie dog colonies develop during the construction phase, coordinate with the Construction Manager 4 weeks before construction to identify any work that may occur within 1/8-mile buffer of any prairie dog burrows between March 15 and October 31. If the work may impact this buffer, a burrowing owl survey will be completed. If owls are present in the project area, activities will be restricted within 660 feet of nest burrows until the owls have migrated from the site, which will be determined through monitoring.
- c. Prairie Dogs
 - 1) No prairie dog burrows were found during the design phase of the project. If prairie dog colonies develop during the construction phase, passive relocation of prairie dogs is required before construction. Owner's Environmental Consultant will take the lead in permitting, managing, and relocating the animals from the work area before construction.
 - a) It is expected that the Contractor will be able to construct in the area without efforts on their own behalf to manage the habitat.
 - b) If there are any conflicts with prairie dogs, the Contractor should contact the Owner's Construction Manager.
 - c) The current approach is to passively relocate the prairie dogs using a combination of techniques including barriers, surveys, and removal of the holes before construction by the Contractor.
 - (1) Passive relocation cannot take place during the animal birthing season, March 1 through May 31.
 - 2) The Contractor shall not start work within any prairie dog colony area until the necessary BMP's are installed and the animals are relocated out of the area of disturbance.
 - 3) Contractor must coordinate their construction schedule and activities through any colony with the Owner's Construction Manager and Owner's Environmental

Consultant so that passive relocation can be completed before construction activities in the area.

- a) Provide the Owner's Construction Manager at least four (4) weeks notification before the date of mobilization in the area.
- 4) If relocated prairie dogs re-inhabit the disturbance area, construction activities should cease in the area until the prairie dogs are effectively relocated again.
- d. Northern Leopard Frog
 - 1) If feasible, schedule construction activities outside of the northern leopard frog breeding season (March 1 –May 31) along stream channels, drainage features, and wetlands along stream channels, drainage features, and wetlands within the limits of disturbance for northern leopard frogs. If a frog is encountered during construction, Owner's Environmental Consultant will coordinate with CPW on actions to be taken, in accordance with Larimer County 1041 Conditions of Approval #58 and #61, which may include ceasing construction in the area until the end of the breeding season (June 1). Contact the Owner's Construction Manager two (2) weeks prior to vegetation removal to schedule the surveys during the breeding season.
2. All irrigation ditch crossings shall be conducted when ditches are not flowing. This is generally November 1 – March 31, but can vary depending upon weather. Coordinate directly with ditch companies for exact timing and notify Owner's Construction Manager prior to construction.
 - a. Construction within Larimer County Canal is limited to [November 1] to [March 31].
3. Any surface irrigation disrupted by construction must be conveyed around or across construction zones such that irrigation flows are not impacted.
4. Maximum time allowable for trenches to remain open is five (5) days.
 - a. Trenches left open for longer than two (2) days require wildlife escape ramps in accordance with Section 01 57 05 – Temporary Controls.
5. Maximum length of disturbance without restoration is limited to one surface mile, per active construction crew.
6. Parcel-specific seasonal work constraints as defined in Section 01 35 13 – Project Special Procedures.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 20 00
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Measurement and Payment criteria applicable to portions of the Work performed under a unit price payment method.
- B. Defect assessment and non-payment for rejected work.

1.2 UNIT QUANTITIES SPECIFIED

- A. Quantities indicated in the Bid Form are for bidding and award purposes only. Quantities and measurements supplied or placed during performance of the Work are verified by the Owner to determine payment.
- B. If the actual Work requires greater or lesser quantities than those indicated in the Bid Form, provide the required quantities at the unit/lump sum prices contracted. Unless otherwise stated in the Contract Documents, the bid unit prices shall be in effect throughout the contract duration. When the variance between the estimated quantities and the actual installed quantities is more than 25 percent, the Contractor or the Owner may negotiate a change to the Unit Price. That change will be made in accordance with the Change Order process as defined in the Contract Documents.
- C. When excavation or trenching is involved, unit and lump sum price bid includes all costs. No direct payment shall be made for excavation or trenching, unless otherwise specified. Excavation and trenching shall not be further classified by depth, type, or material unless otherwise specified.

1.3 TOTAL BID PRICE

- A. The total bid price shall cover all Work required by the Contract Documents.
- B. All Work not specifically set forth as a pay item shall be considered subsidiary obligations of the Contractor and shall be included in the overall price for the Work.

1.4 MEASUREMENT OF QUANTITIES

- A. Weighing, measuring, and metering devices used to measure quantity of materials for Work shall be suitable for purpose intended and conform to tolerances and specifications as specified in National Institute of Standards and Technology, Handbook 44.
- B. Whenever pay quantities of material are determined by weight, material shall be weighed on scales furnished by Contractor and certified accurate by state agency responsible. Weight or load slip shall be obtained from weigh station and delivered to Owner's Construction Manager at point of delivery of material.
- C. If material is shipped by rail, car weights will be accepted provided that actual weight of material only will be paid for and not minimum car weight used for assessing freight tariff, and provided further that car weights will not be acceptable for material to be passed through mixing plants.
- D. Vehicles used to haul material being paid for by weight shall be weighed empty daily and at such additional times as required by the Owner's Construction Manager. Each vehicle shall bear a plainly legible identification mark.
- E. Materials that are specified for measurement by the cubic yard measured in the vehicle shall be hauled in vehicles of such type and size that actual contents may be readily and accurately determined. Unless all vehicles are of uniform capacity, each vehicle must bear a plainly legible identification mark indicating its water level capacity. Vehicles shall be loaded to at least their water level capacity. Loads hauled in vehicles not meeting above requirements or loads of a quantity less than the capacity of the vehicle, measured after being leveled off as above provided, will be subject to rejection, and no compensation will be allowed for such material.

- F. Quantities Based on Profile Elevations: Existing ground profiles indicated on Drawings were taken from a topographic map drawn with contour intervals of 1 foot.
- G. Quantities will be based on ground profiles shown. Field surveys will not be made to confirm accuracy of elevations shown.
- H. Where measurement of quantities depends on elevation of existing ground, elevations obtained during construction will be compared with those shown on Drawings. Variations of 1 foot or less will be ignored, and profiles shown on Drawings will be used for determining quantities.
- I. Measurement by Area
 - 1. Measured by square dimension using mean length and width or radius.
- J. Measurement by Volume
 - 1. Measured by cubic dimension using mean length width or radius, and depth.
- K. Linear Measurement
 - 1. Measured by horizontal station length, measured station to station after assembly and installation.
 - 2. For bid items without stationing shown on plans, linear measurement is a horizontal length, measured along the horizontal plan centerline after assembly or installation,
- L. Measurement by Count
 - 1. Measurement by count shall be for the number of units provided or installed. Unit bid price shall cover relative variations between such items as the size, depth, or amount of material required to complete the work.
- M. Lump Sum Items
 - 1. No quantity measurement shall be made for lump sum bid items.
- N. Units of measure indicated on Bid Form shall be as follows, unless specified otherwise. Pipe measurement shall be based on horizontal stationing as indicated in the Drawings.

Item	Method of Measurement
AC	Acre - Field Measure by Owner's Construction Manager
ALLOW	Allowance – Based on Actual Field Cost as defined in General Conditions.
CY	Cubic Yard - Field Measure by Owner 's Construction Manager within limits specified or shown
CY-VM	Cubic Yard - Measured in Vehicle by Volume
EA	Each - Field Count by Owner's Construction Manager
GAL	Gallon - Field Measure by Owner's Construction Manager
HR	Hour
LB	Pound(s) - Weight Measure by Scale
LF	Linear Foot - Field Measure by Owner's Construction Manager
LS	Lump Sum
MFBM	Thousand Foot Board Measure - Field Measure by Owner' Construction Manager
MO	Calendar Month
SF	Square Foot
SY	Square Yard
TON	Ton- Weight Measure by Scale (2,000 pounds)

1.5 PAYMENT

- A. Payment includes full compensation for all required labor, products, tools, equipment, plant, transportation, services, incidentals, erection, application and installation of an item of the Work, including Contractor's overhead and profit.

- B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the Owner multiplied by the unit price for Work.
- C. Method of payment for each pay item is included in the following table and generally shall be made based on the percentage of Work completed at the time of each progress payment unless otherwise specified.
- D. Allowance Administration. The following procedure applies to all allowance bid items in the Segment F.1 and Segment F.2 bid schedules. Allowance amounts and allowance bid items remain as listed in each segment's bid schedule.
 - 1. Written authorization is required before performing allowance work. The Contractor shall submit a written request to the Owner's Construction Manager describing the work, the location by segment and station, the applicable allowance bid item, the estimated cost, and any schedule impact, with supporting documentation.
 - 2. The Owner, or the Owner's Construction Manager with the Owner's concurrence, will issue a written Authorization of Allowance Account, executed by the Owner's Construction Manager, the Owner, and the Contractor, establishing the authorized scope and not-to-exceed amount before the work proceeds. Work performed against an allowance without prior written authorization is not eligible for payment.
 - 3. Authorized allowance work will be measured and paid at Actual Field Cost as defined in the General Conditions, with all required evidence and data submitted to and accepted by the Owner's Construction Manager.
 - 4. Allowances are Owner-controlled amounts. There is no guarantee of use, compensation, or profit on allowance items, and no payment will be made for unused allowance amounts.
 - 5. Each authorization will be charged to the applicable segment's allowance bid item as identified in the Authorization.

BASE BID PAY ITEMS – THORNTON WATER PIPELINE F.2

Item No.	Item	General Description	Unit of Measurement	Method of Payment
1	Contractor Mobilization and Demobilization	Includes all costs for bonds, Contractor's safety program, insurance, permits, moving equipment and temporary facilities not covered by Items – "Tunnel Mobilization"(s) and "Engineers Field Office" to and from the site, establishment of contractor offices at the site, securing of permits, preparation of submittals, and all other work required by the drawings and specifications which is not specifically set forth in the Bid Form as a pay item.	LS	Per General Conditions

Item No.	Item	General Description	Unit of Measurement	Method of Payment
2	Site Preparation and Erosion Control	Includes all costs for furnishing and handling, all required labor, equipment, and materials for Site Preparation. The Unit Price includes pre-construction site videotaping and photographs; clearing, grubbing, stripping, removal and disposal of material; stockpiling of topsoil; protection and/or trimming of existing vegetation including trees; tree removal; miscellaneous removals and replacements; installation, maintenance, and removal of any required temporary fencing and construction limit delineation; installation, maintenance, and removal of all required initial, interim, and final erosion control facilities and items; obtaining required permitting and providing an erosion control supervisor as required.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on all work completed as a percentage of approved work and materials furnished.
3	Gravel Access Road	Includes all costs for furnishing and handling all required labor, equipment, and materials for installation of gravel access roads, both temporary and permanent. The Unit Price includes sub grade preparation and compaction, base course placement and compaction; gravel placement and compaction; fine grading; and all other work or materials required to complete the work as specified or detailed on the drawings. This item excludes restoration of existing access points and roadways, which is included under other bid items specific to their locations.	SY	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the area replaced as determined by field measurements or survey information and approved by Owner's Construction Manager. Payment for roadway width wider than specified will not be considered.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
4	Traffic Control	Includes all costs for furnishing and handling all required labor, equipment, and materials for all required project traffic control. The Unit Price includes preparation of and obtaining approval of traffic control submittals, plans and detour; coordinating with governing jurisdictions; permitting; furnishing, installing and maintaining barriers and detour routes and other traffic control devices and personnel.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on all work completed as a percentage of approved work and materials furnished.

5	Steel Water Piping – 42-inch Diameter– Open Cut	Includes all costs for furnishing and handling all required labor, equipment, and materials for pipe manufacture, transportation of materials, layout, and installation. The Unit Price includes any demolition required prior to excavation; trenching; dewatering; lay-back and/or benching; trench boxes/shoring; bedding, embedment, backfilling and compaction; disposal of excess excavated material offsite; control of surface water; pipe, including linings, coatings, specials, welding, and incidentals; fittings; pressure testing; hydrostatic testing; deflection testing; post installation videotaping; jointing materials; butt straps and pipe joints; utility locates and potholes; easement staking and marking; pipeline marking tape; tracer wire, locator balls and associated lead boxes; cathodic protection and all test stations; crossing and protection of existing underground and overhead utilities; protection, support, relocation or replacement of existing utilities, culverts and storm sewers; temporary access provisions; additional temporary construction fencing or barriers not covered under payment for “Site Preparation and Erosion Control” or “Traffic control”; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents. This item excludes steel casing pipe which is included under other bid items for “Steel Casing Pipe Installed Via Open Cut – 54-Inch”, “Tunnel Excavation and Initial Support – Interstate-25 Tunnel”, and “Tunnel Excavation and Initial Support – Larimer County Road 52 Tunnel”. This item excludes steel water carrier pipe installed within steel casing pipe, which is included under other bid items for “Steel Water Piping - Install 42-Inch Diameter Steel Water Piping in	LF	Payment shall be made at the Unit Price listed in the Bid Form based on installed and completed work. The length of the Steel Water Piping shall be measured for payment, after installation, on the basis of the horizontal pipeline stationing as determined by the pipeline installation surveys, with all stations carefully measured. The measurement of the length of each line or run of pipe of each size shall begin and end at the end of the pipe where not connected to any other pipe or structure under this Contract, or the inside edge of the structure.
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Item No.	Item	General Description	Unit of Measurement	Method of Payment
		Open-Cut 54-Inch Steel Casing Pipe", "Tunneled Pipe Installation and Grouting – Interstate-25 Tunnel", and "Tunneled Pipe Installation and Grouting – Larimer County Road 52 Tunnel".		
6	Steel Casing Pipe Installed Via Open Cut – Minimum 54-inch Diameter	Includes all costs for furnishing and handling, all required labor, equipment, and materials for pipe manufacture, transportation of materials, layout, and installation of steel casing pipe. The Unit Price includes any demolition required prior to excavation; trenching; dewatering; lay-back and/or benching; trench boxes/shoring; bedding, embedment, backfilling and compaction; disposal of excess excavated material offsite; control of surface water; pipe, including linings, coatings, specials, welding, and incidentals; fittings; jointing materials; butt straps and pipe joints; utility locates and potholes; easement staking and marking; tracer wire, locator balls and associated lead boxes; cathodic protection and all test stations; crossing and protection of existing underground and overhead utilities; protection, support, relocation or replacement of existing utilities, culverts and storm sewers; temporary access provisions; additional temporary construction fencing or barriers not covered under payment for "Site Preparation and Erosion Control" or "Traffic Control"; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents. This item excludes restoration of the channel cutoff wall, clay liner, and channel banks, which is included under payment for "Larimer County Canal Crossing" and "Allowance for Reconstruction of Disturbed Concrete Cutoff Wall at Larimer County Canal – If Found".	LF	Payment shall be made at the Unit Price listed in the Bid Form based on installed and completed work. The horizontal length of the casing pipe shall be measured for payment, after installation, as determined by the pipeline installation surveys, with all stations carefully measured. The measurement of the length of casing pipe shall begin and end at the respective ends of the casing pipe.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
7	Steel Water Piping - Install 42-inch Diameter Steel Water Piping in Open-Cut Min. 54-inch Steel Casing Pipe	Includes all costs for furnishing and handling, all required labor, equipment, and materials for installing the 42-inch steel water carrier pipe within the constructed casing. The Unit Price includes the manufacture, transport, and installation of carrier pipe, including linings, coatings, specials, welding, and incidentals; fittings; pressure testing; hydrostatic testing; deflection testing; post installation videotaping; jointing materials; butt straps and pipe joints; casing insulators and/or spacers; cathodic protection and all test stations; casing end seals; installing grout between the casing and carrier pipe (including floatation prevention provisions); and all associated work as shown and specified in the Contract Documents. This item excludes steel water carrier pipe installed in tunneled casings, which is paid for under other bid items for "Tunneled Pipe Installation and Grouting – Interstate-25 Tunnel", and "Tunneled Pipe Installation and Grouting – Larimer County Road 52 Tunnel". pipe, including linings, coatings, specials, welding, and incidentals; fittings; pressure testing; hydrostatic testing; deflection testing; post installation videotaping; jointing materials; butt straps and pipe joints;	LF	Payment shall be made at the Unit Price listed in the Bid Form based on installed and completed work. The length of the casing pipe shall be measured for payment, after installation, as determined by the pipeline installation surveys, with all stations carefully measured. The measurement of the length of casing pipe shall begin and end at the respective ends of the associated casing pipe.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
8	Bank of Three (3) 2-inch Fiber Optic Conduits	Includes all costs for furnishing and handling, all required labor, equipment, and materials for installation of the conduit bank consisting of three (3) parallel 2-inch HDPE conduits. The Unit Price includes manufacture, transportation of materials, layout, and installation of the fiber optic conduits; any demolition required prior to conduit installation; excavation; dewatering; backfilling and compaction; conduit; necessary encasement and dye; fittings; connections to pull boxes and handholes; caps; utility locates and potholes; easement staking and marking not included in other bid items; crossing and protection of existing underground and overhead utilities; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	LF	Payment shall be made at the Unit Price listed in the Bid Form based on installed and completed work. Length of the Bank shall be measured for payment horizontally along the centerline of the bank, after installation, with all lengths carefully measured. The measurement of the bank length will include all three conduits as a single bank, and shall begin and end where connected to a new or existing handhole, pull box or structure on the inside edge of the handhole, pull box or structure.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
9	Type 1 (At-Grade) Fiber Optic Handhole	Includes all costs for furnishing and handling, all required labor, equipment, and materials for installation of Type 1 Fiber Optic Handholes. The Unit Price includes manufacture, transportation of materials, layout, and installation of the handholes; any demolition required prior to handhole installation; excavation; dewatering; bedding, backfilling and compaction; utility locates and potholes; easement staking and marking not included in other bid items; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	EA	Payment shall be made at the Unit Price listed in the Bid for each handhole accepted by the Owner's Construction Manager.
10	Type 2 (Buried) Fiber Optic Handhole	Includes all costs for furnishing and handling, all required labor, equipment, and materials for installation of Type 2 Fiber Optic Handholes. The Unit Price includes manufacture, transportation of materials, layout, and installation of the handholes; any demolition required prior to conduit installation; excavation; dewatering; backfilling and compaction; utility locates and potholes; easement staking and marking not included in other bid items; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	EA	Payment shall be made at the Unit Price listed in the Bid for each handhole accepted by the Owner's Construction Manager.
11	Trench Plugs (Groundwater Barriers)	Includes all costs for furnishing and handling, all required labor, equipment, and materials for furnishing and installing the groundwater barriers, including transportation and placement of materials; excavation and shoring over and above that required for pipe installation; dewatering; and all other items required to complete groundwater barrier installation.	EA	Payment shall be made at the Unit Price listed in the Bid Form for each completed groundwater barrier as approved by the Owner's Construction Manager.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
12	CLSM Encasement of Steel Water Pipes at Larimer County Road Crossings	Includes all costs for furnishing and handling, all required labor, equipment, and materials for CLSM encasement required for Steel Water Pipes. The Unit Price manufacture, transportation of materials, and installation of CLSM encasement from bottom of trench to 2-feet below road surface at Larimer County Road Crossings; washout; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	CY	Payment shall be made at the Unit Price listed in the Bid Form based on installed and completed work and measured for payment, after installation, on the basis of the length multiplied by average width and depth, excepting the volume of the encased pipe as measured in by the Owner's Construction Manager. The length, width, and depth of encasement shall conform to the roadway limits shown on the Drawings, directed by the specifications unless otherwise directed by Owner's Construction Manager. Any additional CLSM for encasement required outside the specified pay limits will be considered a subsidiary obligation of Contractor and no direct payment shall be made there for.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
13	Larimer County Canal Crossing	Includes all costs for furnishing and handling, all required labor, equipment, and materials for work associated with restoration of the crossing. The Unit Price includes transportation and placement of materials; sub-grade preparation; clay liner and native soil replacement; bank backfilling and compaction; and canal invert shaping and fine grading; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents. The Unit Price for this item shall exclude excavation and installation of the crossing casing and carrier pipes, which are paid for under the bid item for "Steel Casing Pipe Installed Via Open Cut – Minimum 54-inch" and "Steel Water Piping - Install 42-inch Diameter Steel Water Piping in Open-Cut 54-inch Steel Casing Pipe"	LS	Payment shall be made at the Unit Price listed on the Bid Form as a lump sum payment at the completion of the crossing and acceptance of crossing by Owner's Construction Manager.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
14	Boxelder Creek Crossing	Includes all costs for furnishing and handling, all required labor, equipment, and materials for work associated with the Box Elder Creek Crossing. The Unit Price Includes transportation of and placement of materials; sub-grade preparation; bank backfilling and compaction; canal invert shaping and fine grading according to the Contract Documents; and furnishing, designing, installing, operating, and maintaining a temporary diversion of Boxelder Creek (including all temporary crossings) for continuous uninterrupted flow during the installation of the improvements in Boxelder Creek; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents. The price for this item shall be costs over and above the open cut steel water installation costs, which are paid under the bid item for "Steel Water Piping – 42-inch Diameter by 0.25-inch Minimum Wall Thickness – Open Cut".	LS	Payment shall be made at the Unit Price listed on the Bid Form as a lump sum payment at the completion of the crossing and acceptance of crossing by Owner's Construction Manager.
15	12-inch Blowoff Assembly and Vaults	Includes all costs for furnishing and handling, all required labor, equipment, and materials for the Blowoff Assembly and Vault. The Unit Price includes valve assembly and precast vault manufacture; transportation and installation of all materials; excavation, dewatering; subgrade preparation, backfilling and compaction; CLSM backfill; pipe tap and all 12-inch pipes, valves, fittings and appurtenances; valve boxes and covers; vaults; vault lids, risers, and hatches; vent pipe; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	EA	Payment shall be made at the Unit Price listed in the Bid Form for each complete vault and assembly completed and approved by the Owner's Construction Manager.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
16	6-inch Blowoff Assembly and Vault	Includes all costs for furnishing and handling, all required labor, equipment, and materials for the Blowoff Assembly and Vault. The Unit Price includes valve assembly and precast vault manufacture; transportation and installation of all materials; excavation, dewatering; subgrade preparation, backfilling and compaction; CLSM backfill; pipe tap and all 6-inch pipes, valves, fittings and appurtenances; valve boxes and covers; vaults; vault lids, risers, and hatches; vent pipe; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	EA	Payment shall be made at the Unit Price listed in the Bid Form for each complete vault and assembly completed and approved by the Owner's Construction Manager.
17	Air and Vacuum / Air Release Valve Assembly and Vault	Includes all costs for furnishing and handling, all required labor, equipment, and materials for Air and Vacuum/Air Release Assembly and Vault The Unit Price includes valve assembly and precast vault manufacture; transportation and installation of materials; excavation, dewatering; subgrade preparation, backfilling and compaction; CLSM backfill; pipe tap and riser assembly pipes, valves, fittings and appurtenances; combination air valves and associated pipe, fittings, valves and appurtenances; valve boxes and covers; vaults; vault lids, risers, and hatches; vent pipe; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	EA	Payment shall be made at the Unit Price listed in the Bid Form for each complete vault and assembly completed and approved by the Owner's Construction Manager.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
18	Pressure Sensor and Air and Vacuum / Air Release with Flat Top Valve Assembly and Vault	Includes all costs for furnishing and handling, all required labor, equipment, and materials for Pressure Sensor Air and Vacuum/Air Release with Flat Top Assembly and Vault. The Unit Price includes valve assembly and precast vault manufacture; transportation and installation of materials; excavation, dewatering; subgrade preparation, backfilling and compaction; pipe tap and riser assembly pipes, valves, fittings and appurtenances; valve boxes and covers; vaults; vault lids, risers, and hatches; combination air valves and associated pipe, fittings, valves and appurtenances; vent pipe; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents. This item specifically excludes electrical and instrumentation equipment for this vault, which is paid under other bid items.	LS	Payment shall be made at the Unit Price listed in the Bid Form for each complete vault and assembly completed and approved by the Owner's Construction Manager.
19	Pressure Sensor Vault Electrical and Instrumentation	Includes all costs for furnishing and handling, all required labor, equipment, and materials for Electrical and Instrumentation for the Pressure Sensor Vault. The Unit Price includes manufacture and transportation of materials; underground and above ground conduit and cableway; cable; disconnects, meters, cabinets, fuses, panels, breakers, and switches; fiber optic panels, cables, and associated equipment; network and cellular equipment; grounding system; housekeeping pads; pressure sensor instrument; making up of all panels and terminations; electrical and I/O testing; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on all work completed as a percentage of approved work and materials furnished.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
20	Tunnel Mobilization and Demobilization – Interstate 25 Tunnel	Includes all costs for bonds, insurance, and permits relating to tunneling work. The Unit Price includes fabrication and moving tunneling equipment and temporary facilities to, from and around the site, as well as preparation of submittals, safety plans, post and during construction surveys, as-constructed plans, and all other work required prior to shaft or tunnel construction.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on progress of the Interstate 25 Tunnel as follows: Following approval of tunnel shop drawings, 10 percent of the amount bid for this item will be allowed. Following complete equipment and material mobilization and set up, 65 percent of the amount for this bid for this item will be allowed. Following complete removal of equipment and acceptance of as-built drawing mark-ups, the final 25 percent of the amount bid for this item will be allowed
21	Tunnel Geotechnical Instrumentation and Monitoring – Interstate-25 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for installation and periodic inspection and measurement of survey points. The Unit Price includes monitoring points; extensometers; survey equipment; targets; and all other work associated with monitoring of tunneling impacts to existing utilities and the surrounding ground as shown and specified in the Contract Documents.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on percent complete of the trenchless installation work for the Interstate 25 tunnel.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
22	Tunnel Launch and Receiving Shaft – Interstate-25 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for construction of the tunnel shaft shown on the drawing and described in the specifications. The Unit Price includes design, materials, shoring, dewatering; utility protection, labor, shaft backfilling (including CLSM), and all associated work as shown and specified in the Contract Documents to form a complete tunnel shaft installation.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on all work completed as a percentage of approved work and materials furnished for the Interstate 25 Tunneling Shafts.
23	Tunnel Excavation and Initial Support – Interstate-25 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for initial construction and support of the tunnel. The Unit Price includes providing a slurry control plan - where required for tunneling method utilized; providing equipment and performing tunneling operations; dewatering; furnishing and installing casing pipe; controlling line and grade and meeting tolerances; contact grouting; and all associated work as shown and specified on the Contract Documents to complete the tunnel and install the casing pipe.	LF	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the horizontal tunnel stationing as determined by the tunnel installation surveys, with all stations carefully measured. The measurement of the length of the Tunnel Excavation and Initial Support shall begin and end at the terminal locations of the casing pipe which shall conform to the stationed locations shown on the Drawings.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
24	Tunneled Pipe Installation and Grouting – Interstate-25 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for furnishing and installing the 42-inch steel water carrier pipe at the thickness specified in the Contract Drawings within the constructed tunnel casing. The Unit Price includes the manufacture, transport, and installation of carrier pipe, including linings, coatings, specials, welding, and incidentals; fittings; pressure testing; hydrostatic testing; deflection testing; post installation videotaping; jointing materials; butt straps and pipe joints; casing insulators and/or spacers; cathodic protection and all test stations; casing end seals; installing grout between the casing and carrier pipe (including floatation prevention provisions); and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.		Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, on the basis of the horizontal tunnel stationing as determined by tunnel installation surveys, with all stations carefully measured. The measurement of the length of the Tunneled Pipe Installation and Grouting shall begin and end at the terminal locations of the casing pipe which shall conform to the stationed locations shown on the Drawings.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
25	Tunnel Mobilization and Demobilization – Larimer County Road 52 Tunnel	Includes all costs for bonds, insurance, and permits relating to tunneling work. The Unit Price includes fabrication and moving tunneling equipment and temporary facilities to, from and around the site, as well as preparation of submittals, safety plans, post and during construction surveys, as-constructed plans, and all other work required prior to shaft or tunnel construction.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on progress of the Larimer County Road 52 Tunnel as follows: Following approval of tunnel shop drawings, 10 percent of the amount bid for this item will be allowed. Following complete equipment and material mobilization and set up, 65 percent of the amount for this bid for this item will be allowed. Following complete removal of equipment and acceptance of as-built drawing mark-ups, the final 25 percent of the amount bid for this item will be allowed.
26	Tunnel Geotechnical Instrumentation and Monitoring – Larimer County Road 52 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for installation and periodic inspection and measurement of survey points. The Unit Price includes monitoring points; extensometers; survey equipment; targets; and all other work associated with monitoring of tunneling impacts to existing utilities and the surrounding ground as shown and specified in the Contract Documents.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on percent complete of the trenchless installation work for the Larimer County Road 52 Tunnel.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
27	Tunnel Launch and Receiving Shaft – Larimer County Road 52 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for construction of the tunnel shaft shown on the drawing and described in the specifications. The Unit Price includes design, materials, shoring, dewatering; utility protection, labor, shaft backfilling (including CLSM), and all associated work as shown and specified in the Contract Documents to form a complete tunnel shaft installation.	LS	Payment shall be made at the Unit Price listed in the Bid Form based on all work completed as a percentage of approved work and materials furnished for the Larimer County Road 52 Tunneling Shafts.
28	Tunnel Excavation and Initial Support – Larimer County Road 52 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for initial construction and support of the tunnel. The Unit Price includes providing a slurry or spoils control plan - where required for tunneling method utilized; providing equipment and performing tunneling operations; dewatering; furnishing and installing casing pipe; controlling line and grade and meeting tolerances; contact grouting; and all associated work as shown and specified on the Contract Documents to complete the tunnel and install the casing pipe.	LF	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, on the basis of the horizontal tunnel stationing as determined by the tunnel installation surveys, with all stations carefully measured. The measurement of the length of the Tunnel Excavation and Initial Support shall begin and end at the terminal locations of the casing pipe which shall conform to the stationed locations shown on the Drawings.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
29	Tunneled Pipe Installation and Grouting – Larimer County Road 52 Tunnel	Includes all costs for furnishing and handling, all required labor, equipment, and materials for furnishing and installing the 42-inch steel water carrier pipe at the thickness specified in the Contract Drawings within the constructed tunnel casing. The Unit Price includes the manufacture, transport, and installation of carrier pipe, including linings, coatings, specials, welding, and incidentals; fittings; pressure testing; hydrostatic testing; deflection testing; post installation videotaping; jointing materials; butt straps and pipe joints; casing insulators and/or spacers; cathodic protection and all test stations; casing end seals; installing grout between the casing and carrier pipe (including floatation prevention provisions); and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.		Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the horizontal tunnel stationing as determined by tunnel installation surveys, with all stations carefully measured. The measurement of the length of the Tunneled Pipe Installation and Grouting shall begin and end at the terminal locations of the casing pipe which shall conform to the stationed locations shown on the Drawings.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
30	Barry Lane Crossing Asphalt Replacement	Includes all costs for furnishing and handling, all required labor, equipment, and materials for the asphalt restoration of Barry Lane. The Unit Price includes saw cutting; removal of existing asphalt paving; placement of new base course and paving and compaction; subgrade preparation and compaction; fine grading; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	SY	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the area replaced, as determined by field measurements or survey information. Areas disturbed outside the construction limits shown on the Contract Drawings are considered a subsidiary obligation of the contractor to restore, and no additional payment will be made.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
31	Barry Lane Crossing Concrete Gutter Replacement	Includes all costs for furnishing and handling, all required labor, equipment, and materials for the concrete gutter replacement on Barry Lane. The Unit Price includes saw cutting; removal of existing gutter; placement and compaction of new base course; forming and stripping; reinforcement; placing and finishing of concrete; concrete curing; grade control; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	LF	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the length replaced as determined by field measurements or survey information. Areas disturbed outside the construction limits shown on the Contract Drawings are considered a subsidiary obligation of the contractor to restore, and no additional payment will be made.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
32	Site Restoration and Revegetation	Includes all costs for furnishing and handling, all required labor, equipment, and materials for restoration of areas impacted by construction. The Unit Price includes restoration of existing driveways, roadways, and access roads; gravel, stone, or other hardscape materials to match existing conditions; fine grading; saw cutting; placement of new base course; paving and compaction; subgrade preparation and compaction; finish grading; placing stored topsoil; soil amendments; finish grading and seedbed preparation; reseeding and mulching; noxious weed control; maintenance, as specified, until final establishment or acceptance, of all areas disturbed over the course of construction; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents to return the area to existing or better than existing condition. Merge all costs required for the various materials required for restoration into the Unit Cost. This bid item excludes restoration items covered under bid items "Larimer County Canal Crossing", "Boxelder Creek Crossing", "Barry Lane Crossing Asphalt Replacement", "Barry Lane Concrete Gutter Replacement", and "Remove and Replace Gravel Roadway – Larimer County Road 1 / Weld County Road 13.	AC	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the area within the limits shown on the Contract Drawing restored, as determined by field measurements or survey information. Areas disturbed outside the limits shown on the Contract Drawings are considered a subsidiary obligation of the contractor to restore, and no additional payment will be made.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
33	Remove and Replace Gravel Roadway – Larimer County Road 1 / Weld County Road 13	Includes all costs for furnishing and handling, all required labor, equipment, and materials for the restoration of the road section. The Unit Price includes sub grade preparation and compaction; base course placement and compaction; gravel surface placement and compaction; fine grading; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.		Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the area restored, as determined by field measurements or survey information. Areas disturbed outside the construction limits shown on the Contract Drawings are considered a subsidiary obligation of the contractor to restore, and no additional payment will be made.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
34	Connection to Thornton Water Pipeline Segment F.1	Includes all costs for furnishing and handling all required labor and equipment for connection to the existing water line. Materials will be provided by the Owner. The Unit Price includes any demolition required prior to excavation; trenching; lay-back and/or benching; trench boxes/shoring; excavation; dewatering; removal of bulkheads or blind flanges and thrust restraint; cleaning and dewatering of existing pipe; bedding, embedment, backfilling and compaction; disposal of excess excavated material offsite; control of surface water; welding and incidentals; coating and lining; pressure testing; deflection testing; post installation videotaping; utility locates and potholes; easement staking and marking; crossing and protection of existing underground and overhead utilities; protection, support, relocation or replacement of existing utilities, culverts and storm sewers; temporary access provisions; additional temporary construction fencing or barriers not covered under payment for "Site Preparation and Erosion Control" or "Traffic Control"; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	LS	Payment shall be made at the Unit Price listed in the Bid Form after the connection is completed, successfully tested, and backfilled, as approved by the Owner's Construction Manager.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
35	Connection to Thornton Water Pipeline Segment E	Includes all costs for furnishing and handling all required labor, equipment, and materials for connection to the existing water line. The Unit Price includes any demolition required prior to excavation; trenching; lay-back and/or benching; trench boxes/shoring; removal of bulkheads or blind flanges and thrust restraint; cleaning and dewatering of existing pipe; bedding, embedment, backfilling and compaction; disposal of excess excavated material offsite; control of surface water; welding and incidentals; coating and lining; fittings; pressure testing; deflection testing; post installation videotaping; jointing materials; butt straps and pipe joints; utility locates and potholes; easement staking and marking; pipeline marking tape; tracer wire and associated lead boxes; crossing and protection of existing underground and overhead utilities; protection, support, relocation or replacement of existing utilities, culverts and storm sewers; temporary access provisions; additional temporary construction fencing or barriers not covered under payment for "Site Preparation and Erosion Control" or "Traffic Control"; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	LS	Payment shall be made at the Unit Price listed in the Bid Form after the connection is completed, successfully tested, and backfilled, as approved by the Owner's Construction Manager.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
36	Remove and Replace Precast Concrete Irrigation Ditch, 18-inch Wide x 24-inch Deep	Includes all costs for furnishing and handling all required labor, equipment, and materials for removal and replacement of the precast concrete irrigation ditch. The Unit Price includes any demolition required prior to excavation; trenching; lay-back and/or benching; trench boxes/shoring; cleaning of remaining/existing pipe; bedding, embedment, backfilling and compaction; disposal of excess excavated material offsite; control of surface water; jointing materials; utility locates and potholes; easement staking and marking; protection, support, relocation or replacement of existing utilities, culverts and storm sewers; temporary access provisions; additional temporary construction fencing or barriers not covered under payment for "Site Preparation and Erosion Control" or "Traffic Control"; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents.	LF	Payment shall be made at the Unit Price listed in the Bid Form and measured for payment, after installation, based on the horizontal length replaced as determined by field measurements along centerline. Areas disturbed outside the construction limits shown on the Contract Drawings are considered a subsidiary obligation of the contractor to restore, and no additional payment will be made.
37	Engineers Field Office	Includes all costs for furnishing and handling, all required labor, equipment, and materials for provision of the Engineers Field Office at the site. Unit cost includes building facilities; furnishings and furniture; temporary utilities; security; safety specialties; parking; maintenance; electronics; consumables; clearing, grubbing, and site preparation required to provide and maintain an occupiable office facility as described in the Project Specifications.	MO	Payment shall be made at the Unit Price listed in the Bid Form per calendar month or part thereof, starting on the first day of the calendar month.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
38	Allowance for Reconstruction of Disturbed Concrete Cutoff Wall at Larimer County Canal – If Found	This allowance will cover the necessary labor and materials to reconstruct the disturbed concrete cutoff wall at the Larimer County Canal if it is located or damaged by construction activities. This allowance covers labor, equipment, and materials used in the repair that are over and above the labor, materials, and equipment used being measured and paid under all other bid items.	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.
39	Allowance for Drain Tile Replacement	This allowance will cover the necessary labor and materials to replace any encountered drain tile systems that are encountered by excavation on this project. This allowance covers labor, equipment, and materials used in the repair or replacement required to return the system to existing or better than existing condition. This allowance only covers costs that are over and above the labor, materials, and equipment required for baseline restoration required and paid under "Site Restoration and Revegetation" and "Allowance for Unknown Utilities".	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
40	Allowance for Unknown Utilities	This allowance will cover the necessary labor and materials to repair, replace, and/or relocate any encountered utilities that are unknown and not shown on the Contract Drawings. This allowance covers labor, equipment, and materials used in the repair, replacement, or relocation in order to restore the utility service in accordance with the requirements of the utility owner and any associated permit requirements. This allowance will also cover furnishing and installation of casing pipes depicted on Sheet 01C109 if so requested by Owner.	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.
41	Allowance for Contaminated or Unsuitable Soils (Including Asbestos)	This allowance will cover the necessary labor and materials to remove, isolate, treat, haul, dispose, and replace any contaminated or unsuitable soils that are encountered during the course of construction in accordance with federal, state, and local regulations and the requirements of the Project's Material Management Plan.	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
42	Allowance for General Surface Restoration Directed by Owner	This allowance will cover the necessary labor and materials to conduct surface restoration activities as directed by the Owner. This allowance only covers costs that are over and above the labor, materials, and equipment required for baseline restoration required and paid under "Site Restoration and Revegetation".	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.
43	Allowance for Prairie Dog Relocation	This allowance will cover the necessary labor and materials to conduct any prairie dog relocation activities as directed by the Owner or Owner's Environmental Consultant.	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.

Item No.	Item	General Description	Unit of Measurement	Method of Payment
44	Allowance for Haul Road Maintenance	This allowance will cover the necessary labor and materials to conduct any maintenance activities that are indicated to be necessary by Larimer County or the Owner's Construction Manager in order to maintain the haul roads from excessive or premature degradation resulting from construction activities. This allowance only covers costs that are over and above the labor, materials, and equipment required for baseline restoration required and paid under "Site Restoration and Revegetation".	ALLOW	Payment shall be made on an allowance basis at the Actual Field Cost with documentation submitted and approved by Owner's Construction Manager in accordance with the Allowance Administration Procedures described in Section 1.5 of this Specification.

ALTERNATIVE BID PAY ITEMS

Item No.	Item	General Description	Method of Payment
BID ALTERNATIVE 1: LARIMER COUNTY CANAL (LCC) CASING FOR FUTURE NORTHERN INTEGRATED SUPPLY PROJECT PIPELINE			
1	Steel Casing Pipe Installed Via Open Cut – 54-inch	Includes all costs for furnishing and handling, all required labor, equipment, and materials for pipe manufacture, transportation of materials, layout, and installation of casing pipe. The Unit Price includes any additional demolition required prior to excavation; trenching; lay-back and/or benching; trench boxes/shoring; bedding, embedment, backfilling and compaction; CLSM encasement of the casing pipe; disposal of excess excavated material offsite; pipe including linings, coatings, specials, welding, and incidentals; additional temporary construction fencing or barriers. This cost is for materials, labor, and equipment required for a second, parallel steel casing pipe to the Base Bid “Steel Casing Pipe Installed Via Open Cut – 54-inch” to cover additional impacts of construction not covered under payment for that item.	Payment shall be made at the Unit Price listed in the Bid Form based on installed and completed work. The length of the casing pipe shall be measured for payment, after installation, as determined by the pipeline installation surveys, with all stations carefully measured. The measurement of the length of casing pipe shall begin and end at the respective ends of the casing pipe
2	Larimer County Canal Restoration	Includes all costs for furnishing and handling, all required labor, equipment, and materials for work associated with restoration of the crossing. The Unit Price includes transportation and placement of materials; sub-grade preparation; clay liner and native soil replacement; bank backfilling and compaction; and canal invert shaping and fine grading; and all other appurtenant work not otherwise stipulated to be paid for separately to complete the work as specified or detailed by the Contract Documents. This cost is for materials, labor, and equipment required that are over and above the Base Bid Larimer County Canal Restoration that are directly related to the installation of the parallel steel casing pipe.	Payment shall be made at the Unit Price listed on the Bid Form as a lump sum payment at the completion of the crossing and acceptance of crossing by Owner’s Construction Manager.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for the following types of conferences and meetings required during the Work:
 - a. Requirements applicable to all conferences.
 - b. Preconstruction conference(s).
 - c. Construction progress conferences.
 - d. Closeout conference(s).
 - e. Other construction conferences.

B. Scope:

1. This Section addresses the types of conferences indicated in Paragraph 1.1.A of this Section.
2. Requirements for coordination meetings, including meetings between Contractor and its Subcontractors and Suppliers, as well as meetings between Contractor and contractor's on other projects at or adjacent to the Site, are in these Contract Documents.
3. Requirements for monthly schedule meetings are in Section 01 32 16 - Construction Progress Schedule.
4. Requirements for pre-installation conferences, if any, are in the Specifications of Divisions 02-49.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 32 16 - Construction Progress Schedule.

1.2 REQUIREMENTS APPLICABLE TO ALL CONSTRUCTION CONFERENCES

A. Requirements of this Article apply to all conferences required under this Section.

B. Participants:

1. Lead participant for each participating entity of each conference shall be authorized to represent their employer and its interests on the Project, and shall be sufficiently familiar with the status of their employer's work, services, and activities related to the Project for purposes of the associated conference.
2. Required participants for each type of conference are indicated elsewhere in this Section.
3. Failure to participate by required participants:
 - a. Should a required participant be unavailable for a required conference, inform the designated conference chair not less than one day prior to start of the subject conference. Furnish both oral (either in person or via telephone) and written communication regarding planned non-attendance. Expressly indicate the authorized substitute person who will be empowered to represent that entity at the conference.
 - b. Should Contractor fail to attend without proper, advance notice to conference chair or furnish ill-prepared or unauthorized substitute lead participant, Contractor shall bear full responsibility, including cost- and time-related impacts, for lack of coordination, progress, and other, potentially adverse effects.
4. Conduct:
 - a. Conference participants shall, at all times, exhibit appropriate, professional conduct and demeanor.

- b. Inappropriate conduct, including shouting, unprofessional language, threatening attitudes, or other types of insult or intimidation are unacceptable.
 - c. Conference chair has the authority to eject from a conference, participants exhibiting inappropriate conduct.
 - d. Persons exhibiting repeated or habitual inappropriate conduct will not be allowed to participate in conferences. Such person's employer and the contracting party they represent shall bear full responsibility for consequences of actions by its employees and representatives.
5. Replacement:
- a. If an attendee is ejected or barred from attendance at future conferences, Contractor shall provide a replacement attendee for all impacted conferences. Compensation for cost- or time-related impacts of providing a replacement attendee will not be provided.

C. Agenda:

- 1. Each conference required by this Section shall have an established, written agenda available to required attendees not less than one day prior to the subject conference, unless extenuating circumstances dictate a shorter time period.
- 2. Unless written agenda specific to a given conference is issued in writing, the default agenda shall be in accordance with this Section.
- 3. If a person or entity intending to participate in a required conference desires that such conference should address a given topic not already part of the typical agenda indicated in this Section, a written request for such topic to be added to the agenda must be received by the conference chair not later than two days prior to the scheduled start of such conference.
- 4. The agenda may be amended at the outset of the conference, at the sole discretion of the conference chair. Thereafter, the conference will be conducted, and topics discussed will be in accordance with the established agenda, as may be modified in accordance with this paragraph.

D. Conference Date, Time, and Location:

- 1. Date, start time, anticipated duration, and location of each required conference will be established by conference chair, unless otherwise indicated in the Contract Documents.
- 2. Conference chair will advise, in writing, required participants of conference date, start time, anticipated duration, and location. Such information may be transmitted as part of an agenda. Upon mutual agreement of required participants, date, start time, anticipated duration, and location of recurring conferences, such as construction progress conferences, may be initially established at the outset of the series and, therefore, do not require written advisory for each individual conference.
- 3. Change of Conference Date, Time, or Location:
 - a. In general, required conferences will be held on the date, at the time, and at the location required.
 - b. Designated conference chair may, at their sole discretion, elect to change the conference date, start time, duration, location, or any combination thereof. Such change, if any, shall be communicated in writing to all required conference participants, and others as appropriate. Contractor is responsible for communicating changes to its Subcontractors and Suppliers.
 - c. Notice of such change shall be communicated not later than one day prior to scheduled start of the subject conference. Such changes may be communicated by distributing a written agenda for the subject conference, expressly indicating changes from previous arrangements.
 - d. When changes in date, time, or location are necessary less than the period indicated in the paragraph immediately above, such changes shall be communicated orally, whether in-person or via telephone. When communicated via telephone, calls shall be made to all of the participant's designated telephone numbers on file with the conference chair.

Persons intending to participate in such conference are encouraged to check their voicemail and written communications prior to departing for the conference.

E. Minutes:

1. For each conference required in this Section, the conference chair will be responsible for preparing and distributing a written record ("minutes") of the conference proceedings, unless expressly indicated otherwise for a specified type of conference.
2. Purpose of minutes is to furnish a written record of the following for the associated conference: participants (indicating whether each individual participated in-person, virtually, arrived late, or departed early), topics discussed, questions asked and answered, and decisions made, and other pertinent matters as indicated on the established agenda for the associated conference. Minutes are not intended as a transcript or as complete record of minutia discussed at the associated conference.
3. Distribution of Minutes:
 - a. Minutes will be distributed promptly after the associated conference.
 - b. Minutes will be distributed to all conference participants, personnel invited to or required to attend the conference but who did not attend or participate, and others as appropriate.
4. Amendment of Minutes:
 - a. Minutes distributed by, or on behalf of, the conference chair are subject to comments and potential amendments by other attendees of the subject conference. The period for commenting on, or requesting amendments to, minutes is limited to 7 days following initial distribution of the minutes, unless indicated otherwise elsewhere in the Contract Documents.
 - b. Comments or requests for amendments may be furnished at the next, subsequent meeting in the same series of conferences. For example, comments on minutes of a construction progress conference may be presented at the next, subsequent construction progress conference. Comments on the minutes of the preconstruction conference may be presented at the first construction progress conference unless the designated time limit for requesting amendments has elapsed prior to the first progress conference.
 - c. Minutes may be amended either by issuing revised minutes for the subject conference or by appropriate indication in the minutes of the next, subsequent conference in the same series, at the sole discretion of the conference chair.
 - d. Conference chair has sole authority to accept or reject comments or requests for amendments on previously issued minutes.
 - e. In general, requests, by persons who participated in the subject conference, for amendments to minutes will be given greater consideration by conference chair than request for amendments received from persons who did not participate in the subject conference.
 - f. Should a person or entity believe the final minutes do not accurately reflect their opinion of how events transpired at the subject conference, such person or entity may prepare and submit appropriate correspondence presenting their viewpoint.

1.3 PRECONSTRUCTION CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Preconstruction Conferences - General:
 1. Purpose of preconstruction conference is reviewing administrative and procedural requirements, site mobilization matters, coordination with utility owners, coordination with authorities having jurisdiction, and related matters. Required agenda, unless otherwise amended by conference chair, is indicated in this Article.
 2. Conference Chair: Owner's Construction Manager
 3. Location, Date, and Time:

- a. Preconstruction conference will be held following the Effective Date of the Contract on a day, at a time, and at a location to be established by Owner's Construction Manager following consultation with principal representatives of Owner, Engineer, Contractor, and other required participants. Preconstruction conference will be held prior to commencement of the Work at the Site.
 - b. Anticipated duration of preconstruction conference is two hours, followed by time necessary for visiting the Site.
 - c. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
 - 4. Required Participants:
 - a. Owner: Project manager
 - b. Owner's Construction Manager
 - c. Contractor: Project manager and site superintendent.
 - d. Engineer: Project manager or delegate.
 - e. Larimer County
 - 5. Required participants may invite to the preconstruction conference others they deem necessary or appropriate.
 - 6. Designation of Authorized Representatives:
 - a. Either prior to or at the preconstruction conference, Owner and Contractor each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individuals shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.
- C. Agenda:
- 1. Procedural and Administrative:
 - a. Personnel and Teams:
 - 1) Designation of roles and personnel.
 - 2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
 - 3) Subcontractors and Suppliers in attendance.
 - 4) Authorities having jurisdiction.
 - b. Procedures for communications and correspondence, including electronic communication protocols.
 - c. Copies of the Contract Documents and availability.
 - d. The Work and Scheduling:
 - 1) General scope of the Work.
 - 2) Contract Times, including Milestones (if any).
 - 3) Phasing and sequencing.
 - 4) Preliminary Progress Schedule.
 - 5) Critical path activities.
 - e. Safety and Protection:
 - 1) Responsibility for safety.
 - 2) Contractor's safety representative.
 - 3) Emergency procedures and accident reporting.
 - 4) Emergency contact information.
 - 5) Hazardous materials communication program.
 - 6) Impact of the construction on public safety.
 - 7) Responsibilities for protection of property.

- f. Review of insurance requirements and insurance claim procedures.
- g. Coordination:
 - 1) Coordination of Subcontractors and Suppliers.
 - 2) Construction coordinator (for projects with multiple prime construction contracts and locations where multiple projects may be underway simultaneously in reasonable proximity to each other).
 - 3) Coordination with Owner's operations.
 - 4) Construction progress conferences – schedule and frequency.
 - 5) Coordination conferences with other, separate projects.
- h. Submittals:
 - 1) Current Critical Submittals:
 - a) Preliminary schedules – Progress Schedule, Schedule of Submittals, Schedule of Values.
 - b) Preconstruction photographic documentation.
 - c) List of proposed Subcontractors and Suppliers
 - d) List of emergency contact information.
 - e) Notice of elements of Contractor's safety program with which Owner, Owner's Construction Manager, and Engineer are to comply.
 - f) Evaluation of need for SPCC plan required under Section 01 57 05 – Temporary Controls.
 - g) Traffic control plan required under Section 01 55 26 - Traffic Control.
 - h) Form of Contractor's site superintendent's daily reports.
 - 2) Work is ineligible for payment without approved or accepted Submittals (as applicable).
 - 3) Submittal procedures.
 - a) Compliance with accepted Schedule of Submittals.
 - b) Actions required of Contractor prior to furnishing Shop Drawings and other Submittals.
 - c) Contractor's Submittal approval stamp required; Contractor's coordination of Submittals.
 - d) Furnishing of Submittals.
 - e) Submittal types and meaning of Engineer's action on each.
 - f) Resubmittals—responsibility for, limitations on quantity.
 - 4) Identification of initial, critical Shop Drawings and product data.
 - 5) Construction photographic documentation.
- i. Substitutes and "Or-Equals":
 - 1) Product options.
 - 2) Procedures for proposing "or-equals".
 - 3) Procedures for proposing substitutes.
- j. Contract Modification Procedures:
 - 1) Requests for interpretation.
 - 2) Written clarifications.
 - 3) Field Orders.
 - 4) Proposal Requests.
 - 5) Change Proposals.
 - 6) Work Change Directives.
 - 7) Change Orders.

- 8) Differing site conditions or discovery of unanticipated Hazardous Environmental Condition.
- 9) Substantiating and documenting Change Proposals and Claims.
- 10) Claims.
- k. Progress Payment:
 - 1) Owner's Project financing and funding, as applicable.
 - 2) Owner's tax-exempt status.
 - 3) Preliminary Schedule of Values
 - 4) Procedures for measuring for payment (Unit Price Work).
 - 5) Retainage.
 - 6) Progress payment procedures; documents to accompany Applications for Payment.
 - 7) Payment for stored items not yet installed.
 - 8) Date of Owner's payments; payment is due.
- l. Subcontractors and Suppliers:
 - 1) List of proposed Subcontractors and Suppliers; monthly updates.
 - 2) Coordination and management.
 - 3) Subcontracts and purchase orders.
- m. Testing and inspections:
 - 1) Owner-hired and contractor-hired.
 - 2) Identification of Owner-hired testing entity and special inspectors.
 - 3) Responsibility for advising testing entity and special inspectors of need for services.
 - 4) Results of code-required special inspections and tests.
 - 5) Prompt remedy of apparent defects.
 - 6) Notices of defective Work.
 - 7) Remedy of defective Work.
 - 8) Defective Work is ineligible for payment.
 - 9) Covering up defective Work.
 - 10) Cost responsibility for defective Work and retesting/re-inspection.
- n. Disposal of demolition and spoil materials.
- o. Record documents.
- p. Preliminary discussion of Contract closeout:
 - 1) Procedures for Substantial Completion.
 - 2) Partial utilization procedures; property insurance.
 - 3) Contract closeout requirements.
 - 4) Correction period; duration of Contractor's general warranty and guarantee.
 - 5) Duration of bonds and insurance.
- 2. Authorities Having Jurisdiction (if not covered in a separate conference):
 - a. Municipal licenses.
 - b. Municipal permits required.
 - 1) Permits required and status.
 - 2) Inspections for building code official.
 - 3) Code-required special inspections and tests (if not covered in Administrative and Procedures part of conference).
 - c. Right-of-way work permits; status of occupancy permit(s).
 - d. Environmental permits:
 - 1) Storm water discharges during construction.

- 2) Erosion and sediment control permit.
- 3) Spill prevention control and countermeasures plan (40 CFR 112).
- 4) Earthmoving permit and dust control.
3. Site Mobilization (if not covered in a separate conference):
 - a. Working days, working hours, and overtime.
 - b. Use of Site and other areas; use of existing facilities.
 - c. Field offices, storage trailers, and staging areas.
 - d. Temporary facilities.
 - e. Temporary utilities and limitations on utility use (where applicable).
 - f. Utility company coordination (if not done as a separate conference).
 - g. Access to Site, access roads, and parking for construction vehicles.
 - h. Traffic controls.
 - i. Temporary security; temporary security fencing (where required).
 - j. Storage of materials and equipment to be incorporated into the Work.
 - k. Protection of the Work and property; protective barriers.
 - l. Field engineering:
 - 1) Reference points and benchmarks.
 - 2) Surveys and layouts.
 - 3) Professional services for Contractor's means and methods (not delegated design).
 - 4) Contractor's site superintendent's daily records and submittal requirements.
 - m. Site maintenance during the Project:
 - 1) Progress cleaning; removal of trash and debris.
 - 2) Maintenance and cleaning of existing access roads and parking areas.
 - n. Restoration.
4. Next conference.
5. Site visit, as necessary.

1.4 CONSTRUCTION PROGRESS CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Construction Progress Conferences - General:
 1. Purpose of construction progress conferences is to review and summarize Work performed since the previous construction progress conference; review and summarize planned progress through the next, subsequent construction progress conference; review and summarize compliance with the Progress Schedule; review progress and necessary actions on pending and critical administrative items; discuss matters pertinent to the Site and construction quality; and other matters.
 2. Conference Chair: Owner's Construction Manager
 3. Location, Date, and Time:
 - a. Construction progress conferences will be held at a location to be determined by Owner's Construction Manager..
 - b. Frequency: construction progress conferences will be held once per week. Such conferences are in addition to other recurring conferences that may be required elsewhere in the Contract Documents.
 - c. Construction progress conferences will be held following preconstruction conference on a day and at a time to be established by Owner's Construction Manager, following consultation with principal representatives of Owner, Engineer, Contractor, and other required participants. Timing on which construction progress conferences will commence will be at the discretion of the designated chair of construction progress conferences.

- d. Construction progress conferences required by this Section are separate from schedule meetings required in Section 01 32 16 - Construction Progress Schedule.
 - e. Anticipated duration of each construction progress conference is ninety minutes.
 - f. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
 - 4. Required Participants:
 - a. Owner: Project manager
 - b. Owner's Construction Manager.
 - c. Contractor: Project manager, site superintendent, and safety representative.
 - d. Principal Subcontractors: Project manager or site superintendent, for Subcontractors performing significant Work since the previous conference and that will perform significant Work prior to the next, subsequent construction progress conference. When Subcontractor's site superintendent represents Subcontractor at construction progress conferences, site superintendent shall be authorized and informed of administrative matters relating to Subcontractor's Work in accordance with Article 1.2 of this Section.
 - e. Engineer: Project manager or delegate.
 - 5. Required participants may invite to construction progress conferences others they deem necessary or appropriate. Larimer County and other governing authorities may attend as required by Larimer County 1041 Permit Condition of Approval #41.
- C. Handouts:
- 1. Contractor shall bring to each construction progress conference paper copies of each of the following:
 - a. List of Work accomplished since the previous construction progress conference and list of construction activities planned through the next, subsequent construction progress conference. Coordinate list of planned activities with both the updated Progress Schedule and look-ahead schedule.
 - b. Up-to-date Progress Schedule, in accordance with Section 01 32 16 - Construction Progress Schedule.
 - c. Up-to-date Schedule of Submittals, in accordance with Section 01 33 00 - Submittal Procedures.
 - d. "Look-ahead" schedule, in accordance with Section 01 32 16 - Construction Progress Schedule.
 - e. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.
- D. Preliminary Agenda for Construction Progress Conferences:
- 1. Review of progress since the previous progress conference.
 - 2. Planned progress through next progress conference.
 - 3. Overview of Progress Schedule:
 - a. Review of the Contract Times; Contractor's ability to comply with Contract Times.
 - b. Identification of critical path activities.
 - c. Schedules for fabrication and delivery of materials and equipment.
 - d. Corrective measures, if necessary, including recovery schedule(s).
 - 4. Submittals:
 - a. Review status of critical Submittals.
 - b. Review revisions to Schedule of Submittals.
 - 5. Contract Modifications:
 - a. Requests for interpretation.
 - b. Written clarifications.
 - c. Field Orders.

- d. Proposal Requests.
- e. Change Proposals.
- f. Work Change Directives.
- g. Change Orders.
- h. Claims.
- 6. Progress Payment Requests:
 - a. Status and deadline for submittal.
 - b. Stored materials and equipment; observation by Owner's Construction Manager; documents required.
 - c. Set-offs to which Owner is entitled (as applicable).
 - d. Other matters related to progress payments.
- 7. Problems, conflicts, and observations.
- 8. Quality standards, testing, and inspections.
- 9. Coordination between Project participants.
- 10. Site management issues, including vehicular access and parking, traffic control, security, status of temporary controls and temporary utilities, site maintenance and cleaning, and other Site matters.
- 11. Safety and protection.
- 12. Permits and compliance.
- 13. Construction photographic documentation.
- 14. Record documents status.
- 15. Completion matters (as appropriate):
 - a. Status of checkout, startup, field quality control activities.
 - b. Status of training of facility O&M personnel and O&M manuals.
 - c. Partial utilization; requesting and scheduling inspection for Substantial Completion.
 - d. Punch list status (as applicable).
 - e. Other closeout matters (if any).
- 16. Other business.

1.5 CLOSEOUT CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Closeout Conferences – General.
 - 1. Scheduling: No less than 60 days prior to the contractual Substantial Completion date, Contractor shall initiate Closeout Conferences, to be held separately from Construction Progress Conferences.
 - 2. Purpose of closeout conferences is to familiarize participants with administrative and procedural requirements for Substantial Completion (including partial utilization by Owner) and readiness for final payment, and status of the Work required for achieving Substantial Completion and readiness for final payment.
 - 3. Conference Chair: Same as indicated elsewhere in this Section for construction progress conferences.
 - 4. Location, Date, and Time:
 - a. Closeout Conferences will be held at a time and location to be determined by Owner's Construction Manager.
 - b. Frequency: Construction Closeout Conferences will be held bi-weekly.
 - 5. Required Participants: Same as required participants for construction progress conferences, unless otherwise indicated by conference chair.
- C. Preliminary Agenda for Closeout Conferences:

1. Same as "Completion matters" portion of preliminary agenda for construction progress conferences as indicated elsewhere in this Section.
2. Checkout and startup planning meeting, in accordance with Section 01 75 00 - Checkout and Startup Procedures.
3. Additional closeout related topics as determined by closeout conference chair.

1.6 PROPERTY OWNER REQUIREMENT (POR) CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Property Owner Requirement (POR) Conferences – General.
 1. Purpose of POR Conferences is to discuss upcoming milestones and deadlines related to commencing TCEs, providing crossing notifications, permits, access, landowner agreements, landowner requirements, and review progress.
 2. Conference Chair: Same as indicated elsewhere in this Section for construction progress conferences.
 3. Location, Date, and Time:
 - a. POR Conferences will be held at a time and location to be determined by Owner's Construction Manager.
 - b. Frequency: Construction Closeout Conferences will be held bi-weekly.
 4. Required Participants:
 - a. Owner: Project manager
 - b. Owner's Construction Manager
 - c. Contractor: Project manager, site superintendent, and Permit Manager or other party familiar with permit and project requirements, schedule, and the authority to direct work.
 - d. Principal Subcontractors: Project manager or site superintendent
- C. Preliminary Agenda for POR Conferences:
 1. Upcoming milestones and activities
 2. Upcoming parcels and crossings
 3. Notification requirements for upcoming work and schedule for notifications
 4. Landowner requirements
 5. Progress on completed parcels and crossings

1.7 OTHER CONSTRUCTION CONFERENCES

- A. The requirements of Article 1.2 of this Section also apply to this Article.
- B. Other Construction Conferences – General.
 1. The following Other Construction Conferences shall be planned for and attended by Contractor:
 - a. Preinstallation Conferences. When required by individual Specification sections, and when directed by the Owner's Construction Manager before commencing a major or quality-critical feature of Work (such as pipe installation, field welding, coating and lining, trenchless crossings, and tie-ins), the Contractor shall convene a preinstallation conference at the Site. The Contractor shall require attendance of entities directly affecting, or affected by, that Work; shall notify the Owner's Construction Manager ten working days in advance of the meeting date; and shall provide a suggested agenda addressing conditions of installation, preparation and installation or application procedures, and coordination with related Work. A preinstallation conference may be combined with the preparatory-phase meeting required by the CQC sections for the same feature of Work.
 - b. Pre-Construction Conference with Larimer County Sheriff's Office – single occurrence.
 - c. Pre-Construction Conference with Poudre Fire Authority – single occurrence.

- d. Pre-construction Property Owner Meetings – one occurrence per impacted parcel.
 - e. Post-construction Property Owner Meetings – one occurrence per impacted parcel.
 - f. Larimer County 1041 Compliance - Internal – single occurrence to occur within one week after Construction Notice to Proceed to discuss submittals required for compliance and for submission to Larimer County for approval of the Development Permit.
 - g. Larimer County 1041 Compliance – Larimer County – single occurrence to occur within three weeks after Construction Notice to Proceed to discuss submittals required for compliance and for submission to Larimer County for approval of the Development Permit.
- 2. Other construction conferences may be scheduled and held as deemed necessary by Owner, Owner's Construction Manager or Engineer. Such conferences may be focused on specific matters, such as discussing remedies and schedules for defective Work, negotiating changes in the Contract Price and Contract Times, or other matters related to the Project where time limits prevent addressing such items as part of other conferences addressed elsewhere in the Contract Documents.
 - 3. Conference Chair: Owner's Construction Manager or delegate.
 - 4. Location, Date, and Time:
 - a. Location: Same as location of construction progress conferences as indicated elsewhere in this Section, unless location is changed in accordance with Article 1.2 of this Section.
 - b. Other construction conferences will be held on a day and at a time to be established by Owner's Construction Manager, following consultation with principal representatives of Owner, Contractor, and other required participants.
 - c. Each other construction conference is one hour, plus time that may be necessary for visiting the Site when conference purpose warrants.
 - d. Location, date, and time will be established in accordance with requirements of Article 1.2 of this Section.
 - 5. Required Participants: As deemed necessary by conference chair.
- C. Agenda: Agenda presenting topics to be discussed at each other construction conference will be developed by the conference chair and distributed to required participants, and others as appropriate, in accordance with Article 1.2 of this Section.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Administrative and procedural requirements for Contractor's construction Progress Schedules and related Submittals, including:
 - a. Administrative requirements regarding progress Schedules.
 - b. Qualifications of Progress Schedule preparer and related personnel.
 - c. Submittals of Progress Schedules and associated schedule-related Submittals.
 - d. Initial Progress Schedules.
 - e. Look-ahead schedules.
 - f. Progress Schedule updates.
 - g. Narrative reports.
 - h. Time impact analyses.
 - i. Recovery schedules.

B. Scope:

1. Contractor shall prepare and submit to Owner's Construction Manager required Progress Schedules and related Submittals, as required by this Section and elsewhere in the Contract Documents. Maintain and update Progress Schedules and related Submittals throughout the Project.
2. Owner, Owner's Construction Manager, Engineer, and others involved with the Project have the right to rely on accuracy of Contractor-prepared Progress Schedule.
3. Owner's Construction Manager's review or acceptance of the Progress Schedule or related Submittals, and Owner's Construction Manager's comments on and expressed opinions concerning activities in the Progress Schedule and related Submittals, and progress of the Work, does not control Contractor's independent judgment concerning construction means, methods, techniques, sequences and procedures, unless the associated means, method, technique, sequence, or procedure is required by the Contract Documents. Contractor is solely responsible for complying with the Contract Times.

C. Related Requirements: Include, but are not necessarily limited to:

1. Section 01 11 00 - Summary of Work.
2. Section 01 31 19 - Project Meetings.

1.2 REFERENCES.

A. Defined Terms and Terminology:

1. Defined terms, indicated with initial capital letters, are indicated in the General Conditions, as may be modified by the Supplementary Conditions.
2. Terminology: The following are not defined terms and are not indicated with initial capital letters but, when used in this Section, have the meaning indicated below, whether applied to the singular or plural thereof.
 - a. "Activity" is an element of the Work that has the following specific characteristics: consumes time, requires resources, has a definable start and finish, is assignable, and is measurable.
 - b. "Baseline Progress Schedule" means, in addition to the General Conditions' definition of "Progress Schedule", the version of the Progress Schedule (for the entire Project) initially accepted by the Owner's Construction Manager. In the event of subsequent

modifications to the Project, Contractor and Owner's Construction Manager may mutually agree that a subsequent revision of the Progress Schedule constitutes a new baseline Progress Schedule that supersedes the prior baseline Progress Schedule.

- c. "Constraint" means an imposed date on the Progress Schedule or an imposed time between activities. The Contract Times are constraints.
- d. "CPM Progress Schedule" means, in addition to the General Conditions' definition of "CPM Schedule", a computerized Progress Schedule in critical path method (CPM) format, for the entire Work, indicating interrelationships between elements of the Work; indicates sequences, dates, and durations for Work performed to date; indicates sequences, dates, and duration for incomplete Work yet to be performed; indicates constraints; and indicates the critical path for the Work.
- e. "Critical path" is the continuous chain of activities, from start to completion of the Work, with the longest duration for completion within the Contract Times.
- f. "Early finish" means the earliest date an activity can finish according to the assigned relationships among the activities in the Progress Schedule.
- g. "Early start" means the earliest possible date an activity can start according to the assigned relationships among activities in the Progress Schedule.
- h. "Float" means the time difference between the calculated duration of an activity chain on the Progress Schedule and the critical path.
- i. "Late finish" means the latest date an activity on the Progress Schedule can finish without extending the Contract Times.
- j. "Late start" means the latest date an activity on the Progress Schedule can start without extending the Contract Times.
- k. "Network diagram" means a time-scaled logic diagram showing the durations and relationships of the activities on the Progress Schedule.
- l. "Schedule date" (and similar terms, whether used in this Section or Project communications related to Progress Schedules) mean the "early start" and "early finish" date for the associated activity. "Late start" and "late finish" dates are for determining float and do not represent the schedule dates.
- m. "Total float" means the total number of days an activity (or chain of activities) on the Progress Schedule can be delayed without affecting the Contract Times.
- n. "Work areas" and "work system" means a logical breakdown of the Work elements or a group of activities which, when collectively assembled, are readily identifiable on the Project (for example: yard piping, a structure or building, a treatment process, or other logical grouping).
- o. "Working days" means a period of twenty-four (24) hours, measured from midnight to the next midnight, excluding Saturday, Sunday, and holidays observed by the Owner.

1.3 ADMINISTRATIVE REQUIREMENTS

A. General Provisions on Progress Schedules:

- 1. This Section augments requirements for the Progress Schedule, and Contractor's control of the Work, indicated in the General Conditions, as may be augmented by the Supplementary Conditions..

B. Use of Float:

- 1. Float belongs to the Project and may be used by Contractor or Owner to accommodate changes in the Work, or to mitigate the effect of events delaying the Work or compliance with the Contract Times.
- 2. Changes or delays that influence activities that have float and do not extend the critical path do not justify changes in the Contract Times.
- 3. Float Suppression: Pursuant to float sharing requirements of this Section, use of float suppression techniques in Progress Schedules, such as preferential sequencing logic, special lead/lag logic restraints, and extended activity durations are unacceptable.

C. Factors Affecting the Progress Schedule:

1. In preparing and updating the Progress Schedule, take into consideration: preparing and signing subcontracts and purchase orders, complying with Submittal requirements and Submittal review times, fabricating materials and equipment, source quality control (including required shop tests and inspections), shipping and deliveries, field quality control (including required field tests and inspections at the Site), Work by Subcontractors, coordination with others (such as other contractors including those indicated in Section 01 11 00 – Summary of Work, utility owners, and owners of transportation facilities), compliance with Laws and Regulations and permits, availability of construction equipment and machinery, abilities of workers, weather conditions, condition of the Site, seasonal restrictions, restrictions in operations at the Site and coordination with Owner's (or facility manager's) operations, training of facility operation and maintenance personnel, checkout, startup, adjusting and balancing, and other factors that have the potential to affect completion of the Work within the Contract Times.

D. Scheduling Workshop Conferences:

1. Prior to preparing the preliminary Progress Schedule, Contractor shall participate with Owner's Construction Manager, Engineer and Owner in one workshop conference, up to two hours in duration, to discuss technical requirements relative to sequencing and organizing the Work, Progress Schedule development, and Progress Schedule procedures.
2. Contractor and Owner's Construction Manager will mutually agree on the date, time, and location of scheduling workshop conference(s).
3. Required Attendees:
 - a. Contractor's project manager, site superintendent, and Progress Schedule preparer.
 - b. Engineer.
 - c. Owner.
 - d. Owner's Construction Manager.
4. Owner's Construction Manager will prepare minutes of the scheduling workshop conferences and distribute minutes to conference attendees and others as deemed appropriate by Owner's Construction Manager.

E. Weather:

1. Activity durations in the Progress Schedule shall include the time reasonably anticipated for normal weather conditions, including seasonal inclement weather. Adjustments of the Contract Times for weather are governed by the General Conditions and the schedule provisions of the Contract Documents. These Specifications provide no separate weather-day allowance.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Progress Schedule Preparer.
 - a. Contractor shall retain services of a scheduling consultant to, or shall self-perform, preparation and updating of the Progress Schedule using qualified personnel experienced in: (1) construction scheduling, (2) the scheduling software required for the Project, and (3) serving as Progress Schedule preparer on construction projects of similar type, size, and complexity as the Project.
 - b. Progress Schedule preparer shall have not less than five years' experience using the required schedule software on construction projects of similar type, size, and complexity as the Project.
 - c. Prior to engaging a scheduling consultant or using a qualified, experienced employee, submit to Owner's Construction Manager the following qualifications information:
 - 1) Name, employer, and business address of proposed Progress Schedule preparer and names, employer(s), and business address(es) of personnel who will be assigned to assist the preparer in developing and updating the Progress Schedule.

- 2) Information sufficient to demonstrate that proposed Progress Schedule preparer and scheduling assistant personnel possess qualifications complying with this Section. For each person assigned, submit list of similar type, size, complexity, and construction contract amount for each project, together with project name, owner, location, and dates, and name(s) of scheduling personnel involved.
- d. Owner's Construction Manager's Review of Qualifications:
 - 1) Owner's Construction Manager will complete review of Progress Schedule preparer qualifications within seven days of Owner's Construction Manager's receipt of such qualifications.
 - 2) If qualifications are unacceptable, submit qualifications of acceptable personnel within five days of Contractor's receipt of Owner's Construction Manager's non-acceptance.
 - 3) Owner's Construction Manager's acceptance or non-acceptance of qualifications does not reduce or mitigate Contractor's obligations under the Contract Documents.
- e. If Contractor intends to replace any Progress Schedule preparer personnel previously acceptable to Owner's Construction Manager, submit qualifications of proposed replacement(s) in accordance with this Article.

1.5 SUBMITTALS

- A. Informational Submittals: Submit the following:
 1. Qualifications Statements:
 - a. Submit qualifications of Progress Schedule preparer, and other personnel that will assist Progress Schedule preparer in preparing and updating the Progress Schedule.
 - b. Obtain Owner's Construction Manager's acceptance of qualifications prior to starting preparation of preliminary Progress Schedule.
 2. Proposed Phasing and Sequencing Plan
 - a. Submit within six weeks of Construction Notice to Proceed.
 3. Planned Work Schedule:
 - a. Submit initial and updated (as necessary) planned work schedule, in accordance with this Section's "Progress Schedule" Article.
 4. Progress Schedule:
 - a. Preliminary Progress Schedule with associated narrative report.
 - b. Acceptable Progress Schedule ("baseline Progress Schedule") with associated narrative report.
 5. Look-Ahead Schedules:
 - a. Submit minimum 3-week look-ahead schedule at each construction progress meeting, in accordance with this Section's "Look-Ahead Schedules" Article.
 6. Progress Schedule Updates:
 - a. Progress Schedule updates shall comply with requirements of this Section, and shall include updated Progress Schedule and narrative report.
 - b. Submit updated Progress Schedule with each application for payment.
 7. Time Impact Analyses: Submit in accordance with this Section.
 8. Recovery Schedules: Submit in accordance with this Section.

1.6 INITIAL PROGRESS SCHEDULES

- A. Applicability of this Article:
 1. This Article addresses the initial Progress Schedules and selected, related Submittals required at the outset of the Project's construction phase, through Owner's Construction Manager's acceptance of the Progress Schedule and its related Submittals.

2. Subsequent Progress Schedule Submittals, including Progress Schedule updates, recovery schedules, and other schedule-related Submittals, shall comply with software, type, organization, content, and similar requirements of this Article.
- B. Type and Organization of Progress Schedules:
1. Prepare Progress Schedules using software approved by Owner.
 2. Sheet Size: 11 by 17 inches, unless otherwise accepted by Owner's Construction Manager.
 3. Time Scale: Indicate first date of each work week.
 4. Activity Assignments and Designations:
 - a. Limit activities, where possible, excluding fabrication of materials and equipment, to durations not longer than 20 days. Activities shall be definable and measurable. For example, an activity described only as "Concrete" will likely be unacceptable.
 - b. Assign to each activity an appropriate, unique numerical designation and description.
 - c. Numerical designation shall incorporate the associated Specifications section number.
 - d. Activity description shall include sufficient detail to clearly communicate the intended activity. Descriptions shall include identifiers for physical locations of work area or work system, such as (where appropriate): column lines, stationing (for linear projects), and elevations. Indicate unique description for each activity.
 - e. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
 - f. Group construction into work area sub-schedules (that are part of the Progress Schedule) by activity.
 - g. Clearly indicate, as activities separate from installation, necessary and required curing periods.
 5. Organization of Progress Schedules:
 - a. Indicate interfaces and dependencies with preceding, concurrent, and follow-on activities, including those associated with the Work, other contractors at the Site, Owner and facility manager, Owner's consultants (including Owner's Construction Manager and Engineer), authorities having jurisdiction, and others as appropriate. Clearly indicate activities not under Contractor's control.
 - b. Progress Schedules shall be CPM Progress Schedules.
 - c. Indicate on the separate Schedule of Submittals dates for submitting and reviewing Shop Drawings, product data Submittals, Samples, and other required Submittals. Coordinate Progress Schedule with the Schedule of Submittals.
 - d. Clearly indicate the critical path on the Progress Schedule.
- C. Planned Work Schedule:
1. Within 30 days of the Effective Date of the Contract, indicate to Owner's Construction Manager the work days and hours proposed by Contractor. Also indicate planned non-work days, such as Contractor's holidays, weekends, and the like.
 2. Enforce Subcontractors' and Suppliers' (when at the Site) compliance with Contractor's work schedule submitted to Owner's Construction Manager.
 3. In the event of changes, submit to Owner's Construction Manager revised work schedule. Furnish such Submittal not less than fourteen days prior to changing Contractor's work schedule, except in event of unanticipated emergency.
 4. Account for the working hour constraints as indicated in Section 01 14 34 – Construction and Schedule Constraints.
- D. Preliminary Progress Schedule:
1. Within 30 days after the Contract Times commence running, Contractor shall submit to Owner's Construction Manager the preliminary Progress Schedule covering the entire

Project, with associated schedule-related Submittals required in this Section's "Submittals" Article.

2. Submit preliminary Progress Schedule in accordance with Section 01 33 00 - Submittal Procedures. Also submit preliminary Progress Schedule in its native (executable) format generated by the scheduling software.
3. Owner's Construction Manager will perform timely review of the preliminary Progress Schedule.
4. Preliminary Progress Schedule shall comply with the Contract Documents relative to Progress Schedules.

E. Initial Acceptance of Progress Schedule:

1. Not less than 10 days before submission of the first Application for Payment, a scheduling conference attended by Contractor, Progress Schedule preparer, Owner's Construction Manager, Engineer, and others as appropriate will be held at to review for acceptability to Owner's Construction Manager the preliminary Progress Schedule and associated schedule-related Submittals. Following the scheduling conference, Contractor shall have five days to make corrections and adjustments and to complete and resubmit the Progress Schedule and associated schedule-related Submittals. Contractor will not be eligible for first progress payment until acceptable Progress Schedule and associated schedule-related Submittals are submitted to Owner's Construction Manager and are acceptable to Owner's Construction Manager.
2. Submit acceptable Progress Schedule, together with associated schedule-related Submittals in accordance with this Section's "Submittals" Article and Section 01 33 00 - Submittal Procedures. Also submit acceptable form of Progress Schedule in its native (executable) format generated by the scheduling software.
3. The Progress Schedule will be acceptable to Owner's Construction Manager if it provides an orderly progression of the Work to completion within the Contract Times, in accordance with the Contract Documents.
4. Initially-accepted Progress Schedule shall be identified as the baseline Progress Schedule.

F. Planned Completion Different from the Contract Times:

1. If the Progress Schedule accepted by Owner's Construction Manager indicates completion date(s) different than the Contract Times, the Contract Times are not thereby changed.
2. In the event the Progress Schedule accepted by Owner's Construction Manager indicates one or more early completion dates and the Contract Times have not been reduced, Owner may, at Owner's option, use available float without Owner being liable for Contractor's costs to remain onsite, mobilized, and working (whether on the original scope of the Work or for modified Work) beyond the scheduled early completion date(s), as long as the Work will be completed within the Contract Times.
3. When the Work will not be completed within the Contract Times, the Contract Documents' provisions concerning delays and changes in the Contract Times govern.

1.7 LOOK-AHEAD SCHEDULES

A. Look-Ahead Schedules – General:

1. Look-ahead schedules are short-duration, often more-detailed, time-based schedules for the Work to be performed during the coming month or other required span of the look-ahead schedule.
2. Purpose of look-ahead schedules is to present, for Project stakeholders, including Owner, Owner's Construction Manager, Engineer, Owner-hired testing and inspection entities, other contractors working at or adjacent to the Site, utility owners, transportation facility owners, and others as necessary, Contractor's detailed, time-based plan for performing the Work during the period covered by the timespan of the look-ahead schedule.
3. This Section's "Submittals" Article indicates the required span and frequency of look-ahead schedules.

4. Each look-ahead schedule shall be fully coordinated and consistent with the current Progress Schedule update.
5. Submit look-ahead schedules concurrent with construction progress meetings.
6. As handouts, bring to each construction progress meeting paper copies of the new look-ahead schedule. Furnish quantity equal to typical number of attendees of progress meetings.

B. Organization and Content of Look-Ahead Schedules:

1. Look-ahead schedules shall be prepared from the current Progress Schedule update, of the same type, using the same software, content, and organization required in this Section for initial Progress Schedules.
2. Activity designations on look-ahead schedules shall incorporate the associated activity designations from the Progress Schedule.
3. Sheet Size: Format look-ahead schedules to sheet size of 11 inches by 17 inches, unless other sheet size is acceptable to Owner's Construction Manager.
4. Look-ahead schedules should generally be more-detailed than the Progress Schedule. Activity durations on look-ahead schedules should not exceed five days.

1.8 PROGRESS SCHEDULE UPDATES

A. Updates – General:

1. Schedule Updates are required with Application for Payment in accordance with the CPM Schedule Update provisions of the General Conditions.

B. Monthly Schedule Meeting:

1. During the month, utilizing the previous month's look-ahead schedule. Contractor shall record the percent complete, start and finish dates of each scheduled activity with the remaining duration for each activity started but not completed, including activities associated with procurement of materials and equipment.
2. On the same day each month, not less than one week prior to submittal of Application for Payment, Contractor, Progress Schedule preparer, Owner's Construction Manager, Engineer, Owner, and others as appropriate shall meet at the Site to tour the Work to review and recommend updates to the Progress Schedule and progress information gathered by Contractor during the month. After discussion of Contractor's current progress information and attendees' review of the current status of the Work, Progress Schedule preparer shall appropriately and accurately update the Progress Schedule.

1.9 NARRATIVE REPORTS

A. Narrative Reports – General:

1. Prepare and include with the preliminary Progress Schedule Submittal and each subsequent Progress Schedule Submittal, written narrative report describing the schedule-related constraints required by the Contract Documents and Contractor's plan and schedule for complying with such requirements. Narrative reports shall also include required content indicated above in this Section's "Progress Schedule Updates" Article.
2. Narrative report shall describe the methods of sequencing and operation, resources to be employed, time frames for the construction of each of the major work area or work system on the Project, and time frames for complying with the Contract Times and Contractor's interim schedule milestones.
3. Prepare narrative reports on Contractor's company letterhead and clearly indicate the Progress Schedule revision and date associated with the narrative report.
4. Narrative reports shall be written in English and typed. Use clear, concise, complete, and accurate language in narrative reports. Clearly indicate in narrative report the name of person preparing the narrative report and date of preparation.
5. Narrative report Submittals do not constitute contractual Change Proposals, nor are they notice of a Claim.

6. Owner's Construction Manager's receipt, review, and acceptance of narrative reports does not mitigate or reduce Contractor's obligations to furnish contractually required notices.

1.10 TIME IMPACT ANALYSIS

A. Time Impact Analyses – General:

1. Prepare and submit time impact analysis when one or more of the following occurs: (a) Change Proposal is prepared; (b) Work Change Directive is issued that will affect the Progress Schedule; or (c) when delays occur.
2. Time impact analysis shall illustrate influence of each Change Order, Work Change Directive, allowance authorization, or delay, as applicable, on Contractor's ability to comply with the Contract Times and Progress Schedule constraints.
3. In performing time impact analysis, use Progress Schedule having revision date closest to and prior to the event giving rise to the delay or other change in the Work.
4. Indicate in time impact analysis activities on the Project's critical path prior to the event giving rise to the delay or other Change in the Work; activities added, extended, or deleted as a result of the delay or change in the Work; and impact of such changes on the Project's critical path activities.
5. Indicate in time impact analysis activities not within Contractor's control.
6. Time impact analysis shall demonstrate the time impact, based on date the Change Order, Work Change Directive, or allowance authorization was given to Contractor or, as applicable, date the delay started to occur; the status of the Work at that time; and activity duration of affected activities. Activity duration used in time impact analysis shall be those included in most recent Progress Schedule update accepted by Owner's Construction Manager, closest to start of the delay or start of the Change Order, Work Change Directive, or allowance authorization as adjusted by mutual, written agreement of the parties and Owner's Construction Manager.
7. Timing of Time Impact Analysis:
 - a. Submit time impact analysis with Change Proposal, in accordance contract modification procedures in the Special Conditions.
 - b. When time impact analysis is not part of a Change Proposal, submit each time impact analysis within 15 days after the following, as applicable:
 - 1) Start of the delay.
 - 2) After Contractor's receipt of Work Change Directive.
 - c. When Contractor does not submit time impact analysis for a specific change or delay, within the specified period for such submittal, such non-submittal will indicate extension of the Contract Times is not needed.

B. Evaluation by Owner's Construction Manager and Acceptance:

1. Owner's Construction Manager's evaluation of each time impact analysis comprised of complete information will be completed in timely manner (in accordance with the Contract Documents) after Owner's Construction Manager's receipt.
2. When time impact analysis is incomplete or otherwise inappropriate, Owner's Construction Manager will furnish comments to Contractor. When time impact analysis is complete and apparently appropriate, its acceptability will be indicated by associated Contract modification or allowance authorization.
3. Changes in the Contract Times will be made only by Change Order.
4. When mutual agreement is reached between the parties on effect of the change or delay in the Project, incorporate into the next Progress Schedule update the associated fragments illustrating the influence of changes and delays.

1.11 RECOVERY SCHEDULES

A. Recovery Schedules – General:

1. Recovery schedules shall be in accordance with the General Conditions.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 DEFINITIONS

- A. Action Submittal: Written and graphic information submitted by Contractor that requires Engineer's approval.
- B. Deferred Submittal: Information submitted by Contractor for portions of design that are to be submitted to permitting agency for approval prior to installation of that portion of the Work, along with Engineer's review documentation that submittal has been found to be in general conformance with Project's design.
- C. Informational Submittal: Information submitted by Contractor that requires Owner's Construction Manager or Engineer's review and determination that submitted information is in accordance with the Conditions of the Contract.

1.2 PROCEDURES

- A. Electronic Submittals: Submittals shall, unless specifically accepted, be made in electronic format.
 - 1. Each submittal shall be an electronic file in Adobe Acrobat Portable Document Format (PDF). Use the latest version available at time of execution of the Agreement.
 - 2. Electronic files that contain more than 10 pages in PDF format shall contain internal bookmarking from an index page to major sections of the document.
 - 3. PDF files shall be set to open "Bookmarks and Page" view.
 - 4. Add general information to each PDF file, including title, subject, author, and keywords.
 - 5. PDF files shall be set up to print legibly at 8.5-inch by 11-inch,
 - 6. 11-inch by 17-inch, or 22-inch by 34-inch. No other paper sizes will be accepted.
 - 7. Submit new electronic files for each resubmittal.
 - 8. Include a copy of the Transmittal of Contractor's Submittal form, located at end of section, with each electronic file.
 - 9. Owner's Construction Manager will reject submittal that is not electronically submitted, unless specifically accepted.
 - 10. Provide Owner's Construction Manager with authorization to reproduce and distribute each file as many times as necessary for Project documentation.
 - 11. Electronic submittals will be submitted in Procore Construction Management Software as described in Section 01 35 13 – Special Project Procedures. Detailed procedures for handling electronic submittals will be discussed at the preconstruction conference.
- B. Transmittal of Submittal:
 - 1. Contractor shall:
 - a. Review each submittal and check for compliance with Contract Documents.
 - b. Stamp each submittal with uniform approval stamp before submitting to Owner's Construction Manager.

- 1) Stamp to include Project name, submittal number, Specification number, Contractor's reviewer name, date of Contractor's approval, and statement certifying submittal has been reviewed, checked, and approved for compliance with Contract Documents.
 - 2) Owner's Construction Manager will not have Engineer review submittals that do not bear Contractor's approval stamp and will return them without action.
2. Complete, sign, and transmit with each submittal package, one Transmittal of Contractor's Submittal in format approved by Owner's Construction Manager.
 3. Identify each submittal with the following:
 - a. Numbering and Tracking System:
 - 1) Sequentially number each submittal.
 - 2) Resubmission of submittal shall have original number with sequential alphabetic suffix.
 - b. Specification section and paragraph to which submittal applies.
 - c. Project title and Owner's project number.
 - d. Date of transmittal.
 - e. Names of Contractor, Subcontractor or Supplier, and manufacturer as appropriate.
 4. Identify and describe each deviation or variation from Contract Documents.
- C. Format:
1. Do not base Shop Drawings on reproductions of Contract Documents.
 2. Package submittal information by individual specification section. Do not combine different specification sections together in submittal package, unless otherwise directed in specification.
 3. Present in a clear and thorough manner and in sufficient detail to show kind, size, arrangement, and function of components, materials, and devices, and compliance with Contract Documents.
 4. Index with labeled tab dividers in orderly manner.
- D. Timeliness: Schedule and submit in accordance with Schedule of Submittals and requirements of individual specification sections.
- E. Processing Time:
1. Time for review shall commence on Owner's Construction Manager's receipt of submittal.
 2. Owner's Construction Manager will act upon Contractor's submittal and transmit to Engineer within two (2) business days of receipt from Contractor. Response to Contractor will be within 14 days for routine submittals, 21 days for major equipment, or a longer review timeline for specifically identified critical or complex submittals as approved by the Owner's Construction Manager.
 3. Submittals that are not submitted in accordance with the dates established in Schedule of Submittals are subject to 7 additional days of processing time.
 4. Resubmittals will be subject to same review time.
 5. No adjustment of Contract Times or Price will be allowed as a result of delays in progress of Work caused by rejection and subsequent resubmittals.
- F. Jurisdictional Compliance Submittals: Submit all documentation that is provided to jurisdictional authorities that are required for compliance with Contractor-held permits.
- G. Resubmittals: Clearly identify each correction or change made.
- H. Incomplete Submittals:
1. Owner's Construction Manager will return entire submittal for Contractor's revision if preliminary review deems it incomplete.
 2. When any of the following are missing, submittal will be deemed incomplete:

- a. Contractor's review stamp; completed and signed.
 - b. Transmittal of Contractor's Submittal; completed and signed.
 - c. Insufficient number of copies.
- I. Submittals not required by Contract Documents:
- 1. Will not be reviewed and will be returned stamped "Not Subject to Review."
 - 2. Owner's Construction Manager will keep one copy and return submittal to Contractor.

1.3 ACTION SUBMITTALS

- A. Prepare and submit Action Submittals required by individual specification sections.
- B. Shop Drawings:
- 1. Copies: Submit in digital .pdf format.
 - 2. Identify and Indicate:
 - a. Applicable Contract Drawing and Detail number, products, units and assemblies, and system or equipment identification or tag numbers.
 - b. Equipment and Component Title: Identical to title shown on Drawings.
 - c. Critical field dimensions and relationships to other critical features of Work. Note dimensions established by field measurement.
 - d. Project-specific information drawn accurately to scale.
 - 3. Manufacturer's standard schematic drawings and diagrams as follows:
 - a. Modify to delete information that is not applicable to the Work.
 - b. Supplement standard information to provide information specifically applicable to the Work.
 - 4. Product Data: Provide as specified in individual specifications.
 - 5. Deferred Submittal: See Drawings for list of deferred submittals.
 - a. Contractor-design drawings and product data related to permanent construction.
 - 1) Written and graphic information.
 - 2) Drawings.
 - 3) Cut sheets.
 - 4) Data sheets.
 - 5) Action item submittals requested in individual specification section.
 - b. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit required supporting data and drawings for review and acceptance by Engineer. Documentation of review and approval provided on Engineer's comment form, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
 - 6. Foreign Manufacturers: When proposed, include names and addresses of at least two companies that maintain technical service representatives close to Project.
- C. Samples:
- 1. Copies: Two, unless otherwise specified in individual specifications.
 - 2. Preparation: Mount, display, or package Samples in manner specified to facilitate review of quality. Attach label on unexposed side that includes the following:
 - a. Manufacturer name.
 - b. Model number.
 - c. Material.

- d. Sample source.
- 3. Manufacturer's Color Chart: Units or sections of units showing full range of colors, textures, and patterns available.
- 4. Full-size Samples:
 - a. Size as indicated in individual specification section.
 - b. Prepared from same materials to be used for the Work.
 - c. Cured and finished in manner specified.
 - d. Physically identical with product proposed for use.
- D. Action Submittal Dispositions: Engineer will review, comment, stamp, and return to Owner's Construction Manager to distribute as noted:
 - 1. Approved:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal.
 - b. Distribution: Electronic.
 - 2. Approved as Noted:
 - a. Contractor may incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - b. Distribution: Electronic
 - 3. Partial Approval, Resubmit as Noted:
 - a. Make corrections or obtain missing portions, and resubmit.
 - b. Except for portions indicated, Contractor may begin to incorporate product(s) or implement Work covered by submittal, in accordance with Engineer's notations.
 - c. Distribution: Electronic
 - 4. Revise and Resubmit:
 - a. Contractor may not incorporate product(s) or implement Work covered by submittal.
 - b. Distribution: Electronic.

1.4 INFORMATIONAL SUBMITTALS

- A. General:
 - 1. Copies: Submit electronic copies, unless otherwise indicated in individual specification section.
 - 2. Refer to individual specification sections for specific submittal requirements.
 - 3. Engineer will review each submittal. If submittal meets conditions of the Contract, Engineer will forward to Owner's Construction Manager for distribution to appropriate parties. If Engineer determines submittal does not meet conditions of the Contract and is therefore considered unacceptable, Engineer will notify Owner's Construction Manager who will provide comments to Contractor and require that the submittal be corrected and resubmitted.
- B. Certificates:
 - 1. General:
 - a. Provide notarized statement that includes signature of entity responsible for preparing certification.
 - b. Signed by officer or other individual authorized to sign documents on behalf of that entity.
 - 2. Welding: In accordance with individual specification sections.
 - 3. Installer: Prepare written statements on manufacturer's letterhead certifying installer complies with requirements as specified in individual specification section.

4. Material Test: Prepared by qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.
 5. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in individual specification sections.
 6. Manufacturer's Certificate of Compliance: In accordance with Section 01 61 00 - Common Product Requirements.
- C. Construction Photographs and Video: As required to document pre- and post-construction conditions and construction progress and in accordance with Section 01 33 50 - Site Conditions Surveys.
- D. Closeout Submittals: As required to provide complete record of construction.
- E. Contractor-design Data (related to temporary construction):
1. Written and graphic information.
 2. List of assumptions.
 3. List of performance and design criteria.
 4. Summary of loads or load diagram, if applicable.
 5. Calculations.
 6. List of applicable codes and regulations.
 7. Name and version of software.
 8. Information requested in individual specification section.
- F. Deferred Submittals: See Drawings for list of deferred submittals.
1. Contractor-design data related to permanent construction:
 - a. List of assumptions.
 - b. List of performance and design criteria.
 - c. Summary of loads or load diagram, if applicable.
 - d. Calculations.
 - e. List of applicable codes and regulations.
 - f. Name and version of design software.
 - g. Factory test results.
 - h. Informational submittals requested in individual specification section.
 2. Prior to installation of indicated structural or nonstructural element, equipment, distribution system, or component or its anchorage, submit calculations and test results of Contractor-designed components for review by Engineer. Documentation of review and indication of compliance with general design intent and project criteria provided on Engineer's comment form as meets conditions of the Contract, along with completed submittal, shall be filed with permitting agency by Contractor and approved by permitting agency prior to installation.
- G. Manufacturer's Instructions: Written or published information that documents manufacturer's recommendations, guidelines, and procedures in accordance with individual specification section.
- H. Operation and Maintenance Data: Provide complete O&M data.
- I. Payment:
1. Application for Payment: In accordance with General Conditions – Progress Payments.
 2. Schedule of Values: In accordance with General Conditions – Progress Payments.
 3. Schedule of Estimated Progress Payments: In accordance with Special Conditions – Contractor's Schedule of Work.

- J. Quality Control Documentation: As required in Section 01 45 16.13, Contractor Quality Control.
- K. Schedules:
1. Schedule of Submittals: Prepare separately or in combination with Progress Schedule as specified in Special Conditions – Contractor's Schedule of Work.
 - a. Show for each, at a minimum, the following:
 - 1) Specification section number.
 - 2) Identification by numbering and tracking system as specified under Paragraph Transmittal of Submittal.
 - 3) Estimated date of submission, including reviewing and processing time.
 - b. On a monthly basis, submit updated Schedule of Submittals to Owner's Construction Manager if changes have occurred or resubmittals are required.
 2. Progress Schedules: In accordance with Special Conditions – Contractor's Schedule of Work.
- L. Special Guarantee: Supplier's written guarantee as required in individual specification sections.
- M. Statement of Qualification: Evidence of qualification, certification, or registration as required in Contract Documents to verify qualifications of professional land surveyor, engineer, materials testing laboratory, specialty Subcontractor, trade, Specialist, consultant, installer, and other professionals.
- N. Submittals Required by Laws, Regulations, and Governing Agencies:
1. Promptly submit notifications, reports, certifications, payrolls, and otherwise as may be required, directly to the applicable federal, state, or local governing agency or their representative.
 2. Transmit to Owner's Construction Manager for Owner's records one copy of correspondence and transmittals (to include enclosures and attachments) between Contractor and governing agency.
- O. Test, Evaluation, and Inspection Reports:
1. General: Shall contain signature of person responsible for test or report.
 2. Factory:
 - a. Identification of product and specification section, type of inspection or test with referenced standard or code.
 - b. Date of test, Project title and number, and name and signature of authorized person.
 - c. Test results.
 - d. If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
 - e. Provide interpretation of test results, when requested.
 - f. Other items as identified in individual specification sections.
 3. Field:
 - a. As a minimum, include the following:
 - 1) Project title and number.
 - 2) Date and time.
 - 3) Record of temperature and weather conditions.
 - 4) Identification of product and specification section.
 - 5) Type and location of test, Sample, or inspection, including referenced standard or code.
 - 6) Date issued, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.

- 7) If test or inspection deems material or equipment not in compliance with Contract Documents, identify corrective action necessary to bring into compliance.
- 8) Provide interpretation of test results, when requested by Engineer.
- 9) Other items as identified in individual specification sections.

P. Testing and Startup Data: In accordance with applicable specifications.

Q. Training Data: In accordance with applicable specifications. Jurisdictional Compliance Submittals:

1. Copies of all documentation submitted to jurisdictional agencies.

1.5 SUBSTITUTIONS

- A. Substitution and or-equal requests, including requests involving pipe materials, linings, and coatings, are governed by the General Conditions, the applicable technical Specification sections, and the bidding requirements. The administrative submittal procedures of this Section do not authorize substitutions, and processing of a submittal does not constitute approval of a substitution.

1.6 SUPPLEMENTS

- A. The supplements listed below, following "End of Section", are part of this specification.

1. Forms: Transmittal of Contractor's Submittal.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL

(ATTACH TO EACH SUBMITTAL)

DATE: _____

FROM: _____ Contractor		Submittal No.: _____	
		☐ New Submittal ☐ Resubmittal	
		Project: _____	
		Project No.: _____	
		Specification Section No.: _____	
		(Cover only one section with each transmittal)	
		Schedule Date of Submittal: _____	
SUBMITTAL TYPE:		☐ Shop Drawing	☐ Sample
		☐ Deferred	☐ Informational

The following items are hereby submitted:

Number of Copies	Description of Item Submitted (Type, Size, Model Number, Etc.)	Spec. and Para. No.	Drawing or Brochure Number	Contains Variation to Contract	
				No	Yes

Contractor hereby certifies that (i) Contractor has complied with the requirements of Contract Documents in preparation, review, and submission of designated Submittal and (ii) the Submittal is complete and in accordance with the Contract Documents and requirements of laws and regulations and governing agencies.

By: _____
Contractor (Authorized Signature)

SECTION 01 33 50

SITE CONDITIONS SURVEYS AND CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Pre-Construction, Progress, and Post-Construction Photos, Videos, and Survey
 - a. Videographic and Photographic Surveys
 - b. Utility Locating and Engineering Survey
 - c. Topographic Surveys

B. Scope:

1. Contractor shall provide and maintain materials, equipment, labor, services, and temporary construction as necessary and required to record pre-, post-, and in progress construction conditions at the Site and adjacent areas during construction.
2. Perform photography (i.e., still photography and video) and submit construction photographic documentation, in accordance with this Section, throughout the Work.
3. Perform locating and survey of existing utilities and submit documentation, in accordance with this Section, throughout the Work.
4. Perform topographic, line, and grade surveys and submit documentation, in accordance with this Section, throughout the Work.

C. Related Requirements:

1. Include, but are not necessarily limited to, the following:
 - a. Section 01 33 51 – Project Record Documents
 - b. Section 01 50 10 – Protection of Existing Facilities
 - c. Section 01 57 05 – Temporary Controls

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate survey and photographic activities with progress of the Work. Unless otherwise required by the Contract Documents, do not cover or conceal the Work until construction documentation has been properly obtained.

1.3 QUALITY ASSURANCE

A. Qualifications:

1. Construction Photographer
 - a. Pre and post-construction video surveys shall be conducted by a professional commercial videographer, experienced in shooting construction videos.
 - b. Minimum of 3 years experience in video pre-construction surveys.
 - c. Use the same photographer for the entire Project. Do not replace photographer without notifying Owner's Construction Manager and submitting qualifications of the proposed new photographer. Owner's Construction Manager may reject the qualifications of a proposed photographer.
2. Land Surveyor
 - a. Professional land surveyor shall be licensed in the State of Colorado and experienced in performing field measurements and topographic surveys.

B. Photographic Equipment:

1. Picture quality and definition shall be to the satisfaction of the City of Thornton Project Manager. Video or photographic equipment that fails to produce satisfactory image quality shall be removed.

1.4 SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.
- B. Action Submittals:
 1. Qualifications of video survey subcontractor.
 2. Documentation of survey plan including route: survey schedule and the method of documentation.
 3. Digital photos, videos, and logs of first day's site conditions surveys.
 4. Potholing Reports
 - a. The complete Potholing Report shall be submitted to the Engineer and accepted, with no exceptions taken, before the Contractor may submit pipe Shop Drawings. The pothole report shall identify the underground points of connection, pipes, conduits, and facilities, including bedding material, and presents the dimensions, diameter, elevation of the top and the bottom of the utility, type, condition, station and location of each pipe, conduit or facility with reference to finish surface elevations.
 - b. In order to allow for timely advancement of shop drawings and pipe fabrication, Potholing Reports and subsequent associated shop drawing submittal may be segmented and submitted in phases, clearly marked from starting station to ending station, at Contractors discretion.
 5. Post-construction topographic mapping within 60 days of completing Work on any individual location indicated in this Specification. Submit electronic files CAD Civil3D format.
- C. Informational Submittals:
 1. Larimer County pre-construction site survey: A copy of the digital video surveys specific to the water line installation corridor in and near the existing Larimer County Right of Way within 6 weeks of Construction Notice to Proceed. As required by Larimer County 1041 Permit Condition of Approval #32.
 - a. Documentation shall reference the Larimer County 1041 Permit Condition of Approval #32.
 2. Pre-construction site condition information: A copy of the digital video surveys, photographs, and narrative logs of the pre-construction conditions at least 7 calendar days prior to the commencement of any construction activities within the area of the survey.
 3. Pre-construction topographic mapping at least 7 calendar days prior to the commencement of any construction activities within the area of the survey indicated within this Specification. Submit electronic files CAD Civil3D format.
 4. Construction progress photographs, submit monthly.
 5. Digital files of all post-construction photographs within 14 calendar days of completing the Work in any area.
 6. Larimer County post-construction site survey: A copy of the digital video surveys specific to the water line installation corridor in and near the existing Larimer County Right of Way within 14 days of completion of restoration activities.
 - 7.

1.5 NOTIFICATION

- A. Notify City of Thornton Project Manager, Owner, and property owners, as appropriate, a minimum of 7 calendar days prior to the anticipated commencement of site conditions surveys in any one area and 24 hours in advance of actual start.

1.6 CONSTRUCTION PHOTOGRAPHY – GENERAL

- A. Images - General:

1. Photographic documentation shall be in color.
2. Photographic images shall be suitably staged and set up ("framed"), focused, and have adequate lighting to illuminate the Work and conditions that are the subject of the photograph.
3. For still photographs and video, use digital camera equipment with resolution of not less than 16.0-megapixels.
4. Do not imprint date and time in the image.

B. Photographic Electronic Documents:

1. For each still photograph submitted, furnish high-quality, high-resolution digital image in JPEG (".jpg") file format compatible with Microsoft Windows 10 and higher operating systems.
2. GPS geo-tagging enabled and recorded with each image.
3. Each photograph shall be minimum resolution of 756 by 504 pixels and 24 bit, millions of colors, .jpeg format file size 2MB. Each electronic file of a photograph shall be titled with the date and brief description of the view; for example: "2019-10-25 - Blower Building South Façade.jpg". Save copy of Electronic Documents of photographic documentation in a Procore directory for Contractor's photographic images. Each time photographs are obtained, save the associated Electronic Documents files in a new subdirectory named for the date and basic subject of the photographs. For example, "2024-06-30 – Site Work" and "2024-03-21 – New Control Room".

C. Video:

1. Video shall be high-definition (HD), high-quality video of the Site and Project work.
2. Submit all video files for the entire Project as Electronic Documents in a single type of container file. Electronic Document video files shall be in one of the following container file types:
 - a. ".mp4" (MPEG-4 Part 14).
 - b. ".wmv" (Windows Media Video).
3. Minimum resolution: 1080p
4. Video image shall include imprinted date and time the video was taken.
5. Include audio track narration, in American-English, sufficient to explain the scenes shown.
6. Electronic Document video filename shall indicate date video was taken and shall describe the video; do not submit filenames automatically created by camera. For example, acceptable Electronic Document video filenames are, "2023-07-24 – Site Work" or "2024-09-29 – Primary Clarifiers".

D. Narrative Log

1. Maintain an ongoing written narrative log of each video tape including:
 - a. Name of owner.
 - b. Title of Project including Schedule of Work.
 - c. Inclusive dates of video.
 - d. General location(s) of video.
 - e. Detail description of contents including location, date, and special features and observations.

1.7 ENGINEERING SURVEYS AND TOPOGRAPHIC MAPPING

A. General Requirements:

1. All pre- and post-construction topographic mapping and other data, including spot elevations, shall be prepared, signed and sealed by a Professional Land Surveyor registered in Colorado.
2. Accuracy of survey shall be not less than 0.01-foot.

B. Topographic Mapping:

1. Topographic mapping shall be developed using the Project coordinates and shall be referenced to the Project base lines and benchmarks.
2. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of one-inch = 40-feet horizontal and 1-foot contour intervals as required for National Map Accuracy Standards.
3. Electronic mapping files shall be 3 dimensional.
4. Submit point lists for topographic surveys in ASCII text file format.
5. Site mapping to document site conditions shall be submitted as an electronic map (drawing) in CAD Civil 3D.

C. Utility Mapping

1. Following location of buried utilities and improvements by excavation methods, conduct pre-construction survey of existing buried utilities and improvements or any portion thereof that will be encountered during execution of the Work.
 - a. Record horizontal coordinates (X,Y), elevation (Z), diameter or size of utility and materials of construction at a minimum of 2 locations bisecting new buried piping or improvements in the vicinity of existing utilities or improvements.
 - b. The electronic mapping files shall be produced using field survey techniques with sufficient accuracy for reproduction and use as base maps at a scale of one-inch = 40-feet horizontal and 1-foot contour intervals as required for National Map Accuracy Standards.
 - c. Site mapping to document utility locations shall be submitted as an electronic map (drawing) in CAD Civil 3D.
 - d. Submit point lists for utility mapping surveys in ASCII text file format.
2. Field Report: The surveying field report(s) shall be submitted with the Potholing Report. Any variation in the actual elevations and the elevations indicated on the Project Drawings shall be clearly marked in the Potholing Report and brought to Owner's Construction Manager's attention.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PRE- AND POST-CONSTRUCTION SITE CONDITION DOCUMENTATION SURVEY

- A. Conduct thorough pre- and post-construction site condition visual documentation surveys of the entire Project. Site conditions observations shall be documented by written logs and video recordings, supplemented by photographs.
- B. Pre- and post-construction site condition observations and documentation intended to be used to help resolve damage claims. Such documentation shall be used as indisputable evidence in ascertaining whether and to what extent damage occurred as a result of Contractor's operations, and is for the protection of the adjacent property owners, Contractor, and Owner.
- C. A separate, specific pre- and post-construction video specific to the water line installation corridor in and near the existing Larimer County Right of Way shall be completed and submitted for permit compliance.
- D. Continuous color audio digital video and photographs shall be recorded along the entire route of the proposed pipeline corridor, associated working areas including crossed private driveways or roads, temporary and permanent easements, and all Larimer County roads used for construction traffic. This documentation will be provided to Larimer County.
- E. After the Effective Date of the Agreement and before Work at site is started on a particular area of Work and again within 10 days following date of Substantial Completion, Contractor, City of Thornton Project Manager, and affected property owners and utility owners shall make a

thorough examination of pre-existing and post-construction conditions including existing buildings, structures, and other improvements in vicinity of Work.

- F. In the case of pre-construction recording, no Work shall begin in the area prior to City of Thornton Project Manager's review and approval of content and quality of photo and video for that area.
- G. Periodic re-examination and post-construction site condition documentation survey shall be jointly performed to include, but not limited to, cracks in structures, settlement, leakage, and similar conditions.
- H. Particular emphasis shall be directed to physical condition of the following:
 - 1. Existing vegetation, fencing, buildings, and other structures, and pavement within the pipeline alignment and adjacent areas.
 - 2. Creek crossings.
 - 3. Access roads used to transport material or equipment to and from the Project site.
 - 4. Any facilities or roads utilized by Contractor that are outside of the designated Work area, including all Larimer County Roads used for construction traffic.
 - 5. All Work areas, including, but not limited to, actual Work sites, materials processing and stockpiling areas, access corridors, disposal areas, temporary and permanent easements, and staging areas.
 - 6. Existing structures within 40 feet of an excavation and 150 feet of dewatering.
 - 7. Landscaping and property owner features and improvements.
 - 8. Work adjacent to or involving connection to existing facilities.
 - 9. Any work completed by other contractors at the site that will be impacted or otherwise affected by the Contractor's Work.
 - 10. Other as selected by the City of Thornton Project Manager.
- I. Submit audio, video, and photographic documentation survey of pre-construction site condition documentation at least 7 calendar days prior to the start of construction in any area.
- J. Complete and submit post-construction documentation surveys of within 14 calendar days after completing in any areas.
- K. Photograph the same locations with views in the same direction for both pre- and post-construction photographs.
- L. Provide narrative description of any special site features, observations and conditions.

3.2 CONSTRUCTION PROGRESS PHOTOGRAPHS

- A. Photographically demonstrate progress of construction showing every aspect of site and adjacent properties as well as interior and exterior of new or impacted structures, and utility crossings and relocations. Provide a minimum of 40 photographs each month showing the progress of the Work.
- B. Conduct Progress Photography throughout the duration of active work in any given area.
- C. Particular emphasis shall be directed to physical condition of the following through construction activities:
 - 1. Existing vegetation, fencing, buildings, and other structures, and pavement within the pipeline alignment and adjacent areas.
 - 2. Creek crossings.
 - 3. Access roads used to transport material or equipment to and from the Project site.
 - 4. Any facilities or roads utilized by Contractor that are outside of the designated Work area, including all Larimer County Roads used for construction traffic.
 - 5. All Work areas, including, but not limited to, actual Work sites, materials processing and stockpiling areas, access corridors, disposal areas, temporary and permanent easements, and staging areas.

6. Existing structures within 40 feet of an excavation and 150 feet of dewatering.
7. Landscaping and property owner features and improvements.
8. Work adjacent to or involving connection to existing facilities.
9. Any work completed by other contractors at the site that will be impacted or otherwise affected by the Contractor's Work.
10. Other as selected by the City of Thornton Project Manager.

3.3 TOPOGRAPHIC SURVEYS

- A. Topographic mapping shall be developed for fill and embankment areas using the Project coordinates, shall be referenced to the Project base lines and benchmarks, and shall be adequate to ascertain post-construction conditions (including elevations) of all areas within and extending to 50-feet beyond the FEMA 100-year flood plain in all directions. All work shall be conducted in designated work areas.
- B. Transmit electronic survey information for each area of fill no less than 30 days prior to final stabilization or restoration activities.

3.4 UTILITY LOCATING AND SURVEY

- A. Location/Potholing: Contractor shall clearly paint all affected underground pipes, conduits and other utilities on the pavement or identify the location with suitable markers if not on pavement. In addition to the locations of metallic pipes and conduits, non-metallic pipes, ducts and conduits, if present, shall also be similarly located using surface indicators and detection tape and shall then be similarly marked. After the utility survey is completed the Contractor shall commence "potholing" to determine the actual location and elevation of all underground utilities, piping, conduit, structures and facilities where crossings, interferences, or connections to the new pipelines or other facilities (the Work) are shown in the Contract Documents, marked by the utility companies, or indicated by surface signs or other surface markers or indications, including but not limited to visible facilities such as manholes, meter boxes, junction boxes, pull boxes, curb markings, valves, valve boxes, cabinets, walls or the like. The Contractor shall also "pothole" all marked underground utilities parallel to and within 10 feet of the pipeline being constructed.
- B. Surveying: The Contractor shall locate and uncover existing utilities to one foot below the utility including points of connection, services and conduits and other underground facilities. The Contractor shall survey the top of pipe for vertical and horizontal location. The survey shall use the same coordinates and datum as the Project Drawings. The surveying field report(s) shall be submitted with the Potholing Report
- C. Any variation in the actual elevations and the elevations indicated on the Project Drawings shall be clearly marked in the Potholing Report and brought to Owner's Construction Manager's attention.
- D. If the Contractor does not expose all required utilities, the Contractor shall not be entitled to additional compensation for work necessary to avoid interferences nor for repair to damaged facilities.

3.5 FINAL REPORT

- A. Upon completion of post-construction site condition survey, transfer all videos, digital photographs, and narrative logs of the pre-construction, construction progress and post-construction site conditions surveys to external hard drive of sufficient capacity for transmittal to Owner.
 1. Folder Structure shall include folders for pre-construction conditions, post-construction conditions, and monthly progress photos by month.

END OF SECTION

SECTION 01 33 51
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SCOPE

- A. The Contractor shall keep and maintain, at the job site, a copy of contract documents, marked up to indicate all changes made during the course of a project, as specified herein.

1.2 RELATED REQUIREMENTS

- A. Contract Close-out submittals are included in Section 01 77 19 Closeout Requirements.
- B. Record shop drawings are included in Section 01 33 00 Submittal Procedures.
- C. Post-construction topographic surveys are included in Section 01 33 50 Site Conditions Surveys.

1.3 REQUIREMENTS INCLUDED

- A. Contractor shall maintain a record copy of the following documents, marked up to indicate all changes made during the course of a project:
 - 1. Contract Drawings
 - 2. Specifications
- B. Contractor shall assemble copies of the following documents for turnover to the Engineer at the end of the project, as specified.
 - 1. Field Orders, Change Orders, Work Change Directives, and RFIs
 - 2. Field Test records
 - 3. Permits and permit close-outs (final approvals)
 - 4. Certificate of Occupancy or Certificate of Completion, as applicable
 - 5. Certificates of Compliance for materials and equipment
 - 6. Record Shop Drawings
 - 7. Samples
- C. Record Drawings
 - 1. In accordance with Larimer County 1041 Permit Conditions of Approval #54 and #55.
 - 2. The Contractor shall annotate (mark-up) the Contract Drawings to indicate all project conditions, locations, configurations, and any other changes or deviations that vary from the original Contract Drawings. This requirement includes, but is not limited to, buried or concealed construction, and utility features that are revealed during the course of construction. Special attention shall be given to recording the locations (horizontal and vertical) and material of all buried utilities that are encountered during construction – whether or not they were indicated on the Contract Drawings. The record information added to the drawings may be supplemented by detailed sketches, if necessary, clearly indicating, the Work, as constructed.
 - 3. These annotated Contract Drawings constitute The Contractor's Record Drawings and are actual representations of as-built conditions, including all revisions made necessary by change orders, design modifications, requests for information and field orders.
 - 4. Record drawings shall be accessible to the Owner, Owner's Construction Manager and Engineer at all times during the construction period.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 MAINTENANCE OF RECORD DOCUMENTS AND SAMPLES

- A. Store documents and samples in Contractor's field office apart from documents used for construction.
 - 1. Provide files and racks for storage of the record documents.
 - 2. Provide locked cabinet(s) or secure storage space for storage of samples.
- B. File documents and samples in accordance with Construction Specifications Institute (CSI) format.
- C. Maintain documents in a clean, dry, legible, condition and in good order. Do not use record documents for construction purposes.
- D. Make documents and sample available for inspection by the Engineer, Owner's Construction Manager, or Owner at all times.

3.2 MARKING METHOD

- A. Use the color *Red* (indelible ink) to record information on the Drawings and Specifications,
- B. Label each document "PROJECT RECORD" in neat large printed letters.
- C. Unless otherwise specified elsewhere, notations shall be affixed to hardcopies of documents.
- D. Record information contemporaneously with construction progress.
- E. Legibly mark drawings with as-built information:
 - 1. Elevations and dimensions of structures and structural elements.
 - 2. All underground utilities (piping and electrical), structures, and appurtenances
 - 3. Changes to existing structure, piping and appurtenance locations.
 - 4. Record horizontal and vertical locations of underground structures, piping, utilities and appurtenances, referenced to permanent surface improvements.
 - 5. Record actual installed pipe material, class, size, joint type, etc.

3.3 RECORD INFORMATION COMPILATION

- A. Do not conceal any Work until the required information is acquired.
- B. Items to be recorded include, but are not limited to:
 - 1. Location of internal utilities and appurtenances concealed in the construction – referenced to visible and accessible features.
 - 2. Field changes of dimensions and/or details
 - 3. Interior equipment and piping relocations.
 - 4. Architectural and structural changes, including relocation of doors, windows, etc.
 - 5. Architectural schedule changes.
- C. Changes made by Field Order, Change Order, design modification, and RFI, including the label and number of the applicable document directing the change.
- D. Details not indicated on the original Contract Drawings.
- E. Specifications - legibly mark each Section to record:
 - 1. Manufacturer, trade name, catalog number, and Supplier of each product and item of equipment actually installed.
 - 2. Changes made by Field Order, Change Order, RFI, and approved shop drawing, including the label and number of the applicable document directing the change.

3.4 COMBINED RECORD DRAWINGS AND SUBMITTAL

- A. The Contractor shall maintain and submit one record-document set for the Work, organized and indexed by segment (F.1 or F.2), drawing sheet, and station, including record drawings, record specifications, and record shop drawings. One submission, review, and acceptance process applies to the complete set: the Contractor shall submit record documents through the Owner's Construction Manager to the Engineer of record for each segment; the Engineer will review the record documents for its segment; and the Owner's Construction Manager will administer one final acceptance of the complete record set. Where a permit or Specification section requires earlier delivery of specific record documents (for example, the WSSC crossing records under F.1 Section 01 78 39), those deliveries remain due as specified and are incorporated into the record set. Acceptance of the complete record set is a prerequisite to final payment as provided in the Contract Documents.

END OF SECTION

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SECTION 01 35 13
SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. Include and provide all labor, materials and equipment for all Special Project Procedures as indicated throughout the duration of the Project.

1.2 RELATED REQUIREMENTS:

- A. Include, but are not necessarily limited to, the following:
1. Section 01 31 19 – Project Meetings
 2. Section 01 33 50 – Site Conditions Survey
 3. Section 01 41 24 – Permit Requirements
 4. Section 01 42 00 – References
 5. Section 01 55 26 – Traffic Control

1.3 SUBMITTALS

A. Action Submittals

1. Not used.

B. Informational Submittals

1. Submit the Following:
 - a. Contractor-design Data:
 - 1) Sign mounting details
 - b. Deferred Submittals:
 - 1) Contractor and Engineer's Field Office Submittal: Submit all of the following as one Submittal which shall include:
 - a) Site plan indicating proposed location of field office, parking, and other facilities related to field office, and material of both field office parking and sidewalk or walkway to field office.
 - b) Layout and Physical Attributes Shop Drawings of Field Office:
 - (1) Information on proposed field office size, construction, exterior appearance, interior finishes, and field office security measures.
 - (2) Proposed layout of interior of field office, showing location of offices, common areas, restroom, closet, other areas required (if any), with dimensions indicated for each. Show locations of interior partition walls, doors (including direction of opening), and windows.
 - c) Utilities:
 - (1) Proposed type of internet service; name of proposed internet service provider; and product data and technical information on equipment required for internet service.
 - d) Furniture and Furnishings
 - (1) List of furniture and furnishings specified to be provided to illustrate conformance with Specifications.
 - c. Stockpile Stabilization Plan
 - d. Soil Handling Orientation
 - e. Daily Soil Handling Log
 - f. Stockpile Tracking Log
 - g. Stockpile Photo Documentation

- h. Material Test Reports
 - 1) For work in Larimer County ROW, in accordance with Larimer County Standards, for submittal to Larimer County by Owner's Construction Manager, in accordance with Larimer County 1041 Permit Condition of Approval #36
- i. Hazard Communication and Spill Response Plans
- j. Pre-Construction and Post-Construction topographic survey for Anchor Aviation parcel.
- k. Post-Construction topographic survey for Anchor Aviation parcel.

1.4 SUPPLEMENTAL DOCUMENT ORDER OF PRECEDENCE

- A. This project includes additional Contract Documents to those listed the Contract. The established order of precedence for these documents should conflicts with other Contract Documents arise is as follows:
 - a. Contract Order of Precedence
 - b. Geotechnical Baseline Report
 - c. Geotechnical Data Report
 - d. Referenced Standards and Specifications, in accordance with Section 01 42 00 – References.

1.5 DOCUMENT CONTROL SOFTWARE

- A. Document Control for this software will be conducted by Procore Construction Management Software.
 - 1. Procore web access site will be provided and hosted by Owner's Construction Manager.
 - a. Contractor shall provide hardware and software necessary to allow access to Procore for Contractor staff.
 - 2. Contractor shall submit all electronic submittals and documentation via Procore Site, including, but not limited to:
 - a. Submittals
 - b. RFIs
 - c. Contract Modification Documentation
 - d. Schedules
 - e. Applications for Payment
 - f. Formal Communications

1.6 PROJECT PLANS AND LOGS REGISTER

- 1. The Contractor shall prepare, maintain, and make available to the Owner's Construction Manager the plans and logs listed in the attached Plans and Logs Register, at the frequencies listed. Where the Register designates an item as shared, one plan or log covering both Segments F.1 and F.2 satisfies both segment Specifications, provided the accepting agency allows a combined document. Except for items designated 'added by this Register,' the Register is an administrative summary and does not modify or relieve the Contractor of the requirements of the underlying specification sections and permits; items so designated are requirements of the Contract for the Work of both segments. Due dates citing F.2 Section 01 41 24 run from Construction Notice to Proceed; the corresponding F.1 DCP-support submittals are due within 42 calendar days (six weeks) of the initial meeting with Larimer County under Section 01 41 10, paragraph 1.16.C. F.1 citations to Section 01 41 10 rest on its DCP plan-submittal obligations; the individual plans are itemized in the Larimer County 1041 Permit Compliance and Contractor Requirements Matrix included with the F.1 Project Manual.

1.7 PUBLIC OUTREACH PROGRAM

- A. As required by Larimer County 1041 Permit Condition of Approval #23 and #42.

- B. Follow the Owner's TWP Segment F.2 Outreach and Communication Plan and provide requested or required information to Owner's Construction Manager on anticipated scheduled tasks that could impact the public or individual property owners.
- C. Provide information 1 month in advance of the start of task that could impact the public or individual property owners.
- D. Information will be used for public outreach, which could include the distribution of flyers, updating the Thornton Water Project website, or letters to property owners.
- E. Owner and the Construction Manager will coordinate distribution of information for public outreach.

1.8 PROJECT SIGNS

- A. Project signage will be provided to the Contractor by the Owner.
 - 1. Up to six signs with dimensions of approximately 6 feet by 4 feet.
- B. Installation of Project Sign:
 - 1. Mount sign on portable Unistrut frame or other portable structure.
 - 2. Mount sign to resist wind loads as required by authorities having jurisdiction and other loads reasonably imposed on the sign, but not less than the 3-second wind velocity of 117 MPH.
- C. Site Movement:
 - 1. Move signs throughout construction to locations as approved by Owner's Construction Manager and in accordance with Larimer County Sign Permit as described in Section 01 41 24 – Permit Requirements.
- D. Maintenance and Removal:
 - 1. Keep Project sign clean and legible until the sign is removed from the Site.
 - 2. Repair sign when necessary.
 - 3. Provide sign maintenance in accordance with approved Larimer County Sign Permit as described in Section 01 41 24 – Permit Requirements.
 - 4. Remove Project sign entirely from the Site following Substantial Completion and prior to requesting final inspection.

1.9 CONTRACTOR'S FIELD OFFICE

- A. Establish near the Site the Contractor's field office, structurally sound and in accordance with Laws and Regulations, sufficient for Contractor's needs.
 - 1. Location shall be determined by Contractor, within 5 miles of Project location. Suggested location for field office is included in the Drawings.
 - 2. Provide space adequate for Contractor's activities and personnel necessary to execute the work from the field office.
- B. Equipment:
 - 1. Telephone and High Speed Internet
 - 2. Copier/scanner
 - 3. Appropriate computer equipment
 - 4. Other equipment as determined necessary by contractor to conduct operations.
- C. Contractor's personnel will be reasonably present at Contractor's office during working days.
- D. Remove field office from Site or decommission following Substantial Completion of all the Work and prior to final inspection of the completed Work.

1.10 ENGINEER'S FIELD OFFICE

- A. General Requirements:

1. Establish near the Site the Owner's field office, structurally sound and in accordance with Laws and Regulations and the requirements of this Specification.
 - a. Larimer County approval is required if location is within Larimer County and not shown within work limits shown on Contract Drawings.
 - 1) Submit proposed location to Owner's Construction Manager for submittal to Larimer County Approval.
 2. Provide a field office for the Owner, the Engineer, the Owner's Advisor, the Owner's Construction Manager, and Third Party Testing Representatives within 5 miles of the job site.
 3. Field Office to be provided within 10 days of Date of Commencement of the Work.
 4. Provide either: permanent finished office space, trailers, mobile buildings, or buildings (rented space) constructed with floors raised aboveground, with steps, landings, and railings at entrance doors. All offices shall be suitably ventilated.
 - a. Landing and stairs shall have slip-resistant walking surfaces, and be metal, pressure-treated lumber, fiberglass, or concrete. Landing must have a covered entrance platform (minimum 4 feet x 4 feet)
 - 1) Railing shall be metal, pressure-treated lumber, or fiberglass.
 5. Owner's Field Offices should be separate from any Contractor provided Office Space.
 - a. Provide separate structure or single structure separated by a wall.
 6. Provide an office approximately 14 feet x60 feet with sufficient room for Project meetings and a minimum of two (2) offices.
 - 1) Each office shall be suitable height and of ample size to accommodate the furniture and equipment listed below, without crowding (at least 200 sq. ft. of floor area per permanent occupant). The office shall be subdivided and contain one private office of approximately 200 sq. ft. for use by the Owner's Construction Manager and approximately 400 sq. ft. for use by the Owners Engineer and/or Advisor (2 people). Provide privacy door for each office.
 7. Provide adequate space, tables and chairs for progress meetings. Provide enough space for a meeting with fifteen (15) individuals.
 - a. Buildings shall be structurally sound, secure, and weathertight with not less than R-19 insulation. If trailer is furnished, provide weather skirt around trailer base. Storm doors are required at all entrances.
 - 1) Doors:
 - a) Doors shall be secure and lockable with cylinder-type locks. Padlocks are unacceptable.
 - 2) Windows:
 - a) Provide each operable window with insect screen.
 - b) Provide each window with lock approved by Owner's Construction Manager, in addition to other physical security features required, if any.
 8. Provide one restroom facility with one water closet and one lavatory and one storage cabinet for consumables.
 9. Provide in field office a kitchen area suitable for appliances indicated in this Section, including drinking water supply.
 10. Ingress and Egress
 - a. Provide two doors for ingress and egress for each field office unit, each with landing as necessary, stairs, and railing complying with applicable building code and other Laws and Regulations in effect at the Site.
 11. Temporary field office shall be a non-smoking facility.
- B. Site Requirements:
1. Parking
 - a. Provide minimum of ten (10) parking spaces per field office for use by occupants.

- 1) ADA compliant parking spaces shall be provided by the Contractor as needed.
- b. Vehicle parking spaces shall be not less than nine feet wide.
- c. Parking area shall be paved with crushed stone, asphalt concrete, concrete, or other material approved by Owner's Construction Manager.
- d. Provide parking area with safe layout, suitable for vehicle entry to temporary or permanent travelled ways, as applicable, with sufficient space for reasonable vehicle maneuvering.
- e. Parking area shall be properly drained and free of standing water during wet weather.
2. Walkway or Sidewalk to Field Office Entrance:
 - a. Provide sidewalk or walkway, not less than four feet wide, of crushed stone, asphalt concrete, concrete, or other material approved by Owner's Construction Manager.
 - b. Provide sidewalk or walkway for full distance between parking area and entrance to field office.
3. Security: Security of all office and storage areas will be the responsibility of the Contractor. It will be the Contractor's responsibility to secure equipment from vandalism and theft.
- C. Furniture: Provide in field office at the Site the following furniture for use by Engineer and Owner's Construction Manager:
 1. Plan Table: One (1) heavy duty drafting/plan table in conference/meeting room, with a reasonably smooth top, light, and one suitable padded swivel stool.
 2. Conference Table: One (1) conference table and chairs to accommodate 15 persons.
 3. Desks: Three (3) desks for general office use, each about 3 feet by 5 feet, each with a desk chair of the armchair swivel type.
 4. File Storage: Three (3) four-drawer, legal size, metal filing cabinets, each with lock and two keys.
 5. Waste Baskets: Minimum one waste basket in each office and one in the conference room, and one extra waste basket in the restroom.
 6. Printer Table: One (1) folding table for printer and printer supply storage.
 7. Three (3) dry erase boards (min. 48" x 60") with a set of colored markers and erasers. One in each office and one in the conference/meeting room.
 8. Shelves, counters, and tack board as directed.
- D. Furnishings: Provide in field office at the Site the following furnishings:
 1. Ingress/Egress Furnishings: Provide the following at each ingress/egress to and from field office:
 - a. Door mats of suitable size and texture.
 - b. Boot scraper.
 2. LED Television:
 - a. One (1) 48" min. 1080p "Smart" LED high-definition television (HDTV) with min. 1 HDMI connection, 1 USB connection, min. 1 VGA PC connection, built-in Wi-Fi and Ethernet connection.
 - b. Mount on conference room wall with full-motion swiveling wall mount.
 - c. One (1) 50' min. HDMI cable
 - 1) Maintain and replace as needed for duration of the Work.
 3. Safety Equipment for Field Office:
 - a. Provide the following for field office, in accordance with Laws and Regulations and manufacturer's published instructions:
 - 1) Two wall-mounted, 10-pound ABC dry powder fire extinguisher, upright and fully charged, in an easily accessible location, with signage.
 - 2) Two (2) portable ABC type fire extinguishers of at least 10-lb capacity.
 - 3) Ceiling-mounted smoke detectors with supply of batteries for each.

- 4) Carbon monoxide detector with power supply.
 - b. Provide the following for field office, regardless of the quantity of structures comprising field office:
 - 1) One ANSI/ISEA Z308.1, Class B first aid kit, Type III or Type IV, in weatherproof case.
 - a) Contractor shall maintain and restock first aid kit.
 - 2) One OSHA, "Employee Right to Know" Poster, prominently displayed.
 - 3) One automatic external defibrillator (AED) kit, rescue-ready, in appropriate, wall-mounted cabinet (installed by Contractor at location approved by Engineer) with "AED" signage. Product and Manufacturer: Zoll AED Plus, or equal. Upon removal of field office from the Site, defibrillator and accessories shall remain Contractor's property.
 4. Window Coverings: Operable blinds sized for each window in field office.
 5. Kitchen Area: Provide the following furnishings in field office:
 - a. One (1) refrigerator and microwave combo (Daewoo Microwave Combo Model #MF-9B033B or functionally equivalent unit).
 - b. Water Cooler and Potable Water Supply:
 - 1) Provide five-gallon bottled water with electric cooler dispenser.
 - 2) Provide supply of potable, bottled water suitable for dispenser for duration of Project, together with supply of disposable cups.
 - a) Maintain one spare 5-gallon bottle and one extra box of cups on hand at all times.
 - c. Coffee Maker:
 - 1) One electric coffee maker, with ten-cup capacity or larger.
 - 2) For duration of Project, furnish coffee supplies, including coffee (ground), filters, sugar and alternative sweetener, creamer, stir sticks, and disposable cups.
 6. Restroom: Provide restroom supplies including soap dispenser, toilet paper dispenser, trash can, paper towel dispenser, and toilet plunger.
 7. Copier-Printer-Scanner:
 - a. One (1) network-ready wireless, all-in-one, printer with document feeder that can copy, print, and scan up to and including 11-inch by 17-inch sized paper.
 - 1) Copy capability shall be at the approximate rate of 40 copies per minute with the first copy produced in approximately 10 seconds.
 - 2) The machine shall accommodate ordinary, un-sensitized stock paper in variable weight, colors, and sizes.
 - 3) The machine shall use standard 115-volt, 60-hertz electrical power.
 - 4) Maintain the copier throughout the duration of the work.
- E. Utilities and Services:
1. Electrical System and Lighting:
 - a. Electric service as required, including paying all costs.
 - b. Electrical systems shall comply with Laws and Regulations.
 - c. System suitable for 120/240 volt AC, single phase, 60 Hertz service. Provide 120-volt AC, single-phase, 60 Hertz power to convenience receptacles in field office. Provide transformers and other materials and equipment as necessary.
 - d. Electrical system components, including circuit breakers, cabling, convenience receptacles, switches, and lighting fixtures and luminaires, shall be Underwriters Laboratories, Inc. (UL) approved.
 - e. Electric circuits shall be protected by circuit breakers. Fuses are unacceptable. Provide circuit breaker on incoming electric service to field office.
 - f. Duplex convenience receptacles on interior of each structure comprising field office.

- 1) Provide minimum of two per office.
- 2) Provide minimum of one per restroom.
- 3) Provide minimum of three per kitchen area.
- g. Appropriate strike plate for each wall switch and convenience receptacle.
- h. Interior lighting of not less than 100 foot-candles at desktop height.
- i. Exterior, wall-mounted lighting at each entrance to field office, not less than 250 watts (equivalent) each.
- j. Exterior security lighting for field office's parking area.
2. Heating, Ventilating, and Air Conditioning:
 - a. Provide automatic heating to maintain indoor temperature in field office of not less than 70 degrees F in cold weather. Provide fuel and pay utility costs.
 - b. Automatic cooling to maintain indoor temperature in field office of not greater than 72 degrees F in warm weather.
 - c. Provide wall-mounted thermostat for controlling heating and air conditioning.
 - d. Functioning ventilation system for field office with number of air changes in accordance with Laws and Regulations.
3. Water and Sewerage:
 - a. Provide potable water service for each plumbing fixture associated with field office.
 - b. Provide sanitary sewerage for each lavatory/sink and toilet in field office.
 - c. Utility Connections
 - 1) Comply with Laws and Regulations, including plumbing and sewer codes, and requirements of authorities having jurisdiction, including water and wastewater utility owners and operators.
 - 2) Protect plumbing from freezing.
 - d. Potable Water Service: Provide the following:
 - 1) Appropriate copper waterline from potable water main to each plumbing fixture.
 - 2) Reduced pressure zone (RPZ)-type backflow preventer in accordance with Laws and Regulations and requirements of authorities having jurisdiction.
 - 3) Provide 15-gallon electric hot water tank or tankless hot water heater, and hot water piping to serve each lavatory/sink in field office.
 - 4) Before placing potable water system into service, disinfect piping and appurtenances in accordance with Laws and Regulations, and requirements of authorities having jurisdiction.
 - e. Sanitary Sewerage:
 - 1) Provide PVC or other appropriate piping, arranged in accordance with Laws and Regulations, to convey wastewater from field office to sanitary sewer that discharges to one of the following: (1) permitted wastewater treatment facility, (2) onsite wastewater disposal system provided and operated in accordance with Laws and Regulations, or (3) onsite holding tank provided by Contractor.
 - a) When holding tank is provided, also provide pumping and disposal of holding tank contents at appropriate, regular intervals. Dispose of holding tank contents in accordance with Laws and Regulations.
4. High Speed Internet Service
 - a. Provide high speed, non-cellular internet service with high speed router capable of uploading and downloading large files such as pictures for exclusive use of the Owner, Owner Advisor, Engineer, and Owner's Construction Manager.
 - b. Internet connection shall be independent of the Contractor's internet service and contain the following:
 - 1) Include associated peripherals, device, and cables for setting up secure wireless and wired network.

- 2) Minimum of 2 wired connections for each office and conference meeting room.
 - c. Provide service via communication service provider via either cable or fiber-optic service at download speed of not less than 300 megabits per second (Mbps) and upload speed of not less than 25 Mbps.
 - d. Provide with wireless router capable of providing Wi-Fi service to at least 10 internet capable devices.
 - e. Initial set up and future troubleshooting shall be coordinated with service provider and Owner's Construction Manager.
- F. Maintenance Services: Provide the following maintenance services for field office, from establishment of field office until its removal:
1. Maintenance and Repairs:
 - a. Immediately and properly remedy malfunctioning, damaged, leaking, or defective field office structure, site improvements, systems, and equipment.
 - b. Provide supplies for field office electronic equipment. Arrange and pay for maintenance on Contractor-furnished electronic equipment, including copier.
 - c. Promptly provide snow and ice removal for field office, including vehicle parking area, walkways, and stairs and landings.
 2. Cleaning:
 - a. Provide continuous maintenance of and janitorial service for field office and sanitary facilities.
 - b. Janitor service for the duration of the Contract consisting of twice weekly sweeping and mopping of floors, trash removal, weekly restroom cleaning, and weekly dusting of furniture and equipment.
 3. Waste Disposal:
 - a. Properly dispose of trash and waste as needed, not less than twice per week.
 - b. Properly handle and dispose of recyclables. Do not dispose of recyclables as trash.
 - c. Dispose of other waste, if any, as necessary and required, to avoid creation of nuisances and adverse environmental effects. Properly dispose of electronic waste, when necessary, at proper waste receiving facility.
 - d. Dispose of waste from field office in accordance with Laws and Regulations.
- G. Consumables: Provide the following consumables as needed:
1. Toner and ink cartridges for copiers and printers, as required.
 2. Paper supplies for copiers and printers. Always maintain in field office not less than one ream of each size of paper for which copiers and printers are capable.
 3. Dry markers in four colors, and white board eraser set. Replace markers when exhausted or misplaced.
 4. Paper towels, anti-bacterial liquid soap, toilet tissue, and cleaning supplies for field office restroom.
 5. Disposable cups for water service.
 6. Coffee supplies, including coffee, filters, cups, sugar, alternative sweetener(s), creamer, and stir-sticks.
 7. Batteries for smoke detectors and other battery-powered items furnished by Contractor.
 8. Replace fire extinguishers upon expiration.
 9. Supply of disposable ear plugs for visitors.
 10. Not less-often than monthly, inspect first-aid kit and inventory items consumed or used and remove items at or near their expiration date. Promptly replace and restock consumed and expired items.

- H. Maintain field office throughout duration of the Work. Remove field office from Site or decommission following Substantial Completion of all the Work and prior to final inspection of the completed Work.

1.11 CONSTRUCTION MATERIAL STOCKPILE REQUIREMENTS

- A. Construction stockpiles for earth, bedding materials and pipe materials should be placed in off-street areas along the length of the construction corridor where possible. Where material cannot be stored within the existing temporary and construction easements, separate arrangements must be made with property owners and approved by the Owner and Larimer County. All costs for additional storage areas and associated permits and restoration are the responsibility of the Contractor.
- B. Stockpile heights during construction shall not exceed 10 feet.
- C. Stockpiles shall not block any drainage or irrigation flowlines. Measures to control migration of sediment from stockpiles should be put in place, especially if left overnight or over a weekend or other break in the work.
- D. Asphalt millings shall be stored in offsite areas and kept covered.
- E. Stockpile materials and debris outside of riparian areas and protect the soil from stream flows.
- F. Promptly remove waste to minimize site disturbance and attraction of predators.

1.12 END OF WORKDAY SITE CONDITIONS

- A. Pipe trenches shall be backfilled to within a maximum of 250-feet ahead of and behind the active pipe construction installation at the end of each work-day. Work in Rights of Way shall be temporarily protected in accordance with the approved Right of Way permit required under Section 01 41 24 – Permit Requirements. Fencing or other barrier to prevent incidental or unauthorized entry into open excavations shall be erected around the open excavation when outside the roadway.
- B. Plated areas open for traffic shall be backfilled completely.
- C. Streets where there is active work and/or stockpiles placed shall be swept daily at the end of the work shift. All backfilled and stabilized trenches shall be checked daily and repaired as required by the Owner's Construction Manager.

PART 2 - PRODUCTS

2.1 SEED MIXES

- A. Project seed mixes shall be used to re-seed the project, outside of delineated irrigated agricultural areas, as delineated and indicated on the Contract Drawings and as identified by parcel within this Specification. As required by Larimer County 1041 Permit Condition of Approval #69.
- B. Any substitutions to plantings and seed mixes will need to be approved by the Owner's Environmental Consultant and Larimer County.
- C. Upland Seed Mix

Scientific Name	Common Name	Lb/ac (PLS)	Variety
Graminoids			
<i>Achnatherum hymenoides</i>	Indian ricegrass	3	Paloma
<i>Andropogon hallii</i>	Sand bluestem	2	CO Ecotype
<i>Bouteloua curtipendifolia</i>	Sideoats grama	3	Vaughn
<i>Bouteloua gracilis</i>	Blue grama	1	Hachita
<i>Buchloe dactyloides</i>	Buffalograss	5	Bowie
<i>Elymus trachycaulus</i>	Slender wheatgrass	2	San Luis
<i>Hesperostipa comata</i> ssp. <i>comata</i>	Needle and thread grass	0	CO Ecotype
<i>Hilaria jamesii</i>	Galleta grass	2	Viva
<i>Nassella viridula</i>	Green needle grass	4	Cucharas
<i>Panicum virgatum</i>	Switchgrass	1	Blackwell
<i>Pascopyrum smithii</i>	Western wheatgrass	6	Arriba
<i>Schizachyrium scoparium</i>	Little bluestem	1.5	Cimarron
<i>Sporobolus cryptandrus</i>	Sand dropseed	0.1	CO Ecotype
Forbs and Shrubs			
<i>Artemisia ludoviciana</i>	Prairie sage	0.02	CO Ecotype
<i>Dalea purpurea</i>	Purple prairie clover	0.25	CO Ecotype
<i>Galliardia aristata</i>	Blanket flower	1	CO Ecotype
<i>Heterotheca villosa</i>	Hairy goldenaster	0	CO Ecotype
<i>Liatris punctata</i>	Dotted gayfeather	0.25	CO Ecotype
<i>Linum lewisii</i>	Lewis flax	0.75	CO Ecotype
<i>Ratibida columnifera</i>	Prairie coneflower	0.3	CO Ecotype
<i>Sphaeralcea coccinea</i>	Scarlet globemallow	0.2	CO Ecotype
Total		33.37	

*Rate for hand seeding; Lb/ac = pounds per acre; PLS = Pure Live Seed.

- D. Upland Woody Container Species in Upland Areas. The following woody container stock shall be planted to supplement the Upland Seed Mix in areas designated for Upland Seeding. To maintain pipeline integrity, woody species will not be planted within 15 feet of the pipeline alignment.

Scientific Name	Common Name	Quantity
<i>Artemisia frigida</i>	Fringed sagebrush	20
<i>Ericameria nauseosa</i>	Rubber rabbitbrush	30
<i>Heterotheca villosa</i>	Hairy goldenaster	20
<i>Rhus trilobata</i>	Three-leaf sumac	10
<i>Ribes cereum</i>	Wax currant	10
<i>Rosa woodsia</i>	Woods' rose	10
<i>Yucca glauca</i>	Soapweed yucca	30

- E. Riparian Seed Mix:

Scientific Name	Common Name	Lb/ac (PLS)	Variety
Graminoids			
<i>Achnatherum hymenoides</i>	Indian Ricegrass	1.5	Rimrock
<i>Bouteloua gracilis</i>	Blue grama	0.3	Hachita
<i>Calamovilfa longifolia</i>	Prairie sandreed	0.75	Goshen
<i>Distichlis spicata</i>	Inland saltgrass	0.3	CO Ecotype
<i>Elymus canadensis</i>	Canada wildrye	2.5	Mandan
<i>Elymus trachycaulus</i>	Slender wheatgrass	2	San Luis
<i>Hordeum jubatum</i>	Foxtail barley	0.05	CO Ecotype
<i>Juncus arcticus</i>	Mountain rush	0.01	CO Ecotype
<i>Muhlenbergia asperifolia</i>	Alkali muhly	0.1	CO Ecotype
<i>Nassella viridula</i>	Green needle grass	2	Cucharas
<i>Panicum virgatum</i>	Switchgrass	2	Blackwell
<i>Pascopyrum smithii</i>	Western wheatgrass	4	Arriba
<i>Schizachyrium scoparium</i>	Little bluestem	1	CO Ecotype
<i>Sorghastrum nutans</i>	Indiangrass	1	Holt
<i>Spartina pectinata</i>	Prairie cordgrass	2	Red River
<i>Sporobolus cryptandrus</i>	Sand dropseed	0.1	CO Ecotype
Forbs			
<i>Achillea millefolium var. occidentalis</i>	Western yarrow	0.03	CO Ecotype
<i>Artemisia ludoviciana</i>	Prairie sage	0.02	CO Ecotype
<i>Asclepias speciosa</i>	Showy milkweed	2	CO Ecotype
<i>Coreopsis tinctoria</i>	Plains coreopsis	0.08	CO Ecotype
<i>Galliardia aristata</i>	Blanket flower	0.75	CO Ecotype
<i>Heliomeris multiflora</i>	Showy goldeneye	0.1	CO Ecotype
<i>Monarda fistulosa</i>	Wild bergamot	0.05	CO Ecotype
Total		22.64	

*Rate for hand seeding; Lb/ac = pounds per acre; PLS = Pure Live Seed.

- F. Riparian Woody Container Species in Riparian Forested Areas. The following woody container stock shall be planted to supplement the Riparian Seed Mix in woodland areas designated for Riparian Seeding. To maintain pipeline integrity, woody species will not be planted within 15 feet of the pipeline alignment.

Scientific Name	Common Name	Quantity
<i>Ericameria nauseosa</i>	Rubber rabbitbrush	20
<i>Rhus trilobata</i>	Three-leaf sumac	10
<i>Ribes cereum</i>	Wax currant	20
<i>Rosa woodsii</i>	Woods' rose	20

- G. Wetland Seed Mix:

Scientific Name	Common Name	Lb/ac (PLS)*	Variety
Graminoids			
<i>Bolboschoenus maritimus</i>	Alkali bulrush	1.00	CO Ecotype
<i>Carex pellita</i>	Woolly sedge	2.00	CO Ecotype
<i>Distichlis spicata</i>	Inland saltgrass	0.25	CO Ecotype
<i>Eleocharis palustris</i>	Creeping spikerush	0.50	CO Ecotype
<i>Elymus trachycaulus</i>	Slender wheatgrass	1.00	San Luis
<i>Juncus arcticus</i>	Mountain rush	0.07	CO Ecotype
<i>Juncus torreyi</i>	Torrey's rush	0.03	CO Ecotype
<i>Nassella viridula</i>	Green needle grass	1.00	Cucharas
<i>Panicum virgatum</i>	Switchgrass	2.00	Blackwell
<i>Pascopyrum smithii</i>	Western wheatgrass	2.00	Arriba
<i>Schoenoplectus americanus</i>	Olney's three-square bulrush	1.50	CO Ecotype
<i>Schoenoplectus tabernaemontani</i>	Softstem bulrush	0.50	CO Ecotype
<i>Spartina pectinata</i>	Prairie cordgrass	3.50	Red River
<i>Sporobolus airoides</i>	Alkali sacaton	0.20	CO Ecotype
Forbs			
<i>Asclepias incarnata</i>	Swamp milkweed	1.70	CO Ecotype
<i>Asclepias speciosa</i>	Showy milkweed	1.50	CO Ecotype
<i>Helianthus nuttallii</i>	Nuttall's sunflower	0.50	CO Ecotype
<i>Verbena hastata</i>	Blue vervain	0.07	CO Ecotype
Total		19.32	

*Rate for hand seeding; Lb/ac = pounds per acre; PLS = Pure Live Seed.

- H. Willow Cuttings. In the shrub-scrub wetland, as identified within the parcel-specific restoration requirements in this section, willow stakes shall be used to replace lost sandbar willow during construction.
1. When collecting willow cuttings to plant on-site, willows shall be harvested while they are dormant in the spring and planted after spring thaw but before bud break.
 2. Pour a slurry of soil and water around the cutting in its hole to displace any air pockets that could dry out the cuttings.
 3. Cuttings shall be installed approximately 6 to 8 inches below the expected dry-season water table with a few inches above ground after installation.

PART 3 - EXECUTION

3.1 IRRIGATED AGRICULTURAL SOIL HANDLING PROTOCOL – GENERAL

- A. Prior to stripping, confirm the mapped management unit boundaries and the prescribed salvage depths for the work area.
- B. During stripping, verify depth control at a frequency sufficient to maintain the target intervals. Minimum one check per 500 linear feet per lift, and, if management unit is less than 500 linear feet, then at least one check per management unit is required.
- C. Verify segregation by lift: confirm Topsoil Lift, Root-zone Lift, and Backfill are placed in the correct stockpiles.
- D. Observe soil moisture and structure continuously. Document any rutting, smearing, pumping, or balling.
- E. Prior to replacement, verify subgrade is prepared (decompacted/ripped) and free of debris.
- F. During replacement, verify lift thicknesses and replacement sequence (reverse order of salvage).
- G. Two types of handling controls are specified for individual management units as indicated in parcel-specific requirements of this Section:
 1. Standard handling controls apply to areas where clay content <45% within the topsoil and root-zone interval.
 - a. Strip and stockpile by lift (Topsoil, Root-zone, Trench Backfill) and maintain clean separation.

- b. Do not strip, traffic, or place salvaged soil when free water, pumping, or smearing is present, or when rutting exceeds approximately 2 inches.
 - c. Minimize equipment passes on stripped subgrade and on placed lifts; avoid turning/braking on stripped surfaces.
 - d. If rutting/smearing occurs, stop work, allow drying, and re-scarify/decompact the affected surface prior to proceeding.
 - e. Decompact/rip subgrade to minimum 12 inches prior to replacement of root-zone material.
2. Enhanced handling controls apply to areas where clay content $\geq 45\%$ within the topsoil and root-zone interval.
- a. Treat as a higher-vigilance work area. Document a daily workability "go/no-go" determination before stripping and before replacement begins.
 - b. Apply a more conservative stop-work threshold: stop work if rutting exceeds approximately 1 inch, if any smearing/pumping is observed, or if soil exhibits plastic "balling" on tracks/tires.
 - c. Restrict and control traffic: avoid turning in place; limit passes; keep hauling off stripped surfaces where feasible.
 - d. Use more controlled stripping methods under marginal conditions (e.g., excavator peel rather than aggressive blading).
 - e. Mandatory decompaction/scarification of trafficked subgrade to minimum 12 inches prior to placement of the next lift. Take care not to cause upward mixing between lifts during decompaction.
 - f. Increased verification and documentation (photos and additional depth/thickness checks) specific to Enhanced areas.

3.2 SOIL SALVAGING

- A. Schedule stripping and replacement when soils are dry or moderately moist. Avoid stripping or replacement when soils are wet enough to smear or rut.
- B. Soils shall not be mixed with construction debris. Debris encountered shall be removed and managed separately.
- C. Use dedicated equipment or clean buckets when switching between topsoil and subsoil handling where feasible.
- D. Keep stockpile footprints clean of trench spoils and other imported materials.
- E. Stockpiles shall be located:
 - 1. Outside drainageways and areas receiving concentrated flow.
 - 2. Outside irrigation infrastructure footprints and access areas where applicable.
 - 3. On stable, relatively flat ground where perimeter controls can be installed and maintained.
- F. Stockpiles shall be constructed to remain stable and to minimize compaction and erosion:
 - 1. Construct stockpiles in lifts by end-dumping and grading from the stockpile perimeter to reduce tracking over the surface.
 - 2. Provide a stabilized designated access point on the upgradient side where feasible.
 - 3. Preferred topsoil stockpile height is 4 feet. Maximum stockpile height for any soil stockpile is 10 feet.
 - 4. Construct stockpiles with side slopes 3H:1V or flatter and provide a stable toe.
 - 5. Install sediment controls per project Stormwater Management Plan and Erosion and Sediment Control Plan, as described in Section 01 41 24 – Permit Requirements and Section 01 57 05 Temporary Controls.
 - 6. If a stockpile is expected to remain in place longer than 30 days, stabilize by seeding and mulching.

G. Stockpiles in Irrigated Agricultural Lands

1. Stockpile Segregation
 - a. Maintain separate stockpiles for each material type:
 - 1) Topsoil – Salvage the surface lift depth as indicated in parcel specific requirements for this Section. Remove and stockpile material from all impacted areas including haul routes.
 - 2) Rootzone Lift – Salvage the rootzone lift depth as indicated in parcel specific requirements for this Section. Remove and stockpile material from all impacted areas including haul routes.
 - 3) Trench Backfill – Salvage remaining soil as required for native backfill.
 - a) In High Risk backfill areas (Management Unit 9), trench backfill shall be further segregated into Upper Backfill (24-36 inches) and Lower Backfill (below 36 inches).
 - 4) Wet Backfill – Saturated backfill shall be stockpiled separately.
 - b. Maintain segregation by parcel/landowner and by management unit unless written approval is obtained from the Owner/Owner representative and affected landowners.
 - c. Provide a physical separation between stockpiles of different material types (minimum 10 feet horizontal separation or a clearly defined berm).
 - d. Use dedicated loading/placing sequences to avoid cross-contamination (clean bucket before switching material types).
 - e. Keep stockpiles free of construction debris, aggregate, slurry, concrete washout, and chemically treated materials.
 - f. Wet backfill shall be stockpile separately.
2. Clearly identify each stockpile with signage indicating material type and stockpile ID.
3. Track stockpile creation date, approximate volume, stabilization actions, and final placement location using the Stockpile Log in Appendix B.
4. Each stockpile shall be labeled and tracked at minimum by:
 - a. Lift type,
 - b. Management Unit(s),
 - c. Parcel/landowner,
 - d. Date range constructed,
 - e. Estimated volume.

H. Stockpiles in Non-Irrigated Land

1. Upland Topsoil
 - a. The top 4 inches of upland topsoil from the impacted area shall be scraped with a front-end loader and stockpiled for later use
2. Riparian Topsoil
 - a. The top 4 inches of riparian topsoil from the impacted area shall be scraped with a front-end loader and stockpiled for later use
3. Wetland Topsoil
 - a. The top 8 to 10 inches of wetland topsoil from the impacted area shall be scraped with a front-end loader and stockpiled for later use in creating the wetland in the expanded wetland area as shown on the Contract Documents.

3.3 TOPSOIL MANAGEMENT

- A. Stockpiles for topsoil management activities shall comply with Stockpile Requirements specified in this Section as required by Larimer County 1041 Permit Condition of Approval #68.
- B. Topsoil shall not be salvaged in any area densely infested with noxious weeds where at all practicable.

C. Stockpile topsoil outside of riparian areas and protect the soil from stream flows.

3.4 AMENDMENTS AND FERTILIZER

A. Irrigated Agricultural Land

1. Amendments and fertilizers shall be implemented to restore soil function and agronomic parameters to baseline ranges established in the SSR and verified by post-construction sampling.
2. A soil scientist shall evaluate post-construction lab results relative to baseline conditions to recommend amendments and application rates, landowner approval of amendments is required.
3. The key parameters that will be evaluated for fertilizer and amendment requirements post construction include: OM%, NO₃-N, Olsen P, K, pH, EC.
4. Amendment targets and triggers (baseline comparison approach):
 - a. Amendments shall be evaluated by comparing post-construction soil test results to the pre-construction baseline for the same MU/parcel. Implement amendments after landowner approval is received and when one or more of the following conditions are met:
 - 1) Organic matter (OM): post-construction OM in the Surface Lift is more than 25% lower than baseline (relative decrease).
 - 2) NO₃-N: post-construction NO₃-N is below baseline and below agronomic sufficiency for the seed mix/land use.
 - 3) pH: pH deviates from baseline by more than 0.5 pH units or falls outside the typical revegetation tolerance range (approximately 6.0 to 8.5).
 - 4) Salinity/sodicity: EC1:1 increases by more than 2 dS/m from baseline, or ESP increases by more than 3 percentage points from baseline (or exceeds 6%).
 - 5) Compaction: observed compaction inconsistent with baseline. Implement additional decompaction.
5. Acceptable Amendment Materials
 - a. Fertilizers to address nutrient deficits (N, P, K) relative to baseline.
 - b. Organic amendments (compost) to restore organic matter and nutrients where baseline data indicates higher levels.
 - c. Gypsum or other calcium sources where sodicity risk is confirmed.
6. Fertilizer and Amendment types and rates shall be approved in coordination with the affected landowner.
7. Amendments and fertilizers shall be incorporated uniformly into the topsoil to the depth, and at the application rate specified by the soil scientist.
8. Coordination with Final Grading:
 - a. The timing of fertilizer and amendment application shall be aligned with final grading such that the post-construction soil survey shall be performed within 5 days of final grading, laboratory results can be anticipated within 14 days of survey completion.
 - b. The soil scientist shall evaluate laboratory results, and provide amendment and fertilizer recommendations within 3 days of receiving laboratory results.
 - c. Contractor shall implement the amendment and fertilizer recommendations before the appropriate equipment is demobilized from the project site.

B. Non-Irrigated Agricultural Land

1. Testing of stockpiled soil shall occur to determine if any amendments are required prior to seeding.
 - a. No amendments are allowed for wetland areas.
 - b. Fertilizer or amendment rates shall be calculated based on soil tests from stockpiles prior to placement;

- 1) Slow-release fertilizers including Biosol Forte 7:2:1 and Menafee Humate may be recommend to improve soil composition for native species establishment and growth.

3.5 SOIL REPLACEMENT AND SEEDING

A. Irrigated Agricultural Land Soil Replacement and Grading

1. Prior to soil replacement, prepare the subgrade to reduce compaction and promote infiltration and rooting.
 - a. Scarify or rip the subgrade within the planting zone to the specified depth, avoiding creation of a glazed or smeared surface.
 - b. Subgrade preparation depth:
 - 1) Rip/scarify trench backfill to a minimum of 12 inches prior to root-zone soil replacement in all disturbed areas.
 - 2) Where trafficking or wet conditions have caused compaction deeper than 12 inches, increase decompaction depth to match the observed compacted layer thickness, typically up to 18 inches.
2. Root-zone preparation: Any traffic lanes on root-zone material shall be ripped to 12 inches maximum depth, taking care to not cause upward mixing of backfill into the root-zone material. Use ripping tines or tillage implements set to a depth that addresses compaction without disturbing underlying material.
3. Replacement Thicknesses:
 - a. Topsoil and root-zone soil shall be replaced to restore the soil column to pre-construction conditions. Replacement thickness shall match the salvage depth for each Management Unit:
 - 1) Standard areas (most Management Units): Root-zone soil shall be replaced in a 12-inch lift above the trench backfill. Topsoil shall be replaced in a 12-inch lift above the root-zone material.
 - 2) Management Unit 9: Topsoil shall be replaced in an 8-inch lift above the root-zone material. Root-zone (8-24 inch interval) shall be replaced in a 16-inch lift above the trench backfill.
4. Verify lift thicknesses at a minimum frequency of one thickness check per 500 linear feet of ROW per lift (Surface Lift and Root-zone Lift), and, if Management Unit is less than 500 linear feet, then at least one check per Management Unit is required.
 - a. Increase check frequency at transitions.
 - b. Document thickness checks with photos and field notes.
 - c. Confirm final grade and surface condition suitable for revegetation.
 - d. High Risk Backfill areas: Increase thickness verification frequency to one check per 250 linear feet of ROW per lift in Management Units 3, 5, and 9.
5. Placement Methods and Compaction Control
 - a. Place soil in a manner that minimizes compaction of the replaced lifts:
 - 1) Avoid hauling directly on placed topsoil where feasible. Use end-dumping and grading from the edge.
 - 2) Do not compact topsoil as an earthwork structural fill. Topsoil is placed for biological and agronomic function and should remain friable.
 - 3) If localized compaction occurs, re-scarify before proceeding with final grading or seeding.
6. Surface Finish and Stabilization
 - a. Finish grade the replaced topsoil to match pre-construction contours and to avoid concentrated flow paths. Provide a roughened seedbed, track-walk or equivalent, where appropriate for seeding.

- b. Break up large soil clods (peds) to achieve a maximum clod size of 2-4 inches. Utilize harrow, discing, or similar tillage equipment to create a loosened surface suitable for seeding while maintaining moderate surface roughness for erosion control.
- B. Non-Irrigated Land Seedbed Preparation and Seeding
 - 1. Manage noxious weeds in accordance with requirements of Section 01 57 05 – Temporary Controls.
 - 2. Seeding shall occur in early spring or fall.
 - 3. Seeding shall be by broadcast seeding or drill seeding.
 - a. Drill seeding shall be used if feasible for access and equipment in areas where slope is less than 4:1.
 - 1) Drill seeding shall occur 0.5 inches deep.
 - 2) Native grass drills shall be equipped with Coulter wheels, adjustable depth bands, and drill row spacing of 7 inches or less.
 - 3) Drill seeds in two directions, perpendicular to one another.
 - b. Broadcast seeding shall be used where the reapplied soil moisture regime of each project element is too wet or where slopes are too steep and isolated to permit machinery access.
 - 1) For broadcast seeding the specified application rate should be doubled.
 - 4. Before placing the seed mixes, the soil shall be ripped and loosened to 12 inches, and all rocks greater than 3 inches, debris, and large roots should be removed by disking, ripping, plowing, and rototilling.
 - a. Rip in two directions perpendicular to each other.
 - 5. Add soil amendments, if needed per soil test and habitat type, after subsoil is ripped and the topsoil is replaced.
 - a. Till soil to 6 inches, leaving no clod no greater than 3 inches in diameter.
 - 6. Disturbed areas shall be reclaimed as soon as practicable after completion of construction and seeded within 48 hours of topsoil placement with a custom native seed mix (certified as noxious weed-free).
 - 7. Noxious weed-free material will be used for seeding and planting.
 - 8. Wetland Re-seeding
 - a. A qualified wetland ecologist is required to be present onsite to inspect final construction grades and ensure successful revegetation in wetland areas.
 - b. Reduce soil compaction in wetlands through use of a chisel plow to mechanically rip both the topsoil and subsoil layers prior to planting.
 - c. Wetland re-establishment shall be in accordance with USACE Nationwide Permit #58 and Larimer County requirements.
 - 9. Trench Backfill Risk Management
 - a. Trench backfill is not intended to be incorporated into the reconstructed 0-24 inch soil profile.
 - b. Backfill risk ratings identify the areas where subsoil contains high percentages of clay, elevated salt content, elevated sodicity, or where saturated soils were encountered during the pre-construction soil survey.
 - 1) Low
 - a) Indicators: No major chemical/physical constraints indicated by lab data and no saturation observed at depth.
 - b) Controls: Standard segregation. Keep backfill separate from topsoil/root-zone. Replace in reverse order. Two-part backfill segregation not required.
 - 2) Moderate:
 - a) Indicators: Elevated salts and sodicity (EC >2 dS/m, ESP ≥6%), moderate texture constraints, and/or intermittent wetness sensitivity.

- b) Controls:
 - (1) Increase segregation documentation; prevent mixing into the 0-24 inch managed profile.
 - (2) Use clean equipment transitions between material types.
 - (3) If visibly wet/pumping material is encountered, segregate as Wet Backfill. Two-part backfill segregation not required.
- 3) High
 - a) Indicators: Chemical or physical soil characteristics pose high risk. EC >3 dS/m, ESP ≥15%, or saturation observed.
 - b) Controls:
 - (1) Management Unit 3 and Management Unit 5: Segregate wet/pumping trench spoils as 'Wet Backfill'. Place below grade and cap with drier backfill.
 - (2) Management Unit 9: trench backfill into Upper Backfill (24-36 in) and Lower Backfill (>36 in). Place Lower Backfill first, cap with Upper Backfill. Prevent high-salt/sodic/high-clay backfill from being incorporated into the 0-24 inch profile.
 - (3) Increase inspection frequency, thickness checks, and photo documentation.

3.6 PLANTING

- A. Use irrigation or alternative watering technologies, such as slow-release watering blankets (e.g., “tree diapers”), for trees and shrubs through establishment.

3.7 DOCUMENTATION REQUIREMENTS

- A. Stockpiling Stabilization Plan
 - 1. Indicate Proposed stockpile locations, perimeter controls, stabilization method(s), and access points.
 - 2. Submit before stripping activities.
- B. Soil Handling Orientation
 - 1. Written acknowledgment that key soil management requirements were reviewed at landowner pre-construction conference.
- C. Daily Soil Handling Log
 - 1. Document areas stripped, depths achieved, stockpile IDs, and weather/soil moisture conditions. Record equipment transitions (clean bucket/blade confirmation) in the daily log when switching between backfill and topsoil/root-zone material.
 - 2. High Risk Backfill areas: Daily logs shall include specific notation of wet backfill segregation actions in Management Units 3 and 5 or two-part backfill placement sequence in Management Unit 9.
- D. Stockpile Tracking Log
 - 1. Document stockpile creation date, material type, approximate volume, stabilization actions, and final disposition.
- E. Stockpile Photo Documentation
 - 1. As needed to support field decisions and to document compliance at hold points.
 - 2. Moderate Risk Backfill areas: Document segregation compliance at each stockpile load-out with a minimum of one photograph per stockpile per day of active operations, showing material type, stockpile separation, and absence of cross-contamination..
 - 3. High Risk Backfill areas: Photo-document each thickness check and each segregation transition.

3.8 POST-CONSTRUCTION RESTORATION VERIFICATION

- A. After pipeline installation and final grading, the soil specialist will revisit baseline survey points to verify replacement thickness and collect samples for post-construction laboratory analysis. Sampling methodology will be consistent with the baseline survey from the Segment F.2 Soil Management Plan to support direct comparison.
- B. Post-construction sampling shall be performed within 5 days of final grading completion.
 - 1. Sampling Intervals:
 - a. Unless field observations indicate a need for additional discrete intervals, the soil specialist shall collect samples from the following depth intervals at each sampling location:
 - 1) 0 to 12 inches
 - 2) 12 to 24 inches
 - 3) 24 to 48 inches
 - b. If samples collected from the 12-24 and 24-48 inch intervals are observed to be generally homogenous, and only if the sample point is within an Management Unit with a "low risk" backfill rating, then these intervals may be combined to submit as a composite 12-48 inch sample.
- C. Post-Construction Acceptance Framework:
 - 1. Post-construction acceptance focuses on verifying that:
 - a. Replacement thickness targets were met.
 - b. Post-construction soil condition is reasonably consistent with baseline condition.
 - 2. Acceptance criteria:
 - a. Replacement thickness: Surface Lift and Root-zone Lift thicknesses meet the specified intervals, and indicated by parcel and Management Unit within this Specification.
 - b. Material integrity: Salvaged materials are free of construction debris and have not been commingled with trench backfill.
 - c. Subgrade condition: Subgrade has been decompacted to the specified depth prior to replacement.
 - d. Post-construction testing: Post-construction soil test results are comparable to baseline for the same Management Unit or parcel.
- D. Adaptive Management
 - 1. Adaptive management may be needed when field conditions differ from mapped expectations, or per landowner requests.
 - 2. Triggers include:
 - a. Observed topsoil thickness differs materially from mapped salvage depth over a sustained reach.
 - b. Unexpected restrictive layers or unsuitable indicators are encountered within the planned salvage interval.
 - c. Weather or irrigation causes wet-soil conditions that would damage soil structure if operations continue.
 - 3. Corrective Actions
 - a. Potential corrective actions include:
 - 1) Adjust stripping depth locally to avoid mixing unsuitable subsoil into topsoil. Document adjustment in daily log.
 - 2) Create separate stockpiles for distinct material types if segregation is compromised.
 - 3) Pause operations until soils dry to a friable condition; rework smeared surfaces by scarification when conditions allow.
 - 4) If replacement thickness is inadequate, import suitable material or reallocate salvaged material as approved, then re-verify.

4. Authority and documentation for adaptive actions:
 - a. The soil specialist may recommend field adjustments, but the Contractor shall not implement changes that affect scope, parcel boundaries, or material disposition without approval from Owner's Construction Manager.

3.9 EQUIPMENT DISINFECTION FOR WORK IN WETLANDS WATERWAYS

A. Disinfection:

1. Contractor to disinfect all equipment that was previously used in a river, stream, lake, pond, or other body prior to use in any wetland or waterway.
2. Contractor to disinfect all water bypassing equipment, including hoses, pumps, pipes, tanks, and valves.
3. Disinfection shall be through one of the following methods:
 - a. Remove all mud and debris from equipment and spray/soak equipment with a 1:15 solution of disinfection solution containing the following ingredients:
 - 1) Dialkyl dimethyl ammonium chloride, 5-10% by weight;
 - 2) Alkyl dimethyl benzyl ammonium chloride, 5-10% by weight;
 - 3) Nonyl phenol ethoxylate, 5-10% by weight;
 - 4) Sodium sesquicarbonate, 1-5%;
 - 5) Ethyl alcohol, 1-5%; and
 - 6) Tetrasodium ethylene diaminetetraacetate, 1-5%;
 - 7) Water, keeping the equipment moist for at least 10 minutes and managing rinse as a solid waste in accordance with local, county, state, or federal regulations;
4. Spray/soak equipment with water greater than 140 degrees Fahrenheit for at least 10 minutes.
 - a. Sanitize water suction hoses and water transportation tanks used for disinfection and discard rinse water at an appropriately permitted disposal facility.

3.10 WORK PARALLEL TO BNSF RAILROAD

A. Sta.: 10+00-Sta: 35+25

1. Contractor is advised that work adjacent to BNSF railroad tracks presents the potential of encountering buried materials and contaminants associated with railroad tracks. Contractor shall notify the Owner's Construction Manager immediately and refer to the MMP in the event non-standard conditions are encountered, as further described in Article 3.24 of this Specification.
2. Notify Owner and Owner's Construction Manager immediately upon the discovery or suspicion of any contaminated soil.

3.11 WORK IN PARCEL 8828000001 – SCHWARZ, JOYCE L. – APPROXIMATE STA: 10+00 – STA: 58+57

A. Restoration

1. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Upland
 - b. Wetland
2. The following restoration requirements for irrigated agricultural lands apply, as indicated in this Specification Section and delineated in the Contract Drawings:
 - a. Management Unit: 1
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard

- 5) Trench Backfill Risk Rating: Moderate
- 6) Trench Backfill Risk Type: Moderate Physical and Chemical Limitations

3.12 WORK IN PARCEL 882700905 – CITY OF THORNTON – APPROXIMATE STA: 61+19 – STA: 86+88

A. Restoration

- 1. The following restoration requirements for irrigated agricultural lands apply, as indicated in this Specification Section and delineated in the Contract Drawings:
 - a. Approx. Sta: 61+20 to 80+75 Management Unit: 2
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: Moderate
 - 6) Trench Backfill Risk Type: Moderate Physical and Chemical Limitations
 - b. Approx Sta: 80+75 to 86+90 Management Unit: 3
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Enhanced
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Enhanced
 - 5) Trench Backfill Risk Rating: High
 - 6) Trench Backfill Risk Type: Saturated Soils

3.13 WORK IN PARCEL 8827000009 – ANCHOR AVIATION – APPROXIMATE STA: 86+88 – STA:92+42

A. Restoration:

- 1. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Upland
- B. Sta: 86+88 – Sta: 87+62 – Active Runway
 - 1. Active airfield. Contractor is advised that this property is an active airfield.
 - a. Maximum of 6 flights per week.
 - b. Flights only allowable between sunrise and sunset.
 - c. Contractor shall coordinate work in this vicinity with parcel owner so as to minimize impacts to active flight operations.
 - 2. Contractor is advised that work in area of active rural runway presents increased possibility of encountering contaminated soil associated with aircraft use. Contractor shall notify the Owner's Construction Manager immediately and refer to the MMP in the event non-standard conditions are encountered, as further described in Article 3.24 of this Specification.
 - 3. Refer to Project Special Procedures Appendix A for pre-construction survey, backfill, post-construction survey, and warranty requirements.

3.14 WORK IN PARCEL 882711003, 8827000003, 8826000043– SURVIVORS TRUST/DECLARATION OF TRUST/STEIDL JOHN, ZADA – APPROXIMATE STA: 92+42 – STA: 140+51

A. Seasonal work constraint:

- 1. Contractor shall complete all work across subject parcel from November 1 through March 31 to avoid irrigation season unless written approval is obtained from Property Owner. If

written permission is obtained, Contractor shall submit to Owner's Construction Manager at least 7 days prior to construction outside of the seasonal constraint.

- B. All fiber optic handholes within cultivated land shall follow the buried fiber optic handhole detail. Contractor shall notify Engineer of any at-grade hand holes within land that may be considered cultivated prior to installation.
- C. Contractor is advised of potential presence of buried, unlocated drain lines from approximately Sta: 92+50 to 111+50. Contractor shall notify Owner's Construction Manager immediately if any unlocated drain lines are encountered for confirmation of clearance to steel water pipe.
 - 1. Prior to April 15th following the installation of Improvements, Contractor shall repair or replace all drain tiles and irrigation systems to the conditions existing prior to Contractor's activities on the Property. This includes matching pre-construction locations, invert elevations, and slopes on all drainage tiles uncovered during construction.
 - 2. In the southwest corner of the north field (near pipeline Station 97+00), the proposed fiber optic handhole and a known drain tile are in close proximity. Given the degree of disturbance and proximity of improvements to the drain tile, Contractor will replace and/or relocate the impacted drain tiles.
- D. The irrigation pipe that brings water from Headgate 42 on the east side of the property (near Sta: 113+00) to the large pond on the west side of the property shall be protected in place to the extent practical. If it cannot be protected, the section of pipe exposed by the contractor may be removed and replaced. The existing above-ground vent pipe inside the permanent easement (near Sta: 113+00) shall be removed.
- E. See Contract Drawings 01C108 and 01C109 for conditions regarding potential presence of water casing and electrical line casing installed by property owner in the vicinity of Sta: 99+00. If present and disturbed, restore as shown on plans. If Contractor's work preceeds property owner's installation of these lines, contractor shall install utility casings above the pipeline as follows:
 - 1. Utility Casing Installation:
 - a. One 10-inch diameter casing for waterline.
 - b. One 4-inch diameter casing for electric.
 - 2. Minimum bury depth = 36-inches
 - 3. Slope = 0.0%
- F. Any debris or property within the cleared easement area on this parcel shall be removed by Contractor.
- G. Existing flume near Headgate 43 (Sta: 130+00) that is outside the limits of construction must be protected in place to facilitate property owner's future improvements. Property owner has expressed interest in considering a separately negotiated agreement and payment with Contractor for future improvements; Contractor is not precluded from entering into a separate agreement with property owner for this work; however, Owner shall bear no cost or liability for this work.
- H. See sheet 01C112 and 01C113 for limits of concrete ditch to be removed by Contractor. Area of ditch removal shall be regraded with a cross slope toward the field and a grade not to exceed 10:1 from the toe of slope. Grade shall be sufficient for mowing, UTV operation, and a surface pipeline for flood irrigation purposes.
- I. Engineered shoring or double-height trench boxes are required from approximate Sta: 115+00 to Approximate Sta: 116+00 to reduce impact to cultivated field.
- J. Restoration
 - 1. General Owner Requirement: Contractor shall segregate the topsoil whenever disturbing the surface of the Property and shall remediate any areas affected by post construction settlement within the one year warranty period with clean soil suitable for agricultural activities.

2. Insofar as practical and within six (6) months following the installation of Improvements, Contractor shall restore fences, landscaping, private roads and other improvements, to the conditions existing prior to Contractor's activities on the Property, or at Owner's option pay the actual damages to such items caused by Contractor's activities on the Property. Such remediation shall include, if requested by Grantor, the reseeding of any areas disturbed by Grantee.
 - a. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - 1) Riparian
 - 2) Upland
 - 3) Wetland
 - a) Willow Cuttings to be planted in Scrub-shrub Wetland Community (SF Wetland 8 as shown on Contract Drawings).
3. The following restoration requirements for irrigated agricultural lands apply, as indicated in this Specification Section and delineated in the Contract Drawings:
 - a. Parcel 8827110003 - Management Unit: 4
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: Moderate
 - 6) Trench Backfill Risk Type: Moderate Physical and Chemical Limitations
 - b. Parcel 8827000003 and 8826000043 - Management Unit: 5
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: High
 - 6) Trench Backfill Risk Type: Saturated Soils

3.15 WORK IN PARCEL 8826306001 – SCHNORR, PHILIP C. (.75) AND JONES, REBECCA A (.25) – APPROXIMATE STA: 140+51 – STA: 144+69

A. Restoration

1. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Wetland
 - 1) Willow Cuttings to be planted in Scrub-shrub Wetland Community (SF Wetland 8 as shown on Contract Drawings).
2. The following restoration requirements for irrigated agricultural lands apply, as indicated in this Specification Section and delineated in the Contract Drawings:
 - a. Management Unit: 6
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: Low
 - 6) Trench Backfill Risk Type: N/A

3.16 WORK IN PARCEL 8835105010 – MOWREY, E. SUZANNE AND LARRY J – APPROXIMATE STA: 145+45 – STA: 177+17

A. Restoration

1. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Upland
2. The following restoration requirements for irrigated agricultural lands apply, as indicated in this Specification Section and delineated in the Contract Drawings:
 - a. Management Unit: 7
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: Low
 - 6) Trench Backfill Risk Type: N/A

B. Tree Protection

1. All trees located outside of the temporary easement shown on the drawings shall be protected.

C. Irrigation System

1. Protect the irrigation pivot pad in place and restore the irrigation pond.
2. Survey the existing irrigation pond prior to construction to ensure existing volumes are met after restoration.
3. Upon restoration of the irrigation pond, install a new PVC pond liner to reduce water loss from the pivot irrigation system.

D. Underground Ditch Pipe – Approximate Sta: 161+35 - Sta: 161+55

1. Replace the underground pipe to convey current ditch water from east to west across the easement. The underground pipe shall match the existing pipe diameter, thickness and material.

E. Leach Field

1. The existing leach field shall be protected in place during construction activities.

3.17 WORK IN PARCEL 8835105002 – PETTINE JOINT REVOCABLE TRUST – APPROXIMATE STA: 177+71 – STA: 185+42

A. All trees located outside of the temporary easement area shall be protected.

B. The trees that have been identified for removal will be removed and disposed of by the Contractor.

C. Owner has been made aware of an existing buried irrigation system located within the permanent and temporary easements. Contractor shall field locate, cut and cap this irrigation system at the limits of construction so parcel owner can continue to operate parts of the irrigation system that are outside the limits of construction. Following completion of construction, it shall be parcel owner's responsibility to repair or replace the existing irrigation system inside the easements.

D. Restoration

1. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Upland

3.18 WORK IN PARCEL 8835106001 - BROOKLIND ESTATES HOA – APPROXIMATE STA: 185+42 – 187+57:

A. Seasonal work constraint:

1. Landowner prefers that the Contractor complete work across subject parcel from November 1 through March 31 to avoid irrigation season.
2. If work is unable to be completed during the irrigation offseason, Contractor shall bypass water through the work to maintain unimpeded flows.

B. Restoration:

1. After construction, Contractor shall restore the property to its pre-construction condition and the open ditch will continue to flow in an open channel above the pipeline.
2. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Upland
 - b. Wetland

3.19 WORK IN PARCEL 8836000902 – STATE OF COLORADO – APPROXIMATE STA: 188+22 – STA: 241+64

A. Restoration

1. The following restoration requirements and seed mixes for non-irrigated areas apply to applicable to areas of this parcel, as delineated in the Contract Drawings:
 - a. Upland
2. The following restoration requirements for irrigated agricultural lands apply, as indicated in this Specification Section and delineated in the Contract Drawings:
 - a. Approx Sta: 188+21 to 204+25 Management Unit: 8
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: Low
 - 6) Trench Backfill Risk Type: N/A
 - b. Approx Sta: 204+25 to 224+75 Management Unit: 9
 - 1) Surface Lift Depth Interval (Inches): 0-8
 - 2) Surface Lift Handling Controls: Enhanced
 - 3) Root Zone Lift Depth Interval (Inches): 8-24
 - 4) Root Zone Handling Controls: Enhanced
 - 5) Trench Backfill Risk Rating: High
 - 6) Trench Backfill Risk Type: Severe Physical and Chemical Limitations
 - c. Approx Sta: 224+75 to 241+64 Management Unit: 10
 - 1) Surface Lift Depth Interval (Inches): 0-12
 - 2) Surface Lift Handling Controls: Standard
 - 3) Root Zone Lift Depth Interval (Inches): 12-24
 - 4) Root Zone Handling Controls: Standard
 - 5) Trench Backfill Risk Rating: Low
 - 6) Trench Backfill Risk Type: N/A

B. Approximate Sta: 191+00 – 200+00.

1. Historical agricultural outbuildings are located within the project area that present the potential of encountering buried demolished structures or debris, as further described in Article 3.24 of this Specification.
 - a. A Certified Asbestos Building Inspector (CABI) shall be present during excavations in this project area to assess soils for foundation and/or asbestos containing materials.
 - b. Notify Owner's Construction Manager immediately and refer to the MMP in the event non-standard conditions and potential asbestos materials are encountered.
 - c. CABI shall be familiar with project Materials Management Plan and shall have the authority to direct work in this vicinity to meet the requirements of the Materials Management Plan.
 - d. Obtain Asbestos Abatement Permit in accordance with Section 01 41 24 – Permit Requirements, if encountered.

C. Approximate Sta: 215+00-220+00.

1. Contractor is advised that evidence of a former silage trench exists in this vicinity, as further described in Article 3.24 of this Specification. If unsuitable fill is encountered, Contractor shall notify the Owner's Construction Manager and remove unsuitable fill to the extent required by the Owner's Construction Manager and replace backfill with suitable material.

3.20 WORK IN THE VICINITY OF BOXELDER CREEK – APPROXIMATE STATION 92+00 TO 93+00

A. The following BMPs shall be employed for all work crossing Boxelder Creek:

1. Contractor shall limit crossing of Box Elder creek to a single crossing location.
2. Contractor shall avoid crossings from April 1 to May 31 of any year, or in periods of high flow.
3. Disinfection:
 - a. Contractor to disinfect all equipment that was previously used in a river, stream, lake, pond, or other body prior to use in Box Elder Creek, in accordance with disinfection procedures indicated in this Section.

3.21 EXISTING INFRASTRUCTURE CROSSING REQUIREMENTS

- A. Provide all documentation of all notifications and correspondence for all agencies and infrastructure owners to the Owner's Construction Manager.
- B. Contractor shall coordinate with Owner's Construction Manager to obtain copies of all Owner obtained agreements.
- C. Northern Weld County Water District
 1. Crossing Agreement obtained by Owner. Copies of the agreement will be provided by Owner's Construction Manager.
 2. Approximate Sta: 144+50 – 145+50; 177+00 - 178+00; 242+00-242+50
 - a. When in public right-of-way (R/W), the appropriate permit must be obtained from the agency with jurisdiction for the R/W. When on private property within a NWCWD Easement area, the approval or right-of-entry shall be obtained from the property owner.
 - b. The original/signed copy of the Approval and the Plan and Profile Drawing(s) shall be on-site during construction with a copy available for NWCWD's Inspector.
 - c. Inspection Notice - Contractor shall arrange for a NWCWD inspector prior to any construction activities, including potholing, regardless whether the waterline is in an easement or a R/W.
 - d. A NWCWD representative shall be present to verify all potholing, encroachments, and/or crossings. To schedule this service, call (970) 356-3020 a minimum of 48 hours prior to commencing work on site.
- D. Anheuser Busch Force Mains
 1. Crossing Agreement obtained by [Owner].

2. Approximate Sta: 141+00 to 146+00
- E. Oneok/Magellan HP Gas
1. Crossing Agreement obtained by [Owner].
 2. Approximate Sta: 186+50-188+00
 3. Magellan is a wholly owned subsidiary of Oneok Petroleum.
 4. Magellan's Actual easement boundary as shown on Contract Drawings.
 5. General:
 - a. Magellan pipeline systems operate at high pressures, and for safety reasons, Magellan requires its company representatives to be on-site while Contractor is excavating or performing other activities which could endanger the pipelines or other facilities on Magellan's Easement Tract. For other activities of the Contractor on the Magellan Easement Tract, the Magellan field representative shall determine whether Magellan's continuous presence or periodic monitoring of encroachment activities will be required and shall inform the Contractor. A Magellan representative will be made available upon 48 hours notice (exclusive of weekends and holidays) to determine the location and approximate depth of any Magellan pipelines. No excavation shall be commenced without prior written approval from Magellan and verification by Magellan of the location and approximate depth of its pipelines.
 - b. Magellan's Facilities. The facilities include, but are not limited to, the Easement, rights of way, pipelines, meter and valve sites, aboveground piping manifolds, and cathodic protection systems.
 - c. Contractor must comply with all applicable laws and regulations, as well as Magellan's policies as expressed herein. Contractor is also hereby referred to the Common Ground Alliance Best Practices which can be found on the web site: www.commongroundalliance.com (See "Program Information" / "Best Practices") and which is available from Common Ground Alliance in booklet form for easy reference. Best Practices addresses the most common issues for damage prevention for an encroaching party, including, among others: Planning and Design; One-Call Center; Locating and Marking; Excavation; and Mapping. In the event of a conflict between laws and regulations, Magellan's policies and the Common Ground Alliance Best Practices, the following priority shall govern all encroachments on Magellan's Easement Tract: 1st -- laws and regulations; 2nd -- Magellan policies; and 3rd -- Common Ground Alliance Best Practices.
 6. Magellan Right of Way Practices:
 - a. Personal Property and Fixtures To Be Kept Off of Magellan's Easement Tract. In order to keep Magellan rights of way clear for operations, maintenance, inspection, repair, replacement, and emergency access, personal property and fixtures shall not be placed, stored, or maintained on Magellan's Easement Tract. Personal property and fixtures include, but are not limited to, storage sheds, automobiles, trailers, mobile homes, above-ground swimming pools, business equipment, product inventory, scrap metal, boulders, large rocks, debris, junk, and piles of materials.
 - b. Encroachments Subject to Being Cleared from Magellan's Easement Tract. Subject to the terms of its Easement (including right of way agreement(s) and other written agreements), Magellan shall have the right, but not the obligation, to keep Magellan's Easement Tract clear of items that Magellan determines may hinder the exercise of Magellan's rights to construct, operate, inspect, maintain, repair, replace, and access its pipelines and other facilities. Clearing of the Magellan Easement Tract shall include, but not be limited to, the following: removal of trees, brush, crops, other vegetation and non-permitted encroachments located on or overhanging all or part of any Magellan's Easement Tract. Trees or other vegetation overhanging Magellan's Easement Tract may be side-trimmed.
 - c. Soil On Magellan's Easement Tract -- Removing and Adding. No soil shall be removed from or added to Magellan's Easement Tract without prior written authorization from Magellan. Any soil added must be clean fill dirt (without contaminants, trash or debris)

- and must be limited in amount so that the resulting cover (vertical distance from the surface of the land to the top of Magellan's pipeline) is not greater than eight feet (8').
- d. Erosion Control Materials. Erosion-control materials may be allowed on Magellan's Easement Tract for temporary periods of construction and restoration.
 - e. Location and Approximate Depth of Pipelines. A Magellan representative is normally available with 48 hours notice (exclusive of weekends and holidays) to determine the location and approximate depth of the pipeline(s). Determining actual depths of pipelines may require pot-holing or hand-digging by, and at the expense of Contractor in the presence of an authorized Magellan representative. No excavation on Magellan's Easement Tract shall take place without prior approval by Magellan.
 - f. Construction Equipment Information. Contractor shall provide to Magellan information as to the type, size, and weight of construction equipment that Contractor proposes to use over or in the vicinity of the pipeline(s).
 - 1) Prior to any construction activity occurring with Magellan's easement, provide documentation of correspondence with Magellan to Owner's Construction Manager, including Magellan's requirements for equipment crossing.
7. Utility Crossings:
- a. Minimum Angle for Pipeline/Utility Crossing. Any foreign pipeline or utility that is proposed to cross a pipeline on Magellan's Easement Tract must cross such pipeline at an angle as close to 90 degrees as possible, but in no event at an angle less than 45 degrees.
 - b. Vertical Separation Requirements for Crossing. Foreign pipeline(s), utilities (except high-voltage lines – see below) or flow lines should cross pipeline(s) on Magellan's Easement Tract with at least 24 inches of vertical separation. Special written authorization must be given in the event vertical separation is less than that specified in these General Encroachment Requirements. The preferred method for a foreign pipeline or utility to cross a pipeline is to cross below the Magellan pipeline.
 - c. Warning Tape Required. When any foreign pipeline or utility line is proposed to cross a pipeline on Magellan's Easement Tract, Contractor must place 6" wide McMaster-Carr No. 8288T12 or equal within Magellan's Easement Tract in the following manner:
 - 1) The tape must be placed directly over (parallel to) and at least 15 inches above the foreign line for the entire distance that it occupies Magellan's Easement Tract. Additionally, the tape must be placed directly over (parallel to) and at least 15 inches above each pipeline that is crossed for a minimum distance which is the greater of:
 - a) a minimum distance of 20 feet on each side of the pipeline, or
 - b) across the entire width of Magellan's Easement Tract
 - 2) The placement of warning tape on each side of pipeline(s) on Magellan's Easement Tract will not be required for utility cables that are installed using the directional drill or jacking method.
 - d. Crossings by Metal Pipelines or Conduits. Metallic pipe crossing pipeline(s) on Magellan's Easement Tract may require Magellan to perform a cathodic protection interference survey. If interference with Magellan's cathodic protection system is detected and remediation is necessary, notify Owner's Construction Manager for Coordination.
 - e. Crossing Requirements. Electrical, fiber optic, local service communication, long distance carrier telephone, and utility cables should cross Magellan pipeline(s) with a minimum of 24-inches of vertical separation. All such lines must be covered with a Concrete Slab for the full width of the Easement Tract, if requested by Magellan. If such lines have an exposed concentric neutral, a test point from the ground wire shall be installed by the power company.
 - f. Crossing Requirements for Lines Going Over a Magellan Pipeline. In the event the electrical, fiber optic, local service communication, long distance carrier telephone, and utility cable crosses over a pipeline on Magellan's Easement Tract, such line shall be

encased in red concrete across the full width of Magellan's Easement Tract, unless a variance is granted by Magellan, as set forth below.

- g. Written Authorization for Variance. Contractor must have written authorization from Magellan for any variance from the vertical separation requirements listed above and/or for any variance from the requirement for encasement of high-voltage electrical lines in red concrete.
- 8. Excavation Near Magellan Pipelines
 - a. STATE "ONE-CALL" REQUIRED. No excavation or encroachment shall be performed by Contractor the vicinity of Magellan's facilities or within Magellan's Easement Tract until proper telephone notification has been made to the appropriate "One Call" system and a Magellan representative is on-site to monitor excavation activities. All of the states in which Magellan conducts pipeline operations have "One Call" laws, which require 48-72-hours notification prior to any excavation related activities. After making a One-Call, the state One-Call agency will notify Magellan to mark accurately, in a reasonable and timely manner, the location of Magellan's pipeline facilities in the vicinity of the proposed encroachment.
 - b. ONE-CALL NOTIFICATION. The following information is provided for convenience, but is not warranted by Magellan to be complete or accurate (telephone numbers were copied from each state's web site on 1/5/2004). Contractor is required to acquire and call the appropriate One-Call number(s) for its location of activity.
 - 1) Colorado - www.colorado811.org/ - 811 or 800 922-1987
 - c. Excavation Plan Approval. Contractor shall submit to Magellan for its approval plans for any proposed excavation on Magellan's Easement Tract. No excavation on Magellan's Easement Tract shall be commenced until Contractor has secured Magellan's written approval of the plans. The excavation work shall be in compliance with all applicable laws and regulations. Contractor is also referred to the Common Ground Alliance Best Practices.
 - d. Magellan Representative On-Site for Excavation. A Magellan representative must be on-site when an excavation is occurring on Magellan's Easement Tract.
 - e. Removal of Side-Cutting Teeth from Equipment. Side-cutting teeth shall be removed from buckets of excavating equipment.
 - f. Parallel Excavating Required. When, in preparation for crossing any pipeline on Magellan's Easement Tract with any other pipeline or with electric line, communication line, roadway or any other structure or facility, Contractor needs to locate the pipelines by use of mechanical means. Contractor must perform such locating activity by excavating parallel to each of the pipelines with such mechanical means, but shall cease using the mechanical means when it reaches a point within two feet of the Magellan pipeline (see next provision).
 - g. Exposing Pipeline by Hand. Excavating within 2 feet of any pipeline on Magellan's Easement Tract shall be done by hand-digging until the pipeline is exposed and its location is accurately known. Then, Contractor must position the excavation equipment so that from the point of operations the equipment will not reach within 2 feet of any pipeline.

F. Poudre Valley Rural Electric Association (PVREA)

- 1. Crossing agreement obtained by Owner.
- 2. Approximate Sta: 242+25
 - a. Premises of Electric Lines of PVREA are defined in the Crossing Agreement.
- 3. Contractor has the right of ingress and egress to and from PVREA right-of-way as necessary and reasonable for the exercise of the crossing, said rights to be exercised, however, only within the space of twenty (20) feet on each side of the center-line of the 42-inch waterline, and shall not extend to the entire easement right-of-way.

4. Contractor shall comply with all federal, state and local laws, rules and regulations and codes applicable to the Facilities including, but not limited to, the National Electric Safety Code and industry standards.
5. The Facilities placed in or upon the Premises of the Electric Lines of PVREA, shall be maintained below the Electric Lines at such a depth not less than two (2) feet, so as not to interfere in any manner with the PVREA's operation, maintenance, or other use of its Electric Lines.
6. Durable markers such as Carsonite® posts or equivalent shall be placed where the permitted Facilities enter and depart the Premises and at all points of change in direction of the permitted Facilities within the Premises. If said markers cannot practically be set over the centerline of the permitted Facilities because of roadways, similar obstructions on the surface, or because they would interfere with the operations of the fee title owner of the Premises or others owning proprietary interest in the Premises, the markers shall be placed as closely as practicable to said centerline. Such markers shall have a placard affixed, bearing the legend, "Marker is not over underground facility," or equivalent. All crossings shall be maintained within the restrictions of the National Electrical Safety Code, and other requirements of PVREA.
7. Contractor shall provide PVREA a minimum of 45 calendar days advance written notice before accessing PVREA rights-of-way and commencing any construction. Furthermore, contractor shall notify PVREA at 970-282-6483 and 970-282-6451 a minimum of 3 weeks before performing any excavation or using any oversized equipment near electric facilities.
8. Should any PVREA facilities need supporting during construction, contractor shall provide PVREA a minimum of 15 calendar Days advance notice so PVREA can plan resources accordingly.
9. The contractor shall install utility markers / signs on both sides of the crossing of PVREA rights-of-way or easements.
10. Contractor shall be aware that overhead electric conductors are not insulated and will transmit and continue to transmit electrical current during construction. Contractor shall notify all employees, subcontractors, or other persons involved with construction of the dangers involved. Contractor shall ensure that all workers in proximity of the energized lines are qualified as defined in OSHA 29 CFR 1910.269, latest edition. If contractor does not have OSHA qualified workers, Contractor shall notify PVREA a minimum of 15 calendar days advance notice to schedule qualified standby personnel.

G. Water Supply and Storage Company (Larimer County Canal)

1. Crossing Agreement obtained by Owner.
2. Approximate Sta: 140+50
3. Work within the limits of the Larimer County Canal (LCC) is prohibited when water is running in the canal from April 1 to October 31 (annually) unless written permission is granted from the Water Supply and Storage Company (WSSC).
4. Record documents must be delivered to the WSSC within 30 days of the completion of the LCC Crossing

H. Public Service Company of Colorado (Xcel)

1. Crossing requirements for Xcel infrastructure has been coordinated throughout design with Xcel, the requirements for which have been incorporated into the Contract Drawings. A formal crossing agreement has not been obtained.
2. Approximate Sta: 58+60
3. Approximate Sta: 61+15
4. Approximate Sta: 144+64
5. Approximate Sta: 163+07
6. Approximate Sta: 177+79
7. Approximate Sta: 188+19

3.22 WORK IN LARIMER COUNTY

- A. Contractor shall allow access to Larimer County Staff and consultants for inspections and construction observation throughout the Project and for the term of the construction and any required ongoing monitoring during site reclamation and/or operations. As required by Larimer County 1041 Permit Condition of Approval #39.
- B. Contractor shall allow access and make reasonable accommodations to facilitate independent, supplemental geotechnical or materials testing by Larimer County during the course of construction.
- C. Contractor shall comply with all Larimer County floodplain regulations, including any permit requirements associated with the Floodplain Development Permit.
- D. The areas of construction shall be accessed using existing roads to the maximum extent possible. Any temporary access roads shall be removed upon completion of the Project, and the area restored to preconstruction conditions, in accordance with Larimer County 1041 Permit Condition of Approval #65
- E. Contractor must comply with all requirements and conditions of Owner-obtained Larimer County Development Construction Permit, in accordance with Section 01 41 24 – Permit Requirements.

3.23 WORK IN LARIMER COUNTY ROW

- A. Contractor shall obtain Larimer County Right of Way Permit in accordance with Section 01 41 24 – Permit Requirements and comply with all requirements associated with the permit.
 - 1. Contractor is Advised that Owner's Fiber Optic Contractor may access hand holes within Larimer County ROW for fiber optic installation under Contractor's Permit. Coordinate with Owner's Construction Manager to allow fiber optic installation activities under Contractor's permit when practical.
- B. Contractor shall capture and submit a pre-project video capturing existing conditions of the proposed water line installation corridor in and near the existing ROW in accordance with the requirements of Section 01 33 50 – Site Conditions Survey.
- C. Any proposed open cut road crossing shall be flow-filled to a depth of 2-feet below the surface of the roadway in accordance with Larimer County 1041 Permit Condition of Approval #33.
- D. Material test reports, as per Larimer County Standard, shall be submitted to and approved by Larimer County for any work to take place within County ROW in accordance with Larimer County 1041 Permit Condition of Approval #36.
- E. Contractor is responsible for arranging and paying all costs of: Utility relocations and irrigation company requirements necessary to accommodate the water pipeline in the road ROW, The replacement of existing storm drainage infrastructure, culverts, roadway signage, pavement striping/symbols, landscaping and property fencing necessary to accommodate the water pipeline in the ROW, Damage or relocation of private property services as necessary to accommodate the water pipeline corridor if a reasonable alternative is not possible. As required by Larimer County 1041 Permit Condition of Approval #38.
- F. Coordinate all traffic closures, both full and partial, with Larimer County Emergency Services and Poudre R-1 School District on road closures with advance notice to address school bus access in accordance with Section 01 55 26 – Traffic Control.
- G. When construction activity is taking place within or impacting Larimer County ROW in any way, the applicant shall obtain and abide by the standards and conditions of applicable County ROW permit(s), per the Code of Ordinances and the Land Use Code. Construction plans shall be provided to detail the work to be completed. Additionally, Traffic Control Plans are required in accordance with Section 01 55 26 – Traffic Control.
- H. Access Permits will be required for any new access from Larimer County ROW, in accordance with Section 01 41 24 - Permit Requirements, regardless of whether they are to be used for temporary construction purposes. Staff may also require an Access Permit for existing access

points proposed to be utilized for temporary construction access. Contractor is responsible to apply for access permits for temporary access locations and pay associated permitting fees.

3.24 CULTURAL RESOURCES IN WORK AREA

- A. There are no cultural sites or structures within the limits of construction that are listed on the State or National Register of Historic Places.
- B. If the Contractor identifies or suspects evidence of cultural, historical, or archeological resources during construction, the Contractor shall immediately cease all excavation and notify the Owner's Construction Manager.
 - 1. Owner's Construction Manager will immediately notify the Owner, ERO Resources, the Colorado State Historic Preservation Office, and Larimer County.
 - 2. Contractor may experience delays until the required due diligence is performed by ERO and the governing authorities and plans / procedures are developed for resuming construction.
 - 3. Work shall be discontinued until notified by the Owner's Construction Manager that work may proceed.
 - 4. Compensation to the Contractor, if any, for lost time, demobilization, remobilization, or changes to construction shall be determined in accordance with changed or extra work provisions of the General Conditions.

3.25 CONTAMINATED SOILS AND MATERIALS

- A. An Environmental Records Review (ERR) was conducted to review historical information and federal, state, and local records to identify areas of concern (AOC) with the potential for encountering unknown contamination along the alignment. The following areas of concern (AOC) require actions from the Contractor. [In the event contaminated soils are encountered, the Contractor shall refer to and comply with the requirements of the Materials Management Plan (MMP) included as Appendix /Attachment X]. All handling and disposal requirements of contaminated soils shall comply with Federal and State regulations.
 - 1. AOC 1 Sta 10+00 to Sta 36+00: Portions of the project area that run parallel to the Burlington Northern and Santa Fe (BNSF) presents the potential of encountering buried materials and contaminants associated with railroad tracks. Contractor shall notify the Owner's Construction Manager immediately and refer to the MMP in the event non-standard conditions are encountered.
 - 2. AOC 2 Sta 86+50 to Sta 88+00: Work in the area of active rural runway presents the potential of encountering contaminated soils associated with aircraft use. Contractor shall notify the Owner's Construction Manager immediately and refer to the MMP in the event non-standard conditions are encountered.
 - 3. AOC 3 Sta 191+00 to Sta 200+00: Historical agricultural outbuildings are located within the project area that present the potential of encountering buried demolished structures or debris. A certified asbestos building inspector (CABI) shall be present during excavations in the area to assess soils for foundation and/or asbestos containing building materials. Contractor shall notify the Owner's Construction Manager immediately and refer to the MMP in the event non-standard conditions and potential asbestos materials are encountered.
 - 4. AOC 4 Sta 215+00 to Sta 220+00: Evidence of a former silage trench suspected to be in this vicinity presents the potential of encountering buried debris and unknown soil conditions. If unsuitable fill is encountered, Contractor shall notify the Owner's Construction Manager immediately, remove unsuitable fill to the extent required by the Owner's Construction Manager, and replace backfill with suitable material. Contractor shall refer to the MMP in the event non-standard conditions are encountered.
- B. The Contractor shall designate an Environmental Materials Management Coordinator (EMMC) that has sufficient knowledge and experience to identify suspected contaminated soils, groundwater, or other media within the project area, should they be encountered. The EMMC shall have the knowledge and experience with contaminated soil conditions and:
 - 1. Be accessible during all construction activities should suspicious material be encountered.

2. Have sufficient training, awareness, and knowledge to identify field indications of contamination such as visual staining, discoloration, or oil sheen and able to use and interpret field equipment reading such as a Photoionization Detector (PID) used during the course of excavation to monitor for potential soil contamination.
 3. Have sufficient knowledge, training, and authority to coordinate the identification, confirmation, management and disposal of suspected or confirmed contaminated soils, groundwater, or other media. The presence of potentially contaminated soils shall be determined through:
 - a. Visual detection of staining, discoloration, or oil sheen.
 - b. Odor detection
 - c. PID monitoring device
- C. If contaminated or potentially contaminated soils are identified, the Contractor shall take the necessary precautions to protect all Contractor personnel, Owner, Owners Advisor, Owner's Construction Manager, Engineer, project area and lands.
1. Contractor shall immediately notify the Owner's Construction Manager of the potential for contaminated soil.
 2. Contractor shall segregate and remove potentially contaminated soil from the site for further disposition, analysis, and removal. Contractor shall replace material removed from the site with acceptable fill.
 3. All contaminated soils shall be transported and disposed off-site at a certified Subtitle D landfill under a manifest in accordance with state and federal regulations. Contractor shall retain all copies of all laboratory data, profile approvals, manifests, and bills of lading for any contaminated soils encountered and removed. Owner shall approve waste disposal profile and disposal facility prior to any disposal. Potential Subtitle D landfills include:
 - a. Republic
 - b. Waste Connections
 - c. Waste Management
- D. A bid item is included as a contingency for encountering contaminated soil and is described in the Measurement and Payment.

3.26 TEMPORARY ACCESS CLOSURES

- A. Contractor shall schedule all public and private access closures, if required, with the individual property owners in accordance with Section 01 55 26 – Traffic Control.

3.27 ATTACHMENTS

- A. The following, bound after this Specifications Section's "End of Section" designation, are part of this Specifications Section:
1. Register:
 - a. 01 35 13 Plans and Logs Register
 2. Technical Specifications
 - a. Attachment A – Project Technical Specifications

END OF SECTION

01 35 13 Plans and Logs Register				
Plan / Log	Governing basis	Due / frequency	Reviewed by	Shared or segment-specific
Fugitive Dust Control Plan	F.1: 01 41 10 (1041/DCP support); F.2: 01 57 05, 01 41 24	DCP support, per 01 41 24 (within six weeks of Construction NTP)	Larimer County via Owner's CM	Shared where County accepts
Air Emission Control Plan	F.1: 01 41 10 (APEN); F.2: 01 57 05, 01 41 24	DCP support, per 01 41 24	Larimer County / CDPHE via Owner's CM	Shared where agency accepts
Noise Mitigation Plan	F.1: 01 41 10 (1041/DCP support); F.2: 01 57 05, 01 41 24	DCP support, per 01 57 05	Larimer County via Owner's CM	Shared where County accepts
Exterior Lighting Management Plan	F.1: 01 41 10 (1041/DCP support); F.2: 01 57 05, 01 41 24	Per 01 57 05 (1041 COA #81)	Larimer County via Owner's CM	Shared where County accepts
Comprehensive BMP Plan	F.1: 01 41 10 (1041/DCP support); F.2: 01 57 05, 01 41 24	DCP support, per 01 41 24	Larimer County via Owner's CM	Shared where County accepts
Traffic Control and Management Plan	F.1: 01 55 26; F.2: 01 55 26, 01 41 24	DCP support; before affected work	County / CDOT / Owner's CM	Combined package where agencies accept; segment-specific sheets
SWMP and Erosion and Sediment Control Plan	F.1: 01 41 10 (CDPHE COR-400000); F.2: 01 41 24	With CDPHE permit application; per 01 41 24	CDPHE / County / Owner's CM	Combined where CDPHE and County accept
Emergency Utility Plan	F.1: 01 41 10 (1041/DCP support); F.2: 01 50 10, 01 41 24	DCP support, per 01 41 24	Larimer County via Owner's CM	Shared where County accepts
Haul Road Inventory (pre-construction; update as required)	F.1: 01 41 10 (1041/DCP support); F.2: 01 50 10, 01 41 24	DCP support, per 01 41 24	Larimer County via Owner's CM	Shared where County accepts
Pre-Construction Site Survey and video (Larimer County)	F.1: 01 32 33; F.2: 01 33 50	Video to County within six weeks of Construction NTP	Larimer County via CM	Segment-indexed
Hazard Communication and Spill Response Plans (including SPCC where required) and spill log	F.2: 01 35 13, 01 57 05; F.1: added by this Register	Before construction; log maintained ongoing	Owner's CM	Shared
Stockpile Stabilization Plan	F.2: 01 35 13; F.1: added by this Register	Before stripping/stockpiling; maintain current	Owner's CM	Shared
Daily Soil Handling Log	F.2: 01 35 13; F.1: added by this Register	Daily during soil handling	Owner's CM	Shared, segment-coded entries
Stockpile Tracking Log (F.2 Appendix B form)	F.2: 01 35 13; F.1: added by this Register	Ongoing	Owner's CM	Shared, segment-coded entries
Restoration records (pre/post condition, seeding, soil amendments)	F.1: 01 41 10, 32 90 10; F.2: 01 35 13, Restoration Plan	Ongoing; at restoration milestones	Owner's CM and Owner's specialists	Segment-indexed

Appendix A

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PART 1 - PART 1 – GENERAL CONTRACT PROVISIONS

50-07 Pre-Construction Survey Prior to the start of construction, contractor shall survey the existing surface of the turf runway at a minimum 10-foot longitudinal spacing along the length of the runway, within the area of disturbance, plus an additional 3 10-ft sections (30-ft total) past both limits of disturbance. Minimum cross-section grade points shall include grade at centerline, edges of turf runway, points at 40-ft on either side of centerline of runway (or property limit), 60-ft on either side of runway (or property limit) and any grade breaks in between. The survey and documentation shall be stamped and signed by a State Licensed Land Surveyor and transmitted to the Engineer for review prior to start of excavation. Pre-construction survey shall include necessary horizontal and vertical control.

Contractor shall establish necessary horizontal and vertical control. The establishment of Survey Control and/or reestablishment of survey control shall be by a State Licensed Land Surveyor. Contractor is responsible for preserving integrity of horizontal and vertical controls.

50-07 Construction layout and stakes.

Prior to the start of construction layout and staking, the Contractor will check all control points for horizontal and vertical accuracy and certify in writing to the RPR that the Contractor concurs with survey control established for the project. All lines, grades and measurements from control points necessary for the proper execution and control of the work on this project will be provided to the RPR. The Contractor is responsible to establish all layout required for the construction of the project.

Contractor shall stake the site for finished grading in accordance with the same survey pattern for which the pre-construction survey was conducted. Final grading shall be conducted in accordance with P-152.

50-07 Post-Construction Survey Construction layout and stakes.

Upon completion of final grading, contractor shall conduct a post-construction survey in the presence of the RPR. Survey shall be conducted by a State Licensed Land Surveyor, in the same survey pattern for which the pre-construction survey was conducted.

Copies of survey notes will be provided to the RPR for each area of construction and for each placement of material as specified to allow the RPR to make periodic checks for conformance with plan grades, alignments and grade tolerances required by the applicable material specifications. Surveys will be provided to the RPR prior to commencing work items that cover or disturb the survey staking. Survey(s) and notes shall be provided in the following format(s): **LandXML format for a Civil3D Surface file**
No direct payment will be made, unless otherwise specified in contract documents, for this labor, materials, or other expenses. The cost shall be included in the price of the bid for the various items of the Contract.

1.1 ITEM P-152 EXCAVATION, SUBGRADE, AND EMBANKMENT

DESCRIPTION

152-1.1 This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

152-1.2 Classification. All material excavated shall be classified as defined below:

a. Suitable excavation. Suitable excavation shall consist of the excavation, stockpiling, and reuse and ~~disposal~~ of all material that is considered suitable for embankment, regardless of its nature

152-1.3 Unsuitable excavation. Unsuitable material discovered upon excavation shall be disposed in designated waste areas as shown on the plans. Materials containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction.

CONSTRUCTION METHODS

152-2.1 General. Before beginning excavation, grading, and embankment operations in any area, the area shall be ~~cleared or cleared and grubbed in accordance with Item P-151~~ stripped of topsoil in accordance with T-905.

The suitability of material to be placed in embankments shall be subject to approval by the RPR. All unsuitable material shall be disposed of in waste areas as shown on the plans.

152-2.2 Excavation. No excavation shall be started until the ~~work has been staked out~~ existing site has been surveyed per section 50-07 by the Contractor and the RPR has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface.

All areas to be excavated shall be stripped of vegetation and topsoil in accordance with T-905. Topsoil shall be stockpiled ~~for future use in areas designated on the plans or by the RPR~~ adjacent to the trench excavation. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes ~~as~~ shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

When the volume of the excavation exceeds that required to construct the ~~embankments~~ trench backfill to the grades as indicated on the plans, the excess shall be disposed of as directed by the RPR.

a. Selective grading. When selective grading is indicated on the plans, the more suitable material designated by the RPR shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved.

b. Undercutting. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the RPR. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed of at locations shown on the plans. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill will constitute a part of the embankment.

152-2.8 Formation of embankments.

Prior to backfilling soil in trench. CLSM shall be installed above waterline according to Specification P-153 and details provided. Backfilling shall not begin until CLSM material has met proper cure time.

The material shall be constructed in lifts ~~as established in the control strip,~~ but not less than 6 inches (150 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests

verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the RPR. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within $\pm 2\%$ of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The Contractor will take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D 1557 . A new Proctor shall be developed for each soil type based on visual classification.

Density tests will be taken by the Contractor in the presence of the RPR for each lift which is required to be compacted, or other appropriate frequencies as determined by the RPR.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until each lift of the embankment is compacted to the compaction requirements described in 152-2.10 Compaction requirements.

No compaction will be required on the top 4 inches which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with ASTM 6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. . The Contractor's laboratory shall perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance. If the specified density is not attained, the area represented by the test or as designated by the RPR shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

~~When~~ If rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be disposed of in waste areas as shown on the plans

152-2.9 Proof rolling. The purpose of proof rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. After compaction of each lift is completed, the subgrade area shall be proof rolled with a 20 ton Tandem axle Dual Wheel Dump Truck loaded to the legal limit with tires inflated to 150 psi in the presence of the RPR. Apply a minimum of two coverages, or as specified by the RPR, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be removed and replaced with suitable material or reworked to conform to the moisture content and compaction requirements in accordance with these specifications. Removal and replacement of soft areas is incidental to this item.

152-2.10 Compaction requirements. ~~The subgrade under areas to be paved~~ Each lift of subgrade shall be compacted to a maximum depth of 12 inches (300 mm) and to a density of not less than 100 percent of the maximum dry density as determined by ASTM D698.

The material to be compacted shall be within $\pm 2\%$ of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the $\frac{3}{4}$ inch (19.0 mm) sieve, follow the methods in ASTM D698. Tests for moisture content and compaction will be taken at a minimum of **one per each lift**. All quality assurance testing shall be done by the Contractor's laboratory in the presence of the RPR, and density test results shall be furnished upon completion to the RPR for acceptance determination.

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified. If the specified density is not attained, the entire lot shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment ~~shown on the plans to match the pre-construction existing condition~~, or as directed by the RPR and the finished subgrade shall be maintained.

152-2.11 Finishing and protection of subgrade. Finishing and protection of the subgrade is incidental to this item. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low areas, holes or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been accepted by the RPR.

152-2.12 Haul. All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be made for any work or materials associated with providing, maintaining and removing haul roads or routes.

152-2.13 Surface Tolerances. ~~In those areas on which a subbase or base course is to be placed,~~ The surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor's expense.

- a. **Smoothness.** The finished surface shall not vary more than $\pm \frac{1}{2}$ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 10-foot grid.
- b. **Grade.** The grade and crown shall be measured on a grid as specified in 50-07 and shall be within ± 0.05 feet (15 mm) of the specified grade.

On safety areas, turfed areas and other designated areas within the grading limits where no subbase or base is to be placed, grade shall not vary more than 0.10 feet (30 mm) from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.14 Topsoil. When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located adjacent to the excavation.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

152-2.15 Warranty: Turf Runway Trench Backfill Settlement and Restoration

- Contractor shall be responsible for stability of backfill within the turf runway for a period of twelve (12) months following Substantial Completion
- If surface irregularities caused by settlement or erosion are identified by the Owner or Engineer, the Contractor shall, at no additional cost to the Owner:
 - Return to the site,
 - Fine-grade surface per smoothness requirements
 - Re-establish final grades matching the surrounding turf runway
 - Re-compact backfill, and
 - Restore turf, including topsoil placement, seeding, fertilization, and erosion control, to achieve uniform coverage consistent with adjacent areas.
- Settlement shall be defined as:
 - Vertical differential exceeding ½ inch relative to adjacent runway surface,
 - Loss of positive drainage, or
 - Depressions, rutting, or soft areas that could affect aircraft operations or mowing equipment
- All corrective work shall be completed within five (5) calendar days of notification, or within a timeframe approved by the Owner that considers runway operational requirements.
- All settlement correction and turf restoration work shall be considered incidental to the Contract

METHOD OF MEASUREMENT

152-3.1 Not used

BASIS OF PAYMENT

152-4.1 Not used.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
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ASTM International (ASTM)

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
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ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
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ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2700 kN-m/m ³))
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
Advisory Circulars (AC)	
AC 150/5370-2	Operational Safety on Airports During Construction Software
Software	
FAARFIELD – FAA Rigid and Flexible Iterative Elastic Layered Design	
U.S. Department of Transportation	
FAA RD-76-66	Design and Construction of Airport Pavements on Expansive Soils

END OF ITEM P-152

PART 1 - PART 12 – TURFING

1.1 ITEM T-901 SEEDING

DESCRIPTION

901-1.1 This item shall consist of soil preparation, seeding and fertilizing the areas shown on the plans or as directed by the RPR in accordance with these specifications.

MATERIALS

901-2.1 Seed. The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the RPR duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected. **Seeds shall be applied as follows:**

Seed Properties and Rate of Application

Seed	Minimum Seed Purity (Percent)	Minimum Germination (Percent)	Rate of Application lb/acre (or lb/1,000 S.F.)
Tall Fescue (turf-type, endophyte enhanced)	95%	85%	121 lb/acre
Kentucky Bluegrass (drought-tolerant cultivars)	90%	80%	44 lb/acre
Perennial Ryegrass (turf-type)	97%	90%	22 lb/acre
Crested Wheatgrass or Western Wheatgrass	95%	85%	22 lb/acre
Buffalograss (improved cultivar)	90%	70%	11 lb/acre
			Total: 220 lb/acre

Seeding shall be performed during the period between August 15 and September 30 (primary) or April 15 – May 31 (Secondary) inclusive, unless otherwise approved by the RPR.

901-2.2 Lime. Not required.

901-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state

laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be a complete commercial starter fertilizer with a minimum ratio of 10-20-10 (N-P-K) (or higher phosphorus content) and shall be spread at the rate of 0.5 to 0.75 pound of available nitrogen per 1,000 square feet.

901-2.4 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry application method.

a. Liming. Not required.

b. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity stated in paragraph 901-2.3.

c. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

d. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

901-3.3 Wet application method.

a. General. The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

c. Mixtures. Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Contractor shall identify to the RPR all sources of water at least two (2) weeks prior to use. The RPR may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the RPR following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the RPR, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

901-3.4 Maintenance of seeded areas. The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the RPR. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the RPR. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

901-3.5 Temporary Irrigation Establishment and Maintenance

Temporary Irrigation

Temporary irrigation shall be utilized during the establishment period to ensure germination and early root development.

Contractor shall develop a temporary irrigation plan that provides adequate coverage of the seed development surfaces. Contractor shall submit plan for approval no less than 14 calendar days in advance of starting work.

Temporary irrigation plan shall provide adequate coverage of site of re-seeding while maintaining proper clearance for aircraft or other equipment to operate as necessary. Any temporary irrigation equipment shall be set back at minimum 60-ft from centerlines to remain clear of the Runway Safety Area.

Maintenance Approach

The turf area must be actively inspected and maintained for a period of **90 calendar days** following initial seeding to reduce attractiveness to wildlife and maintain safe operating conditions.

Contractor shall coordinate a maintenance schedule in advance that is acceptable to all parties, as well as provide at least 72-hours' notice of any scheduled arrival. At no time shall the Contractor arrive to the site unscheduled.

Key maintenance elements shall include:

- Mowing: Contractor shall be responsible to mow the site until acceptance. Maintain a consistent, intermediate grass height to discourage wildlife use while ensuring a smooth and uniform surface.
- Weed control: Contractor shall implement an active weed management program, particularly during early establishment, to prevent invasive species from compromising turf quality.
- Reseeding/overseeding: Periodic reseeding by contractor may be required to address localized wear or disturbance and maintain full coverage.
- Inspection and repair: Routine inspection of the runway surface should be conducted by contractor to identify and correct any areas of thinning, rutting, or unevenness.

901-3.6 Warranty: Turf Establishment and Seeding Performance

- Contractor shall warrant all seeding, turf establishment, and associated work performed under Item T-901 for a period of twelve (12) months following Substantial Completion or Final Acceptance of seeding, whichever occurs later.
- Contractor shall be responsible for the successful establishment, uniformity, and continuing viability of turf within all seeded areas during the warranty period.
- If areas of turf failure, inadequate establishment, erosion, or non-uniform growth are identified by the Owner or Engineer during the warranty period, the Contractor shall, at no additional cost to the Owner:
 - Return to the site,
 - Remove failed or deficient vegetation as necessary,
 - Prepare seedbed in accordance with Item T-901,
 - Reapply topsoil where required,
 - Reseed the affected areas using the specified seed mix and application rates,
 - Reapply fertilizer, mulch, and erosion control measures,

- Water and maintain reseeded areas as required to achieve successful establishment consistent with adjacent turf.
- Turf failure shall be defined as one or more of the following conditions:
 - Less than 90 percent uniform turf coverage over any contiguous area greater than 10 square feet.
 - Evidence of erosion, washout, or exposed soil.
 - Excessive weed growth indicating inadequate turf establishment.
 - Turf conditions that could result in foreign object debris (FOD), adverse drainage, or interfere with aircraft operations or mowing equipment.
- Corrective work shall begin within five (5) calendar days of written notification and shall be completed within a timeframe approved by the Owner that considers seasonal constraints and airfield operational requirements.
- All reseeding and turf restoration performed during the warranty period shall reset the warranty for the corrected areas for an additional twelve (12) months from the date of acceptance of the remedial work.
- All warranty-related corrective measures shall be considered incidental to the Contract, and no separate payment will be made.

METHOD OF MEASUREMENT

901-4.1 Not used.

BASIS OF PAYMENT

901-5.1 Not used.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602 Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33 Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-901

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1.1 ITEM T-905 TOPSOIL

DESCRIPTION

905-1.1 This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the RPR.

MATERIALS

905-2.1 Topsoil. Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 µm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

905-2.2 Inspection and tests. Within 10 days following acceptance of the bid, the RPR shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

CONSTRUCTION METHODS

905-3.1 General. Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the RPR before the various operations are started.

905-3.2 Preparing the ground surface. Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the RPR, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

905-3.3 Obtaining topsoil. Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the RPR. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the RPR. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the RPR. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoil purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the RPR. The Contractor shall notify the RPR sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

905-3.4 Placing topsoil. The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the RPR. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

METHOD OF MEASUREMENT

905-4.1 Not used.

BASIS OF PAYMENT

905-5.1 Not used.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C117

Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing

Advisory Circulars (AC)

AC 150/5200-33

Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-905

1.1 ITEM T-908 MULCHING

DESCRIPTION

908-1.1 This item shall consist of furnishing, hauling, placing, and securing hydromulch with tackifier on surfaces indicated on the plans or designated by the RPR.

MATERIALS

908-2.1 Mulch material. Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

a. Manufactured mulch. Cellulose-fiber or wood-pulp mulch shall be products commercially available for use in spray applications.

b. Asphalt binder. Asphalt binder material shall conform to the requirements of ASTM D977, Type SS-1 or RS-1.

908-2.2 Inspection. The RPR shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the approval of the RPR and any materials brought on the site that do not meet these standards shall be rejected.

CONSTRUCTION METHODS

908-3.1 Mulching. Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the RPR. Straw or hay shall be spread over the surface to a uniform thickness at the rate of 2 to 3 tons per acre (1800 - 2700 kg per acre) to provide a loose depth of not less than 1-1/2 inches (38 cm) nor more than 3 inches (75 mm). Other organic material shall be spread at the rate directed by the RPR. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches (150 mm) or more in length. When mulches applied by the blowing method are cut, the loose depth in place shall be not less than one inch (25 mm) nor more than 2 inches (50 mm).

908-3.2 Securing mulch. The mulch shall be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, asphalt binder, or other adhesive material approved by the RPR. Where mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and will be held responsible for any such damage resulting from the operation.

If the "peg and string" method is used, the mulch shall be secured by the use of stakes or wire pins driven into the ground on 5-foot (1.5-m) centers or less. Binder twine shall be strung between adjacent stakes in straight lines and crisscrossed diagonally over the mulch, after which the stakes shall be firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

908-3.3 Care and repair.

a. The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the

RPR, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

b. The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the RPR, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

c. If the "asphalt spray" method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m), or as directed by the RPR, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it. Asphalt binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the asphalt material shall be required. A pump or an air compressor of adequate capacity shall be used to ensure uniform distribution of the asphalt material.

d. If the "asphalt mix" method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m) or as directed by the RPR, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it.

METHOD OF MEASUREMENT

908-4.1 Not used.

BASIS OF PAYMENT

908-5.1 Not used.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D977

Standard Specification for Emulsified Asphalt

Advisory Circulars (AC)

AC 150/5200-33

Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-908

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SECTION 01 35 29
HEALTH AND SAFETY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for health and safety during construction, including:
 - a. Compliance with federal, state, and local safety regulations.

B. Scope:

1. Contractor shall provide and maintain materials, equipment, labor, services, and temporary construction as necessary and required to maintain health and safety conditions at the Site and adjacent areas during construction.
2. Contractor shall pay all costs, including fines and civil penalties, if any, for failure to implement and maintain a safe work site in accordance with Laws and Regulations. Contractor is not eligible for increase in Contract Price or Contract Times due to failure to comply with safety requirements.

1.2 SUBMITTALS

A. Action Submittals:

1. Submit the following:
 - a. Qualifications:
 - 1) Safety Representative Qualifications

B. Informational Submittals:

1. Submit the following:
 - a. General:
 - 1) Safety plans and programs.

1.3 SAFETY PROGRAM

- A. For the purposes of this Section, an "active construction area" is any area where construction activities are occurring or construction activities could be considered a potential hazard to people.
- B. Contractor's obligations for safety shall be implemented in such manner that they are understood and carried out by all, including non-English speaking employees.
- C. Owner's receipt of any safety plans or programs will not relieve Contractor in any way from the full and complete responsibility for safety and training of Contractor's personnel, and the onsite personnel of Owner, Designer, and other visitors to areas of construction activity. On a daily basis, Contractor shall inform Owner's Construction Manager of changes to the boundaries of the active construction areas.
- D. Contractor shall be responsible for safety training all Contractor, Supplier, Subcontractor, and other personnel who will have access to the active construction areas.
- E. Safety Program Requirements:
 1. IMMEDIATE notification to Owner's Project Manager of an accident is REQUIRED.
 2. Contractor's Safety Personnel Requirements:
 - a. Contractor shall assign a Contractor Safety Manager as defined by the General Conditions. This position is not required to be full-time. Contractor shall determine time required for the safety representative to fulfill the requirements of the Contract.
 - b. The Safety Representative's duties and responsibilities will be hazard recognition, accident prevention, new employee orientation (including Subcontractor's employees),

and the maintaining and supervising of safety precautions and program. This person shall have no other duties. The Safety Representative or a qualified and approved deputy shall be onsite at all times while Work is ongoing.

- c. Submit Qualifications of the Safety Representative and assigned deputies for review. Acceptance of their qualifications is required prior to the start of any activity on the Project. The Contractor's Safety Representative shall meet the requirements of regulations for the Colorado Occupational Safety & Health Enforcement Program, as defined in the following paragraph:
 - 1) A Designated Safety Officer (Safety Representative for the purposes of this Contract) means anyone who is capable of identifying the existing and predictable hazards in the areas surrounding a construction project or those working conditions at a construction project that are unsanitary or dangerous to employees. A Designated Safety Officer has the authority to make prompt corrective measures to eliminate those hazards.

3. Hazardous Substances and the Right to Know:

- a. Provide Safety Representative with a list of all hazardous substances Contractor anticipates to bring onsite.
- b. Submit a Material Safety Data Sheet (MSDS) to the Safety Representative prior to arrival of any hazardous substances on the Project.
- c. Storage areas shall be as approved by the Safety Representative.
- d. Use storage areas according to Contractor's Spill Control Plan.
- e. Remove all used and unused hazardous chemicals from the Site at Completion of Work.
- f. Prepare a hazard-specific safety training (HAZCOM) lesson plan for each hazardous substance brought to the Site. Conduct and document training based on these lesson plans. Provide copies of HAZCOM training documentation to the Owner's Project Manager.

4. Job Safety Analysis (JSA):

- a. Outline the sequence of Work, equipment to be used, identify hazards that may exist or may be created and what procedures and/or safety equipment will be used to eliminate or reduce these hazards. Prepare and submit a Scope of Work JSA to the Safety Representative prior to the start of activities on the Project. The name of the competent person assigned to this activity shall be included on the JSA.
- b. Complete a JSA for any activity that may be of an unusual nature or involves unique hazards.

5. Reports

- a. Furnish to copies of Contractor's and Subcontractor's:
 - 1) First aid log (monthly).
 - 2) OSHA 200 injury log (monthly).
 - 3) Certification of new employee orientation (monthly).
 - 4) Safety meeting reports and topics.
 - 5) List of competent persons as required by OSHA.
 - 6) Injury and accident reports, submitted within 24 hours of any incident.
 - 7) Records of employee and supervisor training, including Subcontractors.
- b. Conduct weekly safety inspections, and take corrective actions within 24 hours to address all deficiencies identified during inspections. Prepare and submit deficiency reports to Owner's Project Manager within 48 hours indicating corrective actions taken. Contractor's failure to comply with required corrective measures identified in the safety inspection may result in the delayed signing of the monthly application for progress payment.

- F. Submit report of each periodic audit conducted by Contractor of its safety records and performance.

- G. At a minimum, follow the applicable regulations in 29CFR1910. Examples of such applicable regulations include but are not limited to:
1. 29CFR1910.146: Confined Space Entry Program
 2. 29CFR1910 Subpart Q: Burning and Welding Operations

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 EMERGENCY SERVICES NOTIFICATION

- A. When calling to request a standby or giving information regarding a street closure for Fire or Police/Sherrif, the following information is required.
- B. All notifications must be made 24 hours in advance.
1. Larimer County Sherrif's Office Emergency Services – 970-498-5300
 2. Poudre Valley Fire Authority – Non-Emergency Line - 970-419-3273
- C. Indicate company affiliation and that you are calling to inform them of a street closure or need for fire and or police standby. Then you will be asked to provide the following information.
1. Contact information:
 - a. Company and name
 - b. Call back phone number (give best number to reach you in case of emergency, i.e., cell phone if you are going to be in the field and not desk phone.)
 - c. Who is the point of contact
 - d. Street that is closed? (From what street to what street.)
 - e. Duration of the street closure? (What time the project starts until the expected time to reopen.)
 - f. Is street accessible for Fire and Police response?
 - g. Do you need a standby (on scene) or is this just for information in the event an emergency arises?
 - h. Personnel working above or below ground?
 - i. Kind of safety measures in place?
 - j. Any other pertinent information.
 2. Call back and advise when street closure has concluded.

END OF SECTION

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SECTION 01 35 53

SITE SECURITY

PART 1 - GENERAL

1.1 SECURITY PROGRAM

- A. Protect Work, the Site, stored materials and equipment, existing premises, vehicles and equipment from theft, vandalism, and unauthorized entry.
- B. Initiate security program at mobilization.
- C. Maintain site security program throughout construction period.
- D. Maintain erosion fencing, barrier fencing, livestock fencing and property owner fencing as directed by the Owner's Construction Manager.
- E. Maintain safe and secure site in accordance with Section 01 35 29 – Health and Safety and the Contractor's Safety Program.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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SECTION 01 41 24

PERMIT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements relative to permitting of which Owner, Owner's Construction Manager, and Engineer are aware that apply to the Work.
2. Required municipal permits and licenses of which Owner, Owner's Construction Manager and Engineer are aware.
3. Required State permit and licenses of which the Owner, Owner's Construction Manager and Engineer are aware.

B. Scope:

1. For the purposes of this Section, the word "permits" is defined as all of the permits, approvals, and agreements referenced. Sometimes these permits require fees to be paid by the Contractor and sometimes these permits impose construction conditions. The Contractor shall include in its overall bid the cost of obtaining any necessary permits, including application fees and any other costs; and the cost for complying with all of the conditions set by all of the required permits. All costs including, but not limited to, relocation, removal, or protection of facilities owned by various agencies, public and private, and by property owners shall be paid for by the Contractor unless otherwise shown on the Drawings or noted in these Specifications.
2. Contractor shall provide labor, materials, equipment, tools, and incidentals shown, specified, and required to obtain required permits and comply with required permits and licenses.
3. Obtain, pay for, and comply with required permits and licenses whether or not indicated in this Specifications section or elsewhere in the Contract Documents.
4. Provide labor, materials, equipment, tools, and incidentals shown, specified, and required to comply with permit requirements, including Owner-obtained permits.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate compliance with permit and license requirements with Work under other Specifications sections and with other contractors, if any, working at the Site.
2. Coordinate with the Progress Schedule the time required to apply for and obtain required permits and licenses and to comply with requirements thereof. Changes in Contract Times or Contract Price will not be authorized because of timing and costs associated with obtaining permits and licenses required for the Work.
3. The permits listed in this Section are known required permits. Information herein does not relieve the Contractor from obtaining and paying fees associated with unknown permits.

B. Permits for Combined Work:

1. The Work of Segments F.1 and F.2 is performed under one Contract, and the Contractor shall not obtain duplicate permits or prepare duplicate applications, plans, or submittal packages solely because the same permit requirement appears in both the Segment F.1 and Segment F.2 Specifications. Where a permit requirement applies to both segments, a single permit and submittal package covering the combined Work satisfies both Specifications, unless the issuing agency requires separate segment permits. Where an issuing agency requires separate segment permits, the Contractor shall obtain them at no change in Contract Price or Contract Times. Exception: Larimer County will issue a separate Development Construction Permit (DCP) for each segment, and the Contractor

shall prepare the DCP support documentation for each segment, although supporting plans and documentation may be shared where Larimer County accepts common materials. The Contractor remains responsible for satisfying the conditions of each permit obtained.

1.3 SUBMITTALS

A. Informational Submittals:

1. Submit the following:
 - 1) Stormwater Management Plan and Erosion and Sediment Control Plan
 - a) Within 6 weeks of Construction Notice to Proceed
 - 2) Stormwater General Permit Application
2. Submit the following prior to commencing and Work in affected areas.
 - a. Copy of each of the following permits, as applicable to the Work:
 - 1) Weld County Right of Way Permit.
 - 2) Weld County Access Permit.
 - 3) Larimer County Sign Permit
 - 4) Larimer County Right of Way Permit.
 - 5) Larimer County Access Permit.
 - 6) Larimer County Special Transport Permit
 - 7) Larimer County Electrical Permit.
 - 8) Air Pollution Emission Notice and Construction Permit
 - 9) Construction Stormwater Discharge Permit
 - 10) Construction Dewatering Permit (s)
 - 11) General Permit for Discharge from Hydrostatic Testing of Pipelines, Tanks, and Similar Vessels
 - 12) Asbestos Abatement Permit
 - 13) CDOT Utility/Special Use Permit
 - 14) CDOT Temporary State Highway Access Permit
 - 15) CDOT Transport Permit
 - 16) Division of Water Resources Dewatering Well Permit
 - 17) Other permits and approvals obtained for the Project.

1.4 MUNICIPAL PERMITS

A. Larimer County Permits:

1. Larimer County Sign Permit
 - a. For placement and mounting of project signage.
2. Larimer County Right of Way Permit.
 - a. As necessary for Contractor's impacts to Larimer County Right of Way.
 - b. As required by Larimer County 1041 Permit Condition of Approval #45.
3. Larimer County Access Permit.
 - a. As necessary for any temporary access points to the Work from Larimer County Right of Way.
 - b. As required by Larimer County 1041 Permit Condition of Approval #46.
4. Larimer County Special Transport Permit
 - a. As needed for oversize and/or overweight loads.
5. Larimer County Electrical Permit
 - a. For electrical work at the Pressure Sensor Vault.

B. Weld County Permits:

1. Weld County Right of Way
 - a. As necessary for Contractor's impacts to Weld County Right of Way
2. Weld County Access Permit
 - a. As necessary for any access to the Work from Weld County Right of Way.

1.5 STATE PERMITS

- A. Colorado Department of Health and Environment (CDPHE)
 1. Air Pollution Emission Notice and Construction Permit
 - a. Land Development APEN GP03
 2. Construction Stormwater Discharge Permit
 - a. As required by Larimer County 1041 Permit Conditions of Approval #49.
 - b. COR400000
 - c. Contractor is responsible for preparing Storm Water Management Plan (SWMP) and Erosion and Sediment Control Plan required for Permit Application.
 - 1) As Specified and in accordance with requirements of Section 01 57 05 – Temporary Controls.
 3. Construction Dewatering General Permit
 - a. COG0800000
 - b. As necessary for Contractor's dewatering operation.
 - c. As required by Larimer County 1041 Permit Condition of Approval #49
 4. General Permit for Discharge from Hydrostatic Testing of Pipelines, Tanks, and Similar Vessels
 - a. COG604000
 - b. As necessary for Contractor's Hydrostatic Testing Discharge
 5. Asbestos Abatement Permit
 - a. As necessary for any asbestos encountered.
- B. Office of the State Engineer Division of Water Resources
 1. Dewatering Well Permit
 - a. As necessary for construction dewatering wells.
- C. Colorado Department of Transportation (CDOT)
 1. Utility/Special Use Permit
 - a. Apply for permit at least 28 days prior to any work within or immediately adjacent to CDOT right-of-way.
 - b. Temporary State Highway Access Permit / Right of Way Permit
 - 1) Obtain necessary permit for any temporary access to the Work from CDOT right-of-way, including I-25 frontage roads.
 - c. Transport Permit
 - 1) Apply for and comply with permit conditions for truck transport and hauling as necessary for Contractor's completion of the work.

1.6 OWNER OBTAINED PERMITS AND CONDITIONS

- A. Copies of all Owner Obtained Permits and Conditions are available to the Contractor through the Owner's Construction Manager.
- B. Contractor shall comply with all permit requirements.
- C. US Army Corps of Engineers
 1. Nationwide Permit 58.

- a. Limit impacts to water ways and wetlands to those shown on Contract Drawings in accordance with Larimer County 1041 Permit Conditions of Approval #10 and #71.
 - b. Comply with restoration requirements and grade establishment within water ways and wetlands.
- 2. Nationwide Permit 7.
 - a. Limit impacts to water ways and wetlands to those shown on Contract Drawings in accordance with Larimer County 1041 Permit Conditions of Approval #10 and #71.
 - b. Comply with restoration requirements and grade establishment within water ways and wetlands
- D. Larimer County 1041 Permit
 - 1. Conditions of Approval of this permit have been incorporated into the Contract Drawings and Specifications.
 - 2. All construction activities associated with this permit shall comply with all associated regulations and obtain all required county, state, and federal permits in accordance with Larimer County 1041 Condition of Approval #2.
- E. Larimer County Floodplain Development Permit
 - 1. Comply with grading as shown on the Contract Drawings within floodplains shown. As required by Larimer County 1041 Permit Condition of Approval #52
 - 2. Conduct post-construction Survey for all floodplain impacts in accordance with Section 01 33 50 – Site Conditions Survey within 30 days of project completion to support required as-built, no-rise certification, and letter of compliance submittals to Larimer County by the Engineer.
 - 3. In the event of an impending flood, all construction equipment must be anchored or relocated outside the floodplain.
 - 4. Any changes to the project design after issuance of this permit must be reviewed and approved by the Floodplain Administrator or County Engineer. Additional work is not authorized under this permit. The issuance of this permit does not authorize any new encroachments beyond what was originally submitted within the regulatory floodplain.
 - 5. The Contractor of this permit is responsible for all damages or adverse impacts resulting from the work or activities authorized by this permit. The Contractor shall hold Larimer County, its officers, employees, and agents harmless from all claims, costs, and liabilities arising from or in connection with the permitted work.
 - 6.
- F. Larimer County Development Construction Permit
 - 1. Owner will obtain this permit.
 - 2. Owner will review and approve all documentation prior to submittal to Larimer County for review and approval.
 - 3. Contractor shall immediately begin assembling the submittals below immediately upon Notice of Proceed as the Owner's and Contractor's ability to obtain Development Construction Permit is contingent on the review and approval of these plans. The following documentation from the Contractor is required to be submitted to Owner within 6 weeks of Notice to Proceed to support this application. Owner will not be responsible for project delays associated with late Contractor submittals.
 - a. Fugitive Dust Control Plan in accordance with Section 01 57 05 – Temporary Controls.
 - b. Air Emission Control Plan in accordance with Section 01 57 05 – Temporary Controls.
 - c. Noise Mitigation Plan in accordance with Section 01 57 05 – Temporary Controls.
 - d. Exterior Lighting Management Plan in accordance with Section 01 57 05 – Temporary Controls.
 - e. Comprehensive BMP Plan in accordance with Section 01 57 05 – Temporary Controls.

- f. Pre-Construction Traffic Control and Management Plan in accordance with Section 01 55 26 – Traffic Control
 - g. Stormwater Management Plan and Erosion and Sediment Control Plan in accordance with this Section.
 - h. Emergency Utility Plan in accordance with Section 01 50 10 – Protection of Existing Facilities.
 - i. Pre-construction Inventory of Haul Roads in accordance with Section 01 50 10 – Protection of Existing Facilities.
 - 1) Update as required during construction.
 - j. Larimer County Pre-Construction Site Survey in accordance with Section 01 33 50 Site Surveys.
- 4. Larimer County requires submission of Contractor obtained CDPHE permits before issuance of the DCP.
- G. Larimer County Access Permit.
 - a. For any permanent access points to the Work from Larimer County Right of Way.

1.7 EXISTING INFRASTRUCTURE CROSSING PERMITS AND AGREEMENTS

- A. As indicated in Section 01 35 13 – Special Project Procedures.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

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SECTION 01 42 00

REFERENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Defined terms and terminology.
2. Construction Codes: Indication of applicable building code and other construction codes.
3. Referenced Standard Specifications and Construction Guidelines: Indication of Owner's or third-party specifications and construction standards applicable to one or more parts of the Work.
4. Abbreviations in general use in the Contract Documents.
5. Reference Standards: General requirements regarding reference standards, including a listing of reference standard-issuing organizations (and their acronyms) used in the Contract Documents.

1.2 REFERENCES

A. Contract Language Addressed to Contractor:

1. Unless expressly indicated otherwise, language of the Contract Documents addresses Contractor, and the Contract Documents show and indicate Contractor's obligations.
2. Unless indicated otherwise, expressions such as, "provide", "furnish", "install", "perform", "retain services of", "remove", "demolish", "replace", and the like refer to Contractor's obligations under the Contract.

B. Defined Terms:

1. Defined terms, indicated with initial capital letters or with all-capital letters, used in the Contract Documents, are indicated in the General Conditions, as may be modified by the Supplementary Conditions. Additional defined terms, if any, in general use in the Contract Documents are indicated below. Where used, such defined terms apply to the singular and plural thereof.
 - a. None.
2. Additional defined terms, applicable to the Work of a given Specifications Section, may be indicated in the associated Specifications Section.

C. Terminology:

1. Terminology, indicated without initial capital letters, used in the Contract Documents, are indicated in the General Conditions, as may be modified by the Supplementary Conditions. Additional terminology in general use in the Contract Documents are indicated below. Where used, such terminology applies to the singular and plural thereof.
 - a. "Shown" means information or requirements presented on the Drawings, in schedules, or in other types of graphic instruments.
 - b. "Indicated" means, as applicable: (1) graphic representations, notes, or schedules on the Drawings, or (2) other paragraphs, provisions, tables, or schedules in the Specifications and elsewhere in the Contract Documents.
 - c. "Specified", "noted", "scheduled", and similar terms, have the same meaning as "shown" and "indicated", as applicable, and are used to help the user locate the reference without limitation on the location.
 - d. "Installer", "applicator", or "erector" is Contractor's employees or Subcontractor, engaged to perform a specific construction activity, including installation, erection, application, or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.

- e. “Experienced”, when used in conjunction with terms such as “installer”, “Subcontractor”, “Supplier”, “manufacturer”, and similar terms means (unless expressly indicated otherwise for the subject Work elsewhere in the Contract Documents) such person or entity, as applicable, has successfully completed not less than five previous projects similar in size, scope, and complexity to such person’s or entity’s work on this Project; being familiar with the special requirements indicated and required; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with written requirements of the Supplier of the material or equipment being installed.
 - f. “Assigned specialists” and similar terms: Certain Specifications require specific construction activities be performed by specialists with recognized, extensive experience in such operations. Engage said specialists for such activities, and their engagement is a requirement over which Contractor has no option. These requirements do not conflict with enforcement of building codes and other Laws and Regulations. Such requirements are not intended to interfere with local trade union jurisdictional settlements and similar conventions. Such assignments shall not relieve Contractor of responsibility for complying with the requirements of the Contract Documents.
 - g. Trades: Use of terms such as “carpentry” does not imply that certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as “carpenter”, unless otherwise indicated in the Contract Documents or required by Laws or Regulations, or required by an applicable project labor agreement. Such terminology also does not imply that indicated requirements apply exclusively to trade personnel of the corresponding generic name.
2. Additional terminology, applicable to the Work of a given Specifications Section, may be indicated in the associated Specifications Section.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

- 1. References in the Contract Documents to local building and construction code(s) means the following:
 - a. 2020 National Electric Code
 - b. 2026 International Plumbing Code
 - c. Larimer County Building Code Amendments

1.4 REFERENCED STANDARD SPECIFICATIONS AND CONSTRUCTION GUIDELINES

- A. Except as otherwise shown or indicated in the Contract Documents, the Work shall comply with the Contract Documents and the following referenced specifications and construction guidelines:
 - 1. Rural Area Road Standards by Larimer County, which can be obtained at https://www.larimer.gov/sites/default/files/uploads/2024/lcrars_bookmarked_2017.pdf.
- B. Engineer is not the author of, is not responsible for, and did not seal and sign the referenced specifications and construction guidelines indicated above. Such referenced specifications and construction guidelines are not part of the Contract Documents. Where compliance with referenced specifications or construction guidelines is required by the Contract but requirements are unclear, submit to Engineer request for interpretation or clarification.
 - 1. When conflicts arise between referenced specifications and guidelines and the Contract Documents, the Contract Documents shall govern.

1.5 ABBREVIATIONS.

A. Abbreviations - General:

- 1. Abbreviations commonly used in the Contract Documents are indicated in this Article or on the Drawings, except as further indicated in the following paragraphs, .

2. Additional abbreviations, specific to the Work of a given Specifications section, may be indicated in the associated Specifications.
 3. Piping system abbreviations are indicated in Section 40 05 01 - Common Work Results for Process Piping.
- B. Common abbreviations that may be used in the Contract Documents are indicated below, alphabetically by their written-out meaning:

Alternating current	AC
Ampere	A, or amp
Americans with Disabilities Act	ADA
Americans with Disabilities Act Accessibility Guidelines	ADAAG
Ante Meridiem	a.m.
Architectural barriers act	ABA
Average	avg
Biochemical oxygen demand	BOD
Five-day biochemical oxygen demand	BOD ₅
Brake horsepower	Bhp or BHP
British thermal unit	Btu
Building information model	BIM
Carbonaceous biochemical oxygen demand	CBOD
Five-day carbonaceous biochemical oxygen demand	CBOD ₅
Chemical oxygen demand	COD
Celsius (or Centigrade)	C
Chlorinated polyvinyl chloride	CPVC
Chlorofluorocarbons	CFC
Centimeter	cm
Code of Federal Regulations	CFR
Computer-aided drafting and design	CADD, or CAD
Cubic inch	cu in, or CU IN, or in ³
Cubic foot	cu ft, or CU FT, cf, CF, or ft ³
Cubic yard	cu yd, or CU YD, or CY, or yd ³
Cubic feet per minute	CFM, or cfm
Cubic feet per second	CFS, or cfs
Decibel	dB, dBA, or dBa
Degree Celsius	degrees C, °C, or deg C
Degrees Fahrenheit	degrees F, °F, or deg F
Diameter	dia
Direct current	DC
Dollars	\$

Each	ea
Efficiency	eff
Fahrenheit	F
Feet	ft or FT
Feet per hour	FPH, or ft/hr
Feet per minute	FPM or ft/min
Feet per second	fps, or ft/s
Figure	fig
Flange	flg
Foot-pound	ft-lb or FT-LB
Gallon	gal or GAL
Gallons per hour	GPH, gph, or gal/hr
Gallons per minute	GPM, or gpm
Gallons per second	GPS, or gps
Gram	g
Grams per liter	g/L
Heating, ventilating, and air conditioning	HVAC
Hertz	Hz
Horsepower	hp or HP
Hour	hr or HR
Human-machine interface	HMI
Inch	in. or IN
Inches of mercury	in. Hg
Inches water gage	in. w.g.
Inch-pound	in.-lb
Inside diameter	ID
Iron pipe size	IPS
Kilogram	kg
Thousand pounds	kips
Kilograms per square inch	ksi
Kilovolt-ampere	kva, or kVA
Kilowatt	Kw, or
Kilowatt-hour	Kwhr, kWhr, or kwh, kWh
Linear foot	lin ft or LF
Liter	L
Leadership in Energy and Environmental Design (USGBC)	LEED
Maximum	max

Mercury	Hg
Meter	m
Mile	mi
Miles per hour	mph or MPH
Milligram	mg
Milligrams per liter	mg/l or mg/L
Milliliter	ml
Millimeter	mm
Million gallons per day	MGD or MGD
Million gallon	MG
Minimum	min
National pipe threads	NPT
Net positive suction head	NPSH
Net positive suction head available	NPSHA
Net positive suction head required	NPSHR
Nitrogen oxide (total concentration of mono-nitrogen oxides such as nitric oxide (NO) and nitrogen dioxide (NO ₂))	NOx
Nominal pipe size	NPS
Number	no. or #.
Operator interface terminal	OIT
Ounce	oz
Ounce-force	ozf
Outside diameter	OD
Potential of hydrogen	pH
Parts per hundred	PPH, or ppH
Pounds per cubic foot	pcf
Parts per million	PPM, or ppm
Parts per billion	PPB, or ppb
Polychlorinated biphenyl	PCB
Polyvinyl chloride	PVC
Post Meridiem	p.m.
Pound	lb, LB, lbs, or LBS
Pounds per square inch	PSI, or psi
Pounds per square inch absolute	PSIA, or psia
Pounds per square inch gauge	PSIG, or psig
Pounds per square foot	PSF, or psf
Process control system	PCS

Programmable logic controller	PLC
Revolutions per minute	RPM, or rpm
Second	sec, or s
Specific gravity	sp gr, or SG
Square	sq
Square foot	sq ft, or SQ FT, or sf, or ft ²
Square inch	sq in., or SQ IN, or in ²
Square yard	sq yd, or SY, or yd ²
Standard	std
Standard cubic feet per minute	SCFM, or scfm
Total dynamic head	TDH
Totally-enclosed fan-cooled	TEFC, or tefc
Volt	V
Volts alternating current	VAC, or vac
Volts direct current	VDC, or vdc
Volatile organic compounds	VOC

1.6 REFERENCE STANDARDS AND ORGANIZATIONAL ACRONYMS

A. Reference Standards - General:

1. Each entity engaged in the Work, including Contractor, Subcontractors, and Suppliers, shall be familiar with reference standards applicable to its portion(s) of the Work. Comply with such reference standards when required by the Contract Documents or appropriate fabrication and construction practice, unless the Contract Documents requirements exceed those of the associated reference standard.
2. When discrepancies between reference standards and the Contract Documents exist, the Contract Documents shall govern.
3. Provisions of reference standards are in effect in accordance with the Specifications and other provisions of the Contract Documents where reference standards are cited.
4. Copies of applicable reference standards are not included in or bound with the Contract Documents. Where reference standards are needed for the Work, obtain such reference standards(s) from the publication source.

B. Organization Names and Acronyms:

1. Where reference standards, specifications, manuals, Laws or Regulations, or other published data of international, national, regional, or local organizations are cited in the Contract Documents, the organization issuing the standard (or other type of document) may be referred to by its acronym only.
2. Acronyms that may appear in the Contract Documents shall have the meanings indicated below, unless expressly indicated otherwise in that part of the Contract Documents where such standard (or other document) is cited.
3. Listing is alphabetical by acronym.

AA	Aluminum Association
AABC	Associated Air Balance Council

AASHTO	American Association of State Highway and Transportation Officials
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
ACS	American Chemical Society
AF&PA	American Forest and Paper Association
AGI	American Geosciences Institute
AGMA	American Gear Manufacturers Association
AI	Asphalt Institute
AIHA	American Industrial Hygiene Association
AIIM	Association for Information and Image Management (part of the American National Standards Institute (ANSI))
AIPG	American Institute of Professional Geologists
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standards Committee
AMCA	Air Movement and Control Association
AMPP	Association for Materials Protection and Performance
ANSI	American National Standards Institute
APHA	American Public Health Association
APWA	American Public Works Association
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASQ	American Society for Quality
ASSE	American Society of Safety Engineers
ASTM	Advancing Standards Transforming Markets (ASTM International)
ATSSA	American Traffic Safety Services Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
CASE	Coalition of American Structural Engineers (part of the American Council of Engineering Companies (ACEC))
CBMA	Certified Ballast Manufacturer's Association
CBP	United States Customs and Border Protection
CDA	Colorado Department of Agriculture

CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CEMA	Conveyor Equipment Manufacturers Association
CLFMI	Chain Link Fence Manufacturers Institute
CMAA	Crane Manufacturers Association of America
CMHA	Concrete Masonry & Hardscapes Association
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DBIA	Design-Build Institute of America
DNR	Colorado Department of Natural Resources
EJCDC	Engineers Joint Contract Documents Committee
EPA	United States Environmental Protection Agency
ETL	Intertek Testing Services, Inc. (formerly ETL Testing Laboratories, Inc.)
FCC	United States Federal Communications Commission
FEMA	Federal Emergency Management Agency (US Department of Homeland Security)
FHWA	Federal Highway Administration (US Department of Transportation)
FM	Factory Mutual (FM Global)
HI	Hydraulic Institute
HMI	Hoist Manufacturers Institute
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IFC	International Fire Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFI	Industrial Fasteners Institute
IMC	International Mechanical Code
INDA	Association of the Nonwoven Fabrics Industry
IRI	Industrial Risk Insurers
ISA	International Society of Automation
ISI	Institute for Sustainable Infrastructure
ISO	International Organization for Standardization
LPI	Lightning Protection Institute
MHFD	Mile High Flood District

ML/SFA	Metal Lath/Steel Framing Association
MSS	Manufacturers Standardization Society of the Valve and Fitting Industry
NAPF	National Association of Pipe Fabricators, Inc.
NARUC	National Association of Regulatory Utilities Commissioners
NBHA	National Builders Hardware Association
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology (United States Department of Commerce)
NLGA	National Lumber Grades Authority
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NSPE	National Society of Professional Engineers
NSSGA	National Stone, Sand, and Gravel Association
OSHA	Occupational Safety and Health Administration, United States Department of Labor
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PFI	Pipe Fabrication Institute
PPI	Plastics Pipe Institute
PS	Product Standards Section (United States Department of Commerce)
RCSC	Research Council on Structural Connections (AISC)
RMA	Rubber Manufacturers Association
RUS	Rural Utilities Service (United States Department of Agriculture, Rural Development)
SAE	Society of Automotive Engineers
SCPRF	Structural Clay Products Research Foundation
SCTE	Society of Cable Telecommunications Engineers
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPI	Society of the Plastics Industry
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
TSA	Transportation Security Administration (United States Department of Homeland Security)
UCC	Uniform Commercial Code

UL	UL Solutions (formerly Underwriters Laboratories, Inc.)
UMC	Uniform Mechanical Code
USAB	United States Access Board
USACE	United States Army Corps of Engineers (also abbreviated as COE or USACOE)
USDA	United States Department of Agriculture
USDOT	United States Department of Transportation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
USPHS	United States Public Health Service
WEF	Water Environment Federation (formerly the Water Pollution Control Federation)
WWEMA	Water and Wastewater Equipment Manufacturers Association

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 45 16.13

CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.1 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - b. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.

1.2 DEFINITIONS

- A. Contractor Quality Control (CQC): The means by which Contractor ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.3 SUBMITTALS

- A. Informational Submittals:
 - 1. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
 - 2. CQC Report: Submit, weekly, an original and one copy in report form.

1.4 THORNTON'S QUALITY ASSURANCE

- A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.
- B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:
 - 1. Relieve Contractor of responsibility for providing adequate quality control measures;
 - 2. Relieve Contractor of responsibility for damage to or loss of the material before acceptance;
 - 3. Constitute or imply acceptance; or
 - 4. Affect the continuing rights of Thornton after acceptance of the completed Work.
- C. The presence or absence of a quality assurance inspector does not relieve Contractor from any Contract requirement.
- D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Owner's Construction Manager.
- E. Owner may charge Contractor for any additional cost of inspection or test when Work is not ready at the time specified by Contractor for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.

- B. Maintain complete inspection records and make them available at all times to Owner and Owner's Construction Manager.
- C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.2 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Owner's Construction Manager and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of Contractor's management and control with the Owner's Quality Assurance.
- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by Contractor.

3.3 QUALITY CONTROL ORGANIZATION

- A. CQC System Manager:
 - 1. Designate an individual within Contractor's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the Contractor.
 - 2. CQC System Manager may perform other duties on the Project if approved by Owner.
 - 3. CQC System Manager shall be an experienced construction person, with a minimum of 3 years construction experience on similar type Work.
 - 4. CQC System Manager shall report to the Contractor's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
 - 5. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
 - 6. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.
- B. CQC Staff:
 - 1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Owner's Construction Manager.
 - 2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
 - 3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
 - 4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.
- C. Organizational Changes: Obtain Owner's Construction Manager's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.4 QUALITY CONTROL PHASING

- A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:
1. Preparatory Phase:
 - a. Notify Owner's Construction Manager at least 48 hours in advance of beginning any of the required action of the preparatory phase.
 - b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
 - c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
 - d. Perform prior to beginning Work on each definable feature of Work:
 - 1) Review applicable Contract Specifications.
 - 2) Review applicable Contract Drawings.
 - 3) Verify that all materials and/or equipment have been tested, submitted, and approved.
 - 4) Verify that provisions have been made to provide required control inspection and testing.
 - 5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
 - 6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 - 7) Review the appropriate activity hazard analysis to verify safety requirements are met.
 - 8) Review procedures for constructing the Work, including repetitive deficiencies.
 - 9) Document construction tolerances and workmanship standards for that phase of the Work.
 - 10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Owner's Construction Manager.
 2. Initial Phase:
 - a. Accomplish at the beginning of a definable feature of Work:
 - 1) Notify Owner's Construction Manager at least 48 hours in advance of beginning the initial phase.
 - 2) Perform prior to beginning Work on each definable feature of Work:
 - a) Review minutes of the preparatory meeting.
 - b) Check preliminary Work to verify compliance with Contract requirements.
 - c) Verify required control inspection and testing.
 - d) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards.
 - e) Resolve all differences.
 - f) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
 - 3) Separate minutes of this phase shall be prepared by the CQC System Manager and attached to the QC report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.
 - 4) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.

3. Follow-up Phase:
 - a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
 - b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
 - c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.5 CONTRACTOR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
 - a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system (see Paragraph QC Phasing) for all aspects of the Work specified.
 - b. CQC Staff: The name, qualifications (in resume format), duties, responsibilities, and authorities of each person assigned a QC function.
 - c. Letters of Authority: A copy of a letter to the CQC System Manager signed by an authorized official of the firm, describing the responsibilities and delegating sufficient authorities to adequately perform the functions of the CQC System Manager, including authority to stop Work which is not in compliance with the Contract. The CQC System Manager shall issue letters of direction to all other various quality control representatives outlining duties, authorities and responsibilities. Copies of these letters will also be furnished to Owner.
 - d. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
 - e. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
 - f. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
 - g. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

- h. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.
- C. Acceptance of Plans: Acceptance of the Contractor's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require Contractor to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.
- D. Notification of Changes: After acceptance of the CQC plan, Contractor shall notify Owner's Construction Manager, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Owner's Construction Manager.

3.6 CONTRACTOR QUALITY CONTROL REPORT

- A. Contractor Quality Control Reporting. The Contractor shall use one CQC report format for all Work under the Contract. CQC reports shall:
 - 1. Be prepared weekly, cover and account for every calendar day throughout the life of the Contract, and be signed and dated by the CQC System Manager.
 - 2. Identify all Work, tests, inspections, deficiencies, and corrective actions by segment (F.1 or F.2) and station.
 - 3. Contain the record content required by Section 01 45 16 (F.1) and Section 01 45 16.13 (F.2), including work performed by location and activity; control-phase activities (preparatory, initial, follow-up) with results; tests performed and results; materials received and acceptability; submittals reviewed; safety evaluations; instructions received and conflicts identified; trades and personnel counts, weather, and delays; and the Contractor's verification statement covering conforming and deficient features.
 - 4. Be submitted through the Project's construction management software (Procore) using the format provided by the Owner's Construction Manager. The CQC System Manager shall review the current weekly report and the open-deficiency log at the weekly progress conference.

3.7 SUBMITTAL QUALITY CONTROL

- A. Submittals shall be as specified in Section 01 33 00 – Submittal Procedures. The CQC organization shall be responsible for certifying that all submittals
 - are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by Contractor. Contractor may use other forms as approved.

3.8 TESTING QUALITY CONTROL

- A. Testing Procedure:
 - 1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
 - a. Verify testing procedures comply with contract requirements.
 - b. Verify facilities and testing equipment are available and comply with testing standards.
 - c. Check test instrument calibration data against certified standards.
 - d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 - e. Documentation:
 - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
 - 2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.

- 3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
 - 4) Provide directly to Owner's Construction Manager an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
 - 5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.
- B. Testing Laboratories: Laboratory facilities, including personnel and equipment, utilized for testing soils, concrete, asphalt and steel shall meet criteria detailed in ASTM D3740 and ASTM E329, and be accredited by the American Association of Laboratory Accreditation (AALA), National Institute of Standards and Technology (NIST), National Voluntary Laboratory Accreditation Program (NVLAP), the American Association of State Highway and Transportation Officials (AASHTO), or other approved national accreditation authority. Personnel performing concrete testing shall be certified by the American Concrete Institute (ACI).

3.9 COMPLETION INSPECTION

- A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.
- B. Punchlist:
1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.
 2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
 3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner's Construction Manager.
 4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION

SECTION 01 50 10
PROTECTION OF EXISTING FACILITIES

PART 1 - GENERAL

1.1 GENERAL

- A. Protect all existing utilities and improvements not designated for removal and restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation.

1.2 DEFINITIONS

- A. Excavation: Any digging, trenching, auguring, backfilling, ditching, grading, plowing-in, pulling-in, ripping, scraping or tunneling.

1.3 RIGHTS-OF-WAY

- A. The Contractor shall not do any Work that would affect any oil, gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the Contractor enter upon the rights-of-way involved until notified that the Owner has secured authority from the proper party.
 - 1. Requirements of crossing existing irrigation and utility corridors are listed in Section 01 35 13 – Special Project Procedures.
- B. Contractor shall be responsible for taking all necessary precautions for work near high voltage overhead power lines. Agency notes for overhead lines are included in the drawings and in Section 01 35 13 – Special Project Procedures.
- C. After authority has been obtained, Contractor shall give said party due notice of Contractor's intention to begin work, if required by said party, and remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace the same.

1.4 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following:
 - a. Potholing Reports
 - 1) The complete Potholing Report shall be submitted to the Engineer and accepted, with no exceptions taken, before the Contractor may submit pipe Shop Drawings. The pothole report shall identify the underground points of connection, pipes, conduits, and facilities, including bedding material, and presents the dimensions, diameter, elevation of the top and the bottom of the utility, type, condition, station and location of each pipe, conduit or facility with reference to finish surface elevations.
- B. Informational Submittals:
 - 1. Submit the following:
 - a. Procedural Submittals:
 - 1) Emergency Utility Plan
 - a) Submit within 6 weeks of Construction Notice to Proceed.
 - 2) Preconstruction Inventory of Haul Roads -
 - a) Submit within 6 weeks of Construction Notice to Proceed.
 - b) Submit updates as necessary throughout construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 PROTECTION OF STREET OR ROADWAY MARKERS

- A. Do not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization.
- B. No pavement breaking or Excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed shall be accurately restored after street or roadway resurfacing has been completed.
- C. Contractor is responsible for the cleanliness and safety of all roadways adjacent to the construction site. If at any time, these roadways are found to be dangerous or not passable due to debris or mud, local jurisdictions may shut down the project until necessary clean-up is carried out by the contractor at his expense. If clean-up is deemed to be unsatisfactory or if the local jurisdiction chooses, the local jurisdiction may carry out required clean-up and bill the Owner or Contractor. The Contractor is required to incur the cost of all such clean-up.

3.2 PROTECTION AND RESTORATION OF HAUL ROADS

- A. General: All construction haul roads shall be documented as to pre-construction condition in accordance with Section 01 33 50 – Site Conditions Survey and returned to equivalent or better condition at the conclusion of construction.
 - 1. If it is determined by the Larimer County Engineer that there has been an acceleration in deterioration of the roadway surface during or after construction as a result of construction traffic, equipment, or hauling, the applicant will be required to restore the roadways to their prior condition. This may include the need for regrading and/or resurfacing. As required by Larimer County 1041 Permit Condition of Approval #47
- B. Haul Road Inventory: A pre-construction inventory of County roads to be used for construction traffic shall be created, including pre-construction condition videography, submitted, and updated as needed by the Contractor during construction, documenting preconstruction conditions and any work conducted by the applicant to return the roads to pre- construction conditions throughout construction activities or at the completion of construction. Document haul roads in accordance with photographic and videographic requirements of Specification 01 33 50 – Site Condition Surveys. As required by Larimer County 1041 Permit Condition of Approval #37.
 - 1. Inventory shall reference the Larimer County 1041 Permit Condition of Approval #37.
- C. Heavy equipment traffic will be subject to all weight limit restrictions along adjacent roadways and will obtain oversize/overweight permits in accordance with Section 01 41 24 – Permit Requirements. As required by Larimer County 1041 Permit Condition of Approval #48.

3.3 RESTORATION OF PAVEMENT

- A. General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit.
 - 1. Stabilize and repave all pavement areas disturbed or damaged during pipeline installation in accordance with the Larimer County Rural Area Road Standards for work areas outside the Growth Management Area, as directed by the County. If pipeline construction activities involve more than 100 linear feet of disturbance, the Contractor shall be responsible for pavement repairs and patching/overlay extending to the full limits (width) of the existing pavement, in accordance with Larimer County 1041 Permit Condition of Approval #34.
 - 2. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement.

3. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner.
 4. Pavements which are subject to partial removal shall be neatly saw-cut in straight lines.
- B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction, place temporary surfacing promptly after backfilling and shall maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.
 - C. Permanent Resurfacing: Contractor shall comply with any agency requirements associated with permanent resurfacing in the jurisdiction that resurfacing is completed. In order to obtain a satisfactory junction with adjacent surfaces, saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along Excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.
 - D. Restoration of Sidewalks or Private Driveways: Wherever sidewalks or private roads have been removed for purposes of construction, place suitable temporary sidewalks or roadways promptly after backfilling and shall maintain them in satisfactory condition for the period of time fixed by the authorities having jurisdiction over the affected portions. If no such period of time is so fixed, maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

3.4 EXISTING UTILITIES AND IMPROVEMENTS

- A. Protect underground utilities and other improvements which may be impaired during construction operations, regardless of whether or not the utilities are indicated on the Drawings. Take all possible precautions for the protection of unforeseen utility lines to provide for uninterrupted service and to provide such special protection as may be necessary.
- B. Maintaining in Service: Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Owner's Construction Manager are made with the owner of said utilities.
- C. Locate and Survey utilities as indicated in Section 01 33 50 Site Condition Surveys. Make exploratory Excavations as deemed necessary to determine the exact locations and depths of utilities which may interfere with the Work. All such exploratory Excavations shall be performed within a sufficient time in advance of construction to avoid possible delays. Notify the Owner's Construction Manager if such exploratory Excavations show the noted utility locations to be in error.
- D. Utilities to be Relocated: If necessary to relocate the property of any utility owner, coordinate with the utility owner to relocate such property.
- E. Underground Utilities Indicated: Existing utility lines that are indicated or the locations of which are made known to the Contractor prior to Excavation and that are to be retained, and all utility lines that are constructed during Excavation operations shall be protected from damage and, if damaged, shall be immediately repaired or replaced, unless otherwise repaired by the owner of the damaged utility. If the owner of the damaged facility performs its own repairs, Contractor shall reimburse said owner for the costs of repair.
- F. Underground Utilities Not Indicated: In the event of damages to existing utility lines that are not indicated or the locations of which are not made known to the Contractor prior to Excavation, immediately report the damage to the owner of the damaged utility. Also provide an immediate verbal report of such damage to the Owner's Construction Manager, to be followed by a prompt written report to both the Owner's Construction Manager and the utility owner.
- G. Private Utilities: Locations of private residential utilities (septic systems, water wells, gas storage tanks, irrigation systems, drainage tiles, private fueling stations, etc) as well as utilities and infrastructure along the are indicated on the final design drawings to the extent that they are

known. If/where private utilities fall within the final Project Corridor easements, the property/utility owners shall be consulted and agreed upon repairs or replacements shall be determined prior to commencement of construction. Private utilities (as with other utilities/infrastructure) that are not within the final Project Corridor design but adjacent to the final design easements shall be physically located and marked in the field by the Contractor on each property to ensure avoidance during construction.

- H. Approval of Repairs: All repairs to a damaged utility or improvement are subject to inspection and approval by an authorized representative of the utility or improvement owner before being concealed by backfill or other Work.
- I. Contractor is responsible for arranging and funding all costs of damage, repair, replacement, and/or relocation of all public and private property utilities and infrastructure as necessary to accommodate the construction corridor. As required by Larimer County 1041 Permit Conditions of Approval #27 and #29.

3.5 EMERGENCY UTILITY PLAN

- A. In accordance with Larimer County 1041 Permit Condition of Approval #28, Contractor shall develop and implement an Emergency Utility Plan.
 - 1. Plan shall reference the Larimer County 1041 Permit Condition of Approval #28.
 - 2. Submit to Owner's Construction Manager. Owners Construction Manager will submit to Larimer County.
 - 3. The plan shall document and ensure that:
 - a. The Contractor understands responsibilities associated with existing utility protection.
 - b. Utility notification and locate procedures are following in accordance with this Specification Section, Specification Sections 01 11 00 – Summary of Work and 01 35 13 – Special Project Procedures and State of Colorado utility locate law.
 - c. All emergency utility contacts are known, listed, and kept on site including but not limited to gas, electric, water, irrigation, and communication utilities.
 - d. Plans and procedures to address impacts associated with the types of utilities that could be encountered and the materials needed for quick repair and utility restoration. The plan shall include how the Contractor would secure repair materials in a timely manner.
- B. Plans and procedures to provide temporary utilities or alternative accommodations should public or private utilities be impacted.

3.6 UTILITY COORDINATION

- A. Contact and coordinate with utility companies regarding protection of existing utilities and special requirements at utility crossing locations and other conditions where the Work is nearby existing utilities. Contractor shall be responsible for all costs of coordination with utilities including but not limited to outages, protection or support and any fees for costs from the utility. Furnish copies of all written agreements obtained by Contractor to the Owner's Construction Manager.

3.7 PRIVATE DRIVEWAYS

- A. Any damage to existing driveways resulting from construction activities must be restored to like or better conditions in accordance with applicable County standards.

3.8 TREE PRUNING AND PROTECTION

- A. Where tree pruning is required, hire a certified arborist to perform any necessary pruning in accordance with International Society of Arboriculture (ISA) standards. Pruning for utility line clearance shall be done in accordance with ISA standards and any pruning guidelines adopted by the county of jurisdiction. Contractor shall notify the Owner's Construction Manager of any needed pruning that has not been identified on the Drawings. Tree pruning shall not involve the removal or harassment of active bird nests. The pruning of any trees must be approved in advance by the Owner's Construction Manager to ensure that the land owner and/or jurisdiction

of the tree has approved the plan for tree pruning. Tree pruning shall not be performed in spring or summer unless otherwise approved by the Owner.

3.9 TREES OR SHRUBS WITHIN STREET RIGHTS-OF-WAY AND PROJECT LIMITS

A. General:

1. Except where trees or shrubs are indicated to be removed, exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits. Do not trim or remove trees unless so approved by the owner of the tree or shrub and as directed by the Owner's Construction Manager.
2. Catalog all trees that are removed. Trees indicated for removal shall be catalogued by corresponding number as shown on the Contract Drawings. Trees not indicated for removal shall be catalogued by approximate station and offset, along with reasoning and documentation of approval from owner of the tree and Owner's Construction Manager.

B. Trimming: Trimming or pruning of trees shall be performed by a licensed and insured arborist. Symmetry of the tree shall be preserved; no stubs or split or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1-1/2 inches in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosene, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement of Damaged Trees: Immediately notify the Owner's Construction Manager if any tree or shrub not shown to be removed is damaged by the Contractor's operations so that the Owner may notify the tree or shrub's owner. Replace the tree or shrub if, in the opinion of said owner, the damage is such that replacement is necessary. The replacement tree or shrub shall be of a like size and variety as the one damaged.

3.10 LAWN AREAS

- A. Lawn or landscaped areas damaged during construction shall be repaired to match the pre-construction condition to the satisfaction of the land owner and the Owner's Construction Manager.
- B. Unless otherwise specified on Contract Drawings, use like or better materials to match existing landscape or lawn area species, type, size, color, and texture.

END OF SECTION

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SECTION 01 55 26

TRAFFIC CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for traffic control during construction, including:
 - a. Coordination with owners of streets, highways, and other travelled ways affected by the Project and coordination with owners of properties at or adjacent to the Site regarding traffic control.
 - b. Traffic controls for general vehicular traffic affected by the Work.
 - c. Traffic controls for pedestrians and other non-vehicular traffic affected by the Work.
 - d. Temporary bridging over excavations in travelled ways.
 - e. Traffic control personnel.
 - f. Maintenance of traffic controls.
 - g. Removal of traffic controls.

B. Scope:

1. Contractor shall provide all labor, materials, tools, equipment, services, incidentals, and pay all expenses necessary and required to keep all streets, highways, and other travelled ways open for passage of traffic and pedestrians during the Project, unless: (1) otherwise approved by owner of the street, highway, or travelled way, and Engineer, or (2) as expressly allowed by the Contract Documents.

C. Related Requirements:

1. Include but are not necessarily limited to:
 - a. Section 01 35 13 – Special project Procedures.
 - b. Section 01 35 29 – Health and Safety.
 - c. Section 01 50 10 - Protection of the Existing Facilities
 - d. Section 01 57 05 - Temporary Controls.

1.2 REFERENCES

A. Terminology:

1. The following terminology, although not indicated with initial capital letters, has the following meaning in this Section:
 - a. "Maintenance and protection of traffic" and "traffic control":
 - 1) "Maintenance and protection of traffic" and "traffic control", whether singular or plural, have the same meaning and, unless expressly indicated otherwise, refer to temporary measures provided by Contractor to control, maintain, and safeguard vehicular traffic, pedestrians, bicycles, and other traffic during construction.
 - 2) "Traffic controls" are signage, barriers, barricades, signal and warning lights, and other measures provided by Contractor for controlling other than routine use of existing and temporary access roads and parking areas by construction traffic.
 - 3) "Traffic control" includes, but is not necessarily limited to, traffic controls for: (a) excavations, (b) construction vehicle parking areas, (c) storage and laydown areas for materials and equipment to be incorporated in the Work, and (d) other work-related areas; in, opening into, or adjacent to streets, highways, or other travelled ways.
 - b. "Traffic" means any and all users of the subject street, highway, or other travelled way, including sidewalks, bicycle paths, and similar facilities. "Traffic" includes motor

vehicles of all types, including automobiles, motorcycles and similar vehicles, trucks, busses, light rail, mobile equipment, and others; pedestrians; bicyclists; and others using the travelled way or right-of-way.

- B. Reference Standards: Standards referenced in this Section include, but are not necessarily limited to, the following:
1. Unless otherwise shown or indicated in the Contract Documents, traffic controls shall be in accordance with:
 - a. Approved Larimer County Right-of-Way Permit.
 - b. Larimer County Rural Area Roads Standards.
 - c. Part 6 ("Temporary Traffic Control") of the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD), by the United States Department of Transportation (USDOT) Federal Highway Administration (FHWA).
 2. In the event of conflict between the standard specifications referenced above and the MUTCD, the referenced standard specifications will govern.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Owner of Street, Highway, or Travelled Way:
 - a. Coordinate with owner of each street, highway, and other travelled way affected by the Work and the Project and obtain from such owner requirements for traffic control during construction.
 - b. Obtain and pay for work permits, street opening permits, and other permits required by the owner of the street, highway, or other travelled way.
 - c. Give written notices required by the owner of the street, highway, or other travelled way.
2. Notice to Emergency Services:
 - a. Give required advance, oral and written notices to fire departments, police departments having jurisdiction, ambulance services, and other emergency services as applicable, of proposed construction operations that may impact or affect emergency services' ability to perform their respective functions.
 - b. Larimer County Emergency Services. As required by Larimer County 1041 Permit Condition of Approval #43. Give such notices as indicated In Section 01 35 29 – Health and Safety.
3. Notice to Adjacent Properties:
 - a. Give reasonable advance, written notice to owners and occupants of private property directly affected by construction operations, including properties adjacent to the Site where such property's vehicular or pedestrian access will be affected by the Project.
 - a. Access to all private driveways must be maintained. If maintaining access is not possible, give such notice not less than 72 hours prior to such property being affected by construction operations.
 - b. Such notices to properties shall clearly indicate the intended dates the property will be affected and the scheduled end-date of such activity, and a brief summary of the ways the property will be affected during the Project's construction. Such notices shall be on Contractor's letterhead and shall indicate the Project name, Owner, Owner's project or contract number (if any), and Contractor's contact person with telephone number and office hours.
4. Notice to School Districts:
 - a. Give required advance, oral and written notices to school districts with that may have access or bus route impacts due to construction activities.
 - 1) Poudre R-1 School District. As required by Larimer County 1041 Permit Condition of Approval #43.
5. Full closure approval by Larimer County will result in restricted work hours and days as directed by the County.

6. Coordinate traffic controls with requirements of the following:
 - a. Section 01 35 13 – Special project Procedures.
 - b. Section 01 50 10 - Protection of the Existing Facilities

1.4 SUBMITTALS

- A. Informational Submittals: Submit the following:
 1. Pre-Construction Traffic Control and Management Plan in accordance with the requirements of Larimer County 1041 Permit Condition of Approval #44.
 - a. Plan shall reference the Larimer County 1041 Permit Condition of Approval #44.
 - b. Submit within 6 weeks of Construction Notice to Proceed
 2. Traffic Control Plan: Detailed plan, procedures, and sequencing for traffic control during construction.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT FOR TRAFFIC CONTROL DURING CONSTRUCTION

- A. Materials and Equipment Used for Traffic Control:
 1. Materials and equipment used for traffic control during construction shall comply with the reference specifications indicated in Paragraph 1.2.B of this Section and the MUTCD.
 2. Materials and equipment used for traffic control shall include easily legible, weather-resistant text indicating contact information, including telephone number, for entity providing and maintaining traffic controls, for alerts of damage, mislocation, or apparent unsafe traffic control items.

PART 3 - EXECUTION

3.1 TRAFFIC CONTROL – GENERAL

- A. Traffic Control and Management Plan
 1. As required by Larimer County 1041 Permit Condition of Approval #44.
 2. Clearly indicate the following:
 - a. Traffic control devices/personnel (warning signs, flaggers, traffic control supervisors, etc.)
 - b. Any specific delay times
 - c. Adjacent neighboring property owner notifications and procedures
 - d. Use and placement of message boards
 - e. Requirements to provide safe and acceptable access for emergency responders, mail and package delivery, garbage pickup, and school bus stops.
 - f. All proposed access points
- B. Traffic Control Plan: Detailed plan, procedures, and sequencing for traffic control during construction.
 1. Clearly indicate the following:
 - a. Traffic staging plan, and construction sequencing as applicable to traffic control during construction. Coordinate with the Progress Schedule accepted by Owner's Construction Manager.
 - b. Product data, including Supplier's catalog information, standard detail drawings, and specifications, for temporary barriers, barricades, signs, signals and warning lights, illumination devices, and other items used for traffic control during construction.
 - c. Materials and procedures for providing access to properties along the route of the proposed traffic controls.

- d. Identity and pertinent qualifications of the entity, such as Subcontractor or Contractor, that will select, install, maintain, and remove traffic controls. Traffic Control and Management Plans (TMP), developed by a certified traffic control company, must be submitted for all work performed within Larimer County road Right of Way or that will directly affect the travelling public.
 - e. Number and types of personnel dedicated to traffic control during construction, including flaggers. Include documentation of flaggers' training and qualifications. Indicate where number of personnel will vary by work shift or during certain hours.
 - f. Evidence of plan acceptance from authorities having jurisdiction, including owner of each street, highway, and other travelled ways that will have traffic controls during construction.
 - g. Proposed signage, including layout, colors, text, quantity, and locations, for advising the public in advance of implementing traffic controls, including use and placement of message boards.
 - h. Adjacent property owners requiring notification.
 - i. Any specific delay times.
 - j. Requirements of the following services to provide safe and acceptable access for emergency responders, mail and package delivery, garbage pickup, and school bus stops. Include all proposed access points.
 - k. Crossing method (tunneled versus open-cut)
 - l. Details of safe and suitable detours. This includes consideration of emergency vehicles, delivery/mail services, garbage pickup, and school bus stops.
- 2. Unless expressly allowed otherwise by the Contract Documents, traffic control plan Submittal shall cover all traffic control during construction for the entire Project. Do not furnish separate, staged traffic control plan Submittals.
 - 3. Furnish acceptable traffic control plan Submittal not less than 15 days prior to installing traffic controls.
 - 4. Submit updates to the traffic control plan as necessary.
 - a. Engineer's, Owner's Construction Manager, or Owner's comments on or acceptance of traffic control plan Submittal is only for the limited purpose of endeavoring to verify compliance with the Contract Documents and in no way imposes on Owner, Owner's Construction Manager, Engineer, or any of their respective consultants or subcontractors, any responsibility for construction means, methods, procedures, techniques, or sequences, or the safety and protection measures and programs incident thereto, or any of Contractor's other responsibilities under the Contract. Engineer's and Owner's review is in no way for benefit of Contractor or anyone for whom Contractor is responsible.

C. General Provisions for Traffic Control:

- 1. Provide traffic controls, as necessary and required, prior to commencing work in, or adjacent to, streets, highways, and other travelled ways.
- 2. Provide traffic controls in accordance with the Contract Documents, applicable permits, requirements of authorities having jurisdiction, referenced standard specifications indicated in Paragraph 1.2.B of this Section, and the MUTCD.
- 3. Not less than once per month, check and ensure legibility of contract information on each traffic control device or item, as required in Article 2.1 of this Section.
- 4. Traffic controls such as temporary barriers and barricades; channelizing devices such as delineators, traffic cones, traffic barrels, temporary bollards, vertical panels, and similar items; signs (including reflective signs, mobile changeable-message signs, and temporary LED-illuminated signs), temporary signals; warning lights; and temporary illumination shall be prominently but safely positioned and located, be highly visible to traffic and pedestrians, and include provisions for visibility during periods of darkness, reduced light, and reduced visibility such as smoke and fog.

5. Supplement temporary traffic barriers and barricades with standard delineation pavement markings or channelizing devices for improved daytime and nighttime visibility, when traffic controls channel vehicular traffic.
 6. Keep accessible for use permanent facilities such as hydrants, utility valves, fire alarm boxes, postal boxes, delivery service boxes, existing permanent traffic controls (including signs and signals) as appropriate, and other facilities that may require access or use during construction.
 7. Do not block access to essential facilities including hospitals, emergency services, and the like, and public facilities such as public buildings, public schools, public event venues, recreational facilities open during construction, and similar facilities.
 8. Coordinate traffic controls for commercial and residential access with their respective owners and occupants.
 9. Provide traffic controls suitable for pedestrians and bicyclists with disabilities. Comply with the MUTCD, referenced specifications indicated in Paragraph 1.2.B of this Section, and Laws and Regulations, including the Americans with Disabilities Act (ADA).
- D. Temporary Obstructions of Streets, Highways, and Other Travelled Ways:
1. Do not store materials or equipment to be incorporated into the Work; construction equipment, machinery, or tools; Contractor's vehicles, vehicles owned by construction workers and personnel; or other items, whether on short-term, infrequent basis or on a more-frequent basis, in streets, highways, and other travelled ways. Do not store or locate materials and equipment in rights-of-way or adjacent areas in positions that reduce traffic visibility or otherwise create or exacerbate traffic hazards.
 2. When construction activities necessitate a short-term obstruction of traffic, provide adequate traffic controls, flaggers, and other measures as appropriate. Have such obstructions in place for the shortest duration possible and do not leave such obstructions in place at the end of the work day.
 3. When construction activities necessitate a longer-duration obstruction or partial closure to traffic, provide appropriate temporary barriers and barricades, signage, warning devices, and other appropriate measures for traffic control.
 4. Obstruction of public parking shall be in accordance with requirements of authorities having jurisdiction.
- E. Temporary Closures of Streets, Highways, and Other Travelled Ways:
1. This provision applies to full closure of all traffic or partial closure.
 2. Do not close passage to traffic or pedestrians without approval of authorities having jurisdiction and obtaining necessary permits.
 3. Provide appropriate temporary signage, signals and warning devices, temporary barriers and barricades, detours, and temporary facilities (such as temporary bridges or covered walkways, and other temporary facilities) as necessary.
 4. Detours shall be as short as practicable but should generally avoid, when feasible, routing traffic through residential areas and other sensitive areas. Provide appropriate temporary signage to mark detours.
 5. Detours and temporary facilities shall be appropriate for the types of traffic (which may include heavy truck traffic or construction equipment), traffic volume, loading, and hours of the day.
 6. Closures shall be for shortest duration practical, and passage shall be restored immediately after completion of filling and temporary paving, bridging, or other Work.
 7. Obtain approvals and permits needed for full and partial lane closures.
 8. Provide all required temporary signage, signals, and warning devices prior to implementing each closure.

3.2 TRAFFIC SIGNS, SIGNALS, AND LIGHTS

- A. Provide and operate temporary traffic signs, signals, and warning lights necessary and required to direct and maintain orderly flow of traffic in areas under Contractor's control, and areas affected by the Project's construction.
- B. Provide temporary traffic signs, signals, and warning lights mounted on temporary barriers, barricades, or standard posts, at the following locations:
 - 1. Each change of direction of a roadway and at each crossroad.
 - 2. Detours and areas of hazard.
 - 3. Parking areas.
 - 4. Vehicular entrance and exit from each of the Project's construction work areas and construction vehicle and machinery parking and storage areas.
- C. Lighting and Flares: During periods of low visibility provide temporary lights and, where appropriate, flares for the following:
 - 1. To clearly delineate traffic lanes, to guide traffic, and to warn of hazardous areas.
 - 2. For use by traffic control personnel directing traffic.
 - 3. Provide adequate illumination of critical traffic and parking areas.
- D. Power and Fuel:
 - 1. Provide appropriate power supply for temporary lighting and illuminated devices, whether battery-powered, solar-powered, or temporary generators.
 - 2. At the end of each work day, check power supplies and fuel supplies and ensure sufficient power and fuel is in place and available for proper traffic control until Contractor's personnel return to the Site
 - 3. Comply with noise control and air quality control Laws and Regulations and Section 01 57 05 – Temporary Controls.
 - 4. Locate and position temporary generators to avoid nuisances, such as noticeable emissions, odors, noise, and vibration, and other nuisances, and hazards to traffic, pedestrians, adjacent occupants of buildings and structures, and the public.

3.3 TEMPORARY BRIDGING OVER EXCAVATIONS

- A. Areas of Vehicular Access:
 - 1. When necessary or requested by owner of the street, highway, or other travelled way, when other traffic controls are removed while excavations remain open, provide temporary bridging over excavations by providing steel plates to allow unobstructed traffic flow.
 - 2. Size:
 - a. Cover entire length of trench or excavation unless suitable temporary barriers are provided. Each driving lane shall be 15 feet wide unless otherwise acceptable to the owner of the street, highway, or other travelled way.
 - b. Width: Plate shall extend for not less than one trench-width onto competent pavement on each side of the trench or excavation.
 - c. Thickness: Suitable for the traffic load.
 - 3. Anchorage:
 - a. Mechanically anchor each plate to competent pavement using appropriate quantity of railroad spikes or other suitable anchors.
 - b. Anchor not less than each corner of each plate.
 - c. Head of anchors shall not protrude above top surface of the plate.
 - d. Provide appropriate material to level each plate so that plate is not displaced, and does not wobble or rattle, under traffic loads. Provide additional anchors where necessary.
 - 4. Transition to and from Plates:

- a. Provide asphalt concrete “cutback” placed around edges of plates as ramps for smooth transition from pavement to the plate. Ramps’ angle of approach shall be not greater than 1 inch vertical to 12 inches horizontal.
- 5. Excavation Support at Temporary Bridging:
 - a. Provide temporary support of excavations, as necessary for proper support of temporary bridging and traffic loads. Excavation support shall be adequate for excavation depth, soils, groundwater conditions, vibration, and other pertinent considerations.
 - b. Obtain recommendation on type and extent of necessary excavation support from a qualified, experienced professional engineer licensed and registered in the same jurisdiction as the Site. Comply with recommendations of Contractor-hired professional engineer and requirements of owner of the street, highway, or other travelled way.
- B. Sidewalks, Bike Paths, and Other Pedestrian Areas:
 - 1. In sidewalks, bike paths, and other pedestrian areas, provide temporary bridging over excavations of either 1/2 inches thick steel plate or plywood 1-1/8 inches thick.
 - 2. Length and Width: Same as required in this Article for steel plates for vehicle passage.
 - 3. Excavation Support: Same as required in this Article’s provision for steel plates for vehicles.
 - 4. Transitions: Provide asphalt concrete “cutback” or other non-displaceable material as ramp for pedestrians and wheeled items such as handcars, bicycles, and wheelchairs. Angle of ramps shall comply with requirements in this Article for ramps for steel plates for vehicles.
 - 5. If plate is subject to displacement, wobbling, or rattling during use, provide suitable temporary mechanical anchors that do not extend above top surface of the plate.
- C. Vehicular travel over backfilled but unpaved excavations is not allowed, unless Contractor provides temporary surface suitable for vehicles, consisting of not less than 2 inches thick plant mix asphalt concrete paving over not less than 6 inches thick layer of either compacted subbase or flowable fill (also known as “controlled low-strength material”) completely cured, or plates installed over the excavation.
- D. Upon removal of temporary bridging plates, remove all anchors, ramps, and leveling material and completely fill, with non-shrink grout (or other material acceptable to Engineer and owner of street, highway, or other travelled way), all penetrations made for plate anchorages.

3.4 TRAFFIC CONTROL PERSONNEL

- A. Traffic Control Personnel – General:
 - 1. When the Project’s construction operations encroach on traffic lanes, furnish qualified, trained, suitably-equipped traffic control personnel as necessary and required for controlling traffic, in accordance with: requirements of authorities having jurisdiction, the referenced specifications indicated in Paragraph 1.2.B of this Section, and Section 6E of the MUTCD.
 - 2. Traffic control personnel shall use appropriate flags, hand signs or mobile signs.
 - 3. Equip traffic control personnel with appropriate personal protection equipment and appropriate communications devices. Traffic control personnel attire shall be highly-visible, suitable, and shall not create nuisances or distractions to vehicle occupants and pedestrians, and shall not give offense to vehicle occupants, pedestrians, and the public.
 - 4. Conduct of traffic control personnel shall be professional, appropriate, and courteous to vehicle occupants, pedestrians, and the public.

3.5 PARKING CONTROL

- A. Control parking of construction and private vehicles at the Site as follows:
 - 1. Maintain free vehicular access to and through public and private parking areas.
 - 2. Prohibit parking on or adjacent to access roads, and in non-designated areas.
 - 3. Construction vehicles shall possess current vehicle registration and licensure. Do not park or store unregistered vehicles at or adjacent to the Site.

3.6 MAINTENANCE OF TRAFFIC CONTROLS

A. Maintenance of Traffic Controls – General:

1. Properly maintain traffic controls until removal.
2. Relocate traffic controls as the Work progresses.
3. Promptly replace or repair, as appropriate, damaged traffic controls.
4. Ensure adequate power supplies and fuel supplies for traffic controls.
5. Perform manufacturer's recommended routine and preventative maintenance on equipment used for temporary traffic control.
6. Where traffic controls have reduced efficacy or reduced visibility due to accumulations of dirt or foreign matter (including graffiti and vandalism), or exposure to the elements, promptly replace or remedy the subject traffic controls.
7. Maintain traffic controls in operation during adverse weather and climate conditions.

3.7 REMOVAL OF TRAFFIC CONTROLS

A. Duration of Traffic Controls:

1. Prior to Substantial Completion, provide traffic controls at the Site until no longer necessary or required due to the progress of the Work and the Project.
2. After Substantial Completion, provide appropriate traffic controls when Contractor is onsite to perform punch list Work, correction period work, or warranty work.

B. Prior to reopening to traffic, clean streets, highways, and travelled ways.

C. When traffic controls are no longer necessary or required, completely remove traffic controls and restore the Site to condition required by the Contract Documents or, when not indicated in the Contract Documents, restore the Site to pre-construction conditions.

D. Store unused traffic control items at an appropriate location that does not adversely affect public or private property or transportation.

E. Completely remove all traffic control items from the Site and adjacent areas prior to final inspection.

END OF SECTION

SECTION 01 57 05
TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for temporary controls during construction, including:
 - a. Temporary erosion and sediment controls.
 - b. Noise control.
 - c. Dust control.
 - d. Temporary pest and rodent controls.
 - e. Pollution control, including solid waste, water pollution, atmospheric pollution, and other types of pollution.
 - f. Odor control.

B. Scope:

1. Contractor shall provide and maintain materials, equipment, labor, services, and temporary construction as necessary and required to control environmental conditions at the Site and adjacent areas during construction.
2. Contractor shall pay all costs, including fines and civil penalties, if any, for failure to implement and maintain temporary controls in accordance with the Contract Documents, acquired permits, and Laws and Regulations. Contractor is not eligible for increase in Contract Price or Contract Times due to failure to comply with requirements for temporary controls.
3. Maintain temporary controls until no longer necessary or required. Provide temporary controls at all times when Contractor is working at the Site.
4. Prepare Pre-Construction Plans for submittal to Owner's Construction Manager. Owner will submit for approval by Larimer County, as follows:
 - a. Fugitive Dust and Other Emissions Control Plan
 - b. Air Emission Control Plan
 - c. Noise Mitigation Plan
 - d. Exterior Lighting Management Plan
 - e. Comprehensive BMP Plan

C. Related Requirements:

1. Include, but are not necessarily limited to, the following:
 - a. 01 35 13 – Special Project Procedures
 - b. 01 41 24 – Permit Requirements.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable provisions and recommendations of the following:
 - a. Larimer County, Colorado Policy Ordinance No. 97-03 - Ordinance Concerning Noise Levels in Unincorporated Larimer County.
 - b. Weld County, Colorado Charter and County Code Sec. 21-5-416 and Ordinance No. 2025-12.
 - c. Permit requirements and conditions of permits in accordance with Section 01 41 24 – Permit Requirements.

- d. Conditions of construction in accordance with Section 01 35 13 – Special Project Procedures.

1.3 SUBMITTALS

A. Action Submittals:

- 1. Submit the following:
 - a. Shop Drawings:
 - 1) Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a site plan approximate areas of planned disturbance of soils and soil cover over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that Contractor proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional areas.
 - b. Product Data:
 - 1) Silt fencing materials.
 - 2) Other materials proposed for temporary erosion and sediment controls.

B. Informational Submittals:

- 1. Submit the following:
 - a. Deferred Submittals:
 - 1) Fugitive Dust and Other Emissions Control Plan
 - a) In accordance with requirements of this Section.
 - b) Submit within 6 weeks of Construction Notice to Proceed.
 - 2) Air Emission Control Plan
 - a) In accordance with requirements of this Section.
 - b) Submit within 6 weeks of Construction Notice to Proceed.
 - 3) Exterior Lighting Management Plan
 - a) In accordance with requirements of this Section.
 - b) Submit within 6 weeks of Construction Notice to Proceed.
 - 4) Noise Mitigation Plan
 - a) In accordance with requirements of this Section.
 - b) Submit within 6 weeks of Construction Notice to Proceed.
 - 5) Comprehensive BMP Plan
 - a) Submit within 6 weeks of Construction Notice to Proceed.
 - 6) Stormwater Management Plan and Erosion and Sediment Control Plan
 - a) Submit within 6 weeks of Construction Notice to Proceed.
 - b. Field Quality Control:
 - 1) When requested by Owner's Construction Manager or Engineer, promptly obtain and submit results of field measurements and field test data substantiating compliance of Contractor's temporary controls with the Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

- A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Drawings or as otherwise submitted and approved by the Stormwater Discharge permit.

PART 3 - EXECUTION

3.1 NOISE CONTROL

A. Noise Control – General:

1. Contractor's vehicles, construction equipment, and machinery shall minimize noise emissions to greatest degree practicable using the following best practices:
 - a. When necessary, provide mufflers and silencers on construction equipment, machinery, and vehicles.
 - b. Idle equipment motors down when the equipment is not in immediate use.
 - c. Schedule truck deliveries to minimize long queue lines of idling trucks.
 - d. Plan site circulation to minimize backup distances for trucks and other equipment.
 - e. Use sound attenuated pumps and "quiet" generators where practical.
 - f. Install temporary sound barriers when feasible near loud operations.
 - g. Use portable sound barriers when feasible near jackhammer and concrete saw work.
2. Construction equipment and fleet vehicles shall use white noise backup alarms along the entirety of the construction corridor.
3. Noise Mitigation Plan: Submit to Owner's Construction Manager for submittal and approval by Larimer County, as required by Larimer County 1041 Permit Condition of Approval #19, #20, #21, and #22.
 - a. Plan shall reference the Larimer County 1041 Permit Conditions of Approval #19, #20, #21, and #22.
 - b. Include adequate recommendations on how low frequency sound/vibrations are managed.
 - c. Include the details of the outreach and communication plan and in accordance with Section 01 35 13 – Special Project Procedures.
 - d. Include details of project signage in accordance with Section 01 35 13 – Special Project Procedures.
 - e. Include additional noise mitigation to be implemented when construction activities are approved to go beyond the 7am to 7pm time period and all 24-hour operations near occupied residences.
4. Noise threshold levels shall comply with Laws and Regulations, including (a) OSHA requirements and recommendations, and (b) Larimer County Noise Ordinance:
 - a. Allowable Maximum Noise from 7:00 a.m. to 7:00 p.m. is 80 db(A).
 - b. Construction and demolition activities are prohibited between 7:00 p.m. and 7:00 a.m. except as indicated in Section 01 14 34 – Construction and Schedule Constraints.
5. Noise emissions shall not interfere with the work of Owner, facility manager (if other than Owner), or others. The use of noise-producing signals, including horns, whistles, alarms, and bells shall be for safety warning and emergency purposes only.
6. Music or entertainment systems, including personal and vehicle radios, media players, and the like, when used, shall not be audible at the property or easement line and shall not disturb others at the Site.
7. Field Quality Control of Noise:
 - a. If Owner or Owner's Construction Manager believes potential exists that allowable noise levels are being exceeded, Contractor will be required to, and shall promptly perform, appropriate noise monitoring in presence of Owner or Owner's Construction Manager and shall submit written results to Owner's Construction Manager.
 - b. Owner and Owner's Construction Manager reserve the right to perform independent noise monitoring at any time during the Work.
8. If noise level exceeds allowable maximum, Contractor shall immediately cease the activity emitting the excessive noise and promptly implement noise-mitigating measures to comply with noise limitations.

3.2 DUST CONTROL

A. Dust Control – General:

1. Control objectionable dust caused by Contractor's operation of vehicles and construction equipment and machinery, site clearing, demolition, cleaning, and other actions. No visible emissions from disturbed areas, dirt access roads, stockpiles, or haul trucks for construction activities will be allowed.
2. To minimize airborne dust, apply water or use other methods subject to acceptance of Owner's Construction Manager and approval of authorities having jurisdiction. A water truck shall be on-site during operating hours and non-operating hours (including Sundays) to prevent visible emissions.
3. Contractor shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce onsite and off-Site damage, inconvenience, nuisances, and health hazards associated with dust emissions from Contractor's activities.
4. Comply with federal, state, and local regulations.

B. Dust Control Methods:

1. No earthwork is allowed during days of high wind (30 MPH or greater).
2. Speed limit signs shall be posted in active construction areas restricting speeds to 15 miles per hour.
3. Dust control may be accomplished by irrigation in which the dust-prone work activity or area of the Site is sprinkled with water until the surface is moist.
 - a. A water truck shall be on-site during operating hours and non-operating hours (including Sundays) to prevent visible emissions.
4. Apply dust controls as frequently as necessary or required without creating inconveniences, nuisances, or hazards, such as excessive mud and ponding of water at or adjacent to the Site. Do not use water for dust control when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
5. Provide dust control that is non-polluting and does not contribute to tracking-out of dirt, mud, and dust onto pavement.
6. Do not allow water used for dust control to discharge to storm water drainage system or surface waters.
7. Where appropriate, apply gravel or other appropriate binder to access roads and parking areas.
8. Minimize drop height: Drivers and operators shall unload truck beds and loader or excavator buckets slowly and minimize drop height of materials to the lowest height possible. Stockpiles shall remain at a height that a water haul truck or manual water hose can apply water on all surfaces.
9. Litter Control: Work sites, temporary staging areas, field trailer areas, finished construction areas and where workers gather for breaks shall be maintained litter-free and supplied with lidded trash enclosures/dumpsters that can withstand water and wind.
10. Cover loads of material hauling trucks: Loads shall be completely covered, or all material enclosed in a manner that prevents the material from blowing, dropping, sifting, leaking, or otherwise escaping from the truck.

C. Removal of Dust and Dirt from Pavement and Other Travelled Ways:

1. No off-site transport from disturbed areas, dirt access roads, stockpiles, or haul trucks for construction activities will be allowed
2. Remove dust, mud, and dirt from roads, parking areas, and other travelled ways not less than daily. Sediment deposition shall be removed promptly when it occurs on public roads or rights-of-way as a result of the Contractor's operations.
3. Perform dust and dirt removal from travelled ways by mechanical wet vacuum sweeping or other method acceptable to Owner's Construction Manager.

4. Remove mud from roads, parking areas, and other travelled ways by appropriate means, including scraping. Avoid damaging surface of travelled way. Remedy damage to roads, parking areas, and travelled ways resulting from mud removal activities.
- D. Fugitive Dust and Other Emissions Control Plan. Submit to Owner's Construction Manager for submittal and approval by Larimer County.
1. Provide Fugitive Dust Control Plan(s) in order to comply with Local, State, and Federal permitting requirements, and the requirements of this Specification. In accordance with Larimer County 1041 Permit Conditions of Approval #16 and #18.
 - a. Plan shall reference the Larimer County 1041 Permit Conditions of Approval #16 and #18.
 - b. Include Contractor's plans and methods for reducing impacts of fugitive dust resulting from Project, including how the Contractor will comply with permit requirements.

3.3 AIR EMISSIONS

- A. Air Emissions Control Plan. Submit to Owner's Construction Manager for submittal and approval by Larimer County. In accordance with Larimer County 1041 Permit Condition of Approval #17.
1. Plan shall reference the Larimer County 1041 Permit Condition of Approval #17.
 2. Address reduction of other emissions beyond dust and particulate matter specifically for the pipeline construction including but not limited to reducing potential exposure from generators and associated gasoline or diesel powered equipment when used near residences.

3.4 PEST AND RODENT CONTROL

- A. Pest and Rodent Control – General:
1. Provide pest and rodent controls as necessary to prevent infestation of the Site, office areas, storage areas, and adjacent areas.
 2. Pests and rodents include, but are not limited to: flies, mosquitoes, gnats, midges, stinging insects, other insects and the like, worms, rats, mice, moles, voles, and similar animals, raccoons, skunks, objectionable numbers and species of birds, and others.
 3. Implement appropriate pest and rodent controls when pests, rodents, or both are apparent at the Site or offsite storage, staging, or laydown areas.
 4. Control or remove pests and rodents from adjacent properties when Contractor's activities have fostered or exacerbated pest or rodent problems. For example, ground vibration, such as that associated with horizontal directional drilling, may cause migrations of subterranean animals such as moles and voles. Coordinate with affected property owners regarding appropriate control methods, materials, equipment, and disposal techniques.
- B. Methods, Materials, and Equipment for Pest and Rodent Control during Construction:
1. Employ methods and use materials and equipment for pest and rodent control that do not adversely affect conditions at the Site or on adjacent and nearby properties.
 2. Do not use control methods or poisons injurious to household pets or animals other than targeted pests and rodents.
 3. Avoid control methods that present hazards to humans, including children.
- C. Disposal of Pests and Rodents:
1. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled. Do not bury or dispose of deceased animals at the Site or in adjacent areas.

3.5 LIGHTING CONTROL

- A. Lighting Control – General

1. Lighting for construction and associated purposes during construction shall be implemented with the goal of minimizing light pollution, disturbance to nearby residents, and disturbance to migratory birds and other wildlife.
2. Lighting outside of the standard operating hours of 7:00am-7:00pm shall be avoided and is subject to review and approval by Larimer County Staff on a case-by-case basis.
3. Lighting shall be avoided during times of peak spring and fall migration, as determined and agreed to Larimer County Staff on an annual basis, in consultation with Colorado Parks and Wildlife and the local Audubon Society.
 - a. The Owner's Environmental Consultant requested guidance from Colorado Parks and Wildlife and the Northern Colorado Bird Alliance. Neither provided specific best practice nor compliance requirements.

B. Exterior Lighting Management Plan:

1. Submit an Exterior Lighting Management Plan within three (3) weeks of Notice to Proceed that outlines specific best management practices to be implemented by Contractor to comply with the requirements of this section. As required by Larimer County 1041 Permit Condition of Approval #81.
 - a. Plan shall reference the Larimer County 1041 Permit Condition of Approval #81.

3.6 WATER CONTROL

A. Water Control – General:

1. During the Project, provide methods to appropriately control storm water, surface water, water from excavations and structures, groundwater flows altered by Contractor's activities, and groundwater discharges from the Site, to prevent damage to the Work, the Site, adjacent properties, and downstream properties in accordance with the requirements of Stormwater Management permits.
2. Control trenching, filling, and grading to direct water away from excavations, pits, tunnels and other construction areas, and prevent water from entering existing buildings and structures.
3. Properly manage and control storm water, surface water, and groundwater entering the Site from upstream, where such flows or discharges have potential to affect the Work or to be exacerbated by Contractor's activities.
4. Avoid ponding of water onsite, except in specially-designated, temporary settlement basins. Where water ponding occurs during construction, perform rough grading to eliminate ponding.
5. Prevent water from discharging onto roads, parking areas, paved or finished areas, and other travelled ways. Prevent storm water runoff from discharging across access roads and parking areas.

B. Materials, Equipment, and Facilities for Water Control:

1. Provide, operate, and maintain materials, equipment, and facilities of adequate size, materials, and capacity to control storm water, surface water, groundwater, and discharges from tanks.

C. Discharge and Disposal of Water during Construction:

1. Discharge storm water, surface water, and groundwater from the Site, and discharges of clean water from tanks, to proper discharge locations, in accordance with Laws and Regulations and the Contract Documents and associated Permits.
2. Prevent damage and nuisances arising from water discharges on the Site and discharges from the Site.
3. Dispose of water in manner that avoids flooding, erosion, sediment transport, and other damage, in accordance with Laws and Regulations.
4. Avoid overland discharges from the Site and construction activities to adjacent properties,

5. Water discharges from the Site and construction activities shall be via a storm water drainage route or conduit with sufficient capacity for the flow under associated weather and flow conditions and in accordance with requirements of authorities having jurisdiction
6. Do not discharge storm water, surface water, groundwater, or clean water from tanks, into sanitary sewers. Obtain consent of sewerage system owner before discharging such flows into existing combined sewers.
7. Obtain sewerage system owner's consent and approval before discharging polluted water to sewerage system.

3.7 POLLUTION CONTROL

A. Pollution Control – General:

1. Provide means, methods, and facilities necessary and required to prevent contamination of soil, water, and atmosphere caused by accumulation or discharge of substances and materials that are either noxious, polluting, or both, from or caused by construction and related activities.
2. Construction equipment and machinery shall comply with Laws and Regulations.

B. Spills and Contamination:

1. Provide equipment and personnel, perform emergency measures required to contain any spillages, remedy of spills, and remove contaminated soils or liquids.
2. Excavate contaminated material and properly dispose of off-Site and replace with suitable compacted fill and appropriate cover.
3. Notify Owner's Construction Manager within four (4) hours of event, including spill containment actions.

C. . Fueling and Oil/Lubrication Control:

1. The Contractor is responsibility for the safety of personnel and the environment regarding fueling.
2. Contractor shall follow the Code of Colorado Regulations (CCR) and Code of Federal Regulations (CFR) regarding the loading/unloading of fuel.
3. Whenever fueling or changing oil/lubrication of vehicles on the site, the fuel truck shall have spill kits and fire extinguishers.
4. Operator of the fuel truck shall be trained in spill prevention and spill cleanup.
5. No fuel shall be loaded/unloaded from any motor vehicle while the engine is running.

D. Protection of Surface Water and Groundwater:

1. Provide and maintain appropriate, temporary measures to prevent harmful substances from entering surface water, groundwater, and drinking water. Prevent disposal of wastes, effluents, chemicals, and the like into or adjacent to groundwater, surface water, drainage routes (including swales, ditches, and storm sewers) and drinking water.
2. Obtain sewerage system owner's consent and approval prior to discharging into sanitary sewers or combined sewers. Do not discharge pollutants not in accordance with Laws and Regulations into combined sewers, or sewers tributary to combined sewers, when wet weather overflows to receiving waters may occur.

E. Atmospheric Pollutants:

1. Provide and maintain temporary controls for atmospheric pollutants resulting from construction and related activities, whether to outdoor or indoor atmospheres.
2. Prevent harmful dispersal of pollutants into atmosphere.
3. Do not discharge exhaust from internal combustion engines or combustion operations into buildings, structures, or near ventilation intakes for buildings or structures.
4. Prevent toxic and noxious concentrations of chemicals, fumes, and vapors.

F. Solid Waste:

1. Provide and maintain temporary controls for managing solid waste related to the Work.
2. Prevent solid waste from:
 - a. Becoming airborne or blowing in the wind.
 - b. Being inadvertently transmitted to adjacent, offsite properties, and areas of the Site not part of the Project.
 - c. Being deposited in or discharging to surface waters and drainage routes.
3. Properly handle and dispose of solid waste. Burning or burying solid waste, including unused materials, at the Site or adjacent areas is prohibited.
4. Cleaning and Disposal of Debris: Comply with applicable requirements of the General Conditions, as may be modified by the Supplementary Conditions, and Section 01 35 13 – Special Project Procedures.
5. Do not mix or store in the same container solid waste containing Constituents of Concern (and constitutes, or may constitute, a Hazardous Environmental Condition) with solid waste that does not contain Constituents of Concern.
6. Store solid waste in appropriate, covered, containers.
7. Promptly, and at regular intervals, remove solid waste from the Site for transport and disposal in accordance with Laws and Regulations.

3.8 WEED CONTROL

A. Noxious Weeds

1. As required by Larimer County 1041 Permit Condition of Approval #70
2. Identification: Noxious weeds have been identified within or adjacent to the work limits. The observed weed populations occur primarily throughout the disturbed uplands in the site inventory area, with strands of Russian olive along Box Elder creek and unnamed ditches and ponds. Although the List C noxious weed species occur as low-density populations, they are pervasive through large portions of the site inventory area.
 - a. Identified Noxious Weeds Include:
 - 1) List A Species
 - a) No list A species were observed in the work limits; however, disturbance in the project area could result in introduction.
 - 2) List B Species
 - a) Canada thistle (*Cirsium arvense*)
 - b) Leafy spurge (*Euphorbia esula*)
 - c) Hoary cress (*Lepidium draba*)
 - d) Russian olive (*Elaeagnus angustifolia*)
 - 3) List C Species
 - a) Cheatgrass (*Bromus tectorum*)
 - b) Common mullein (*Verbascum thapsus*)
 - c) Field bindweed (*Convolvulus arvensis*)
3. Manage noxious weeds within the limits of construction. Impacted vegetation should be replanted with native vegetation.
 - a. List A Species: Contractor shall eradicate List A Species.
 - b. List B Species: Contractor shall contain dense populations of List B species for control in the wetland, upland, and riparian areas.
 - c. List C Species: Contractor shall suppress List C species.
4. Timing: Conduct initial weed treatment in the spring prior to construction and in the fall prior to planting and restoration.
5. Herbicide Use:
 - a. Herbicide shall be carefully applied by commercial applicators licensed by the Colorado Department of Agriculture as qualified applicators.

- b. Mix and apply all herbicide in accordance with instructions on the registered product label.
- c. Do not apply herbicides when weather conditions, including wind or rain conditions, are unsuitable for herbicide application.
- d. All instructions on the bottle should be followed when using herbicides for weed control.
- 6. Control: Noxious weeds within the work limits shall be controlled using the following best management practices:
 - a. A spring weed treatment and weed treatments during construction shall be used to reduce propagule pressure of noxious weeds in the project area and meet project success criteria.
 - b. Major equipment (track equipment, rubber tire loaders, and backhoes) should be cleaned by high-pressure air or water spray before being delivered to the project area to avoid introducing undesirable plants and noxious weeds.
 - c. After construction is complete, all disturbed areas shall be revegetated as soon as practicable.
 - d. Prompt revegetation with appropriate species shall stabilize disturbed soils and prevent the establishment and spread of noxious weeds.
 - e. Fertilizer rates shall be calculated based on soil tests from stockpiles prior to placement. Slow-release fertilizers shall be used to reduce initial noxious weed invasion and promote the establishment of slower growing native species.
 - f. Large bare patches observed post-construction and during project area monitoring shall be reseeded as soon as practicable to prevent the establishment of noxious weeds.
 - g. The project area shall be monitored by contractor for at least one (1) year. If noxious weeds are present, weed control plans shall be formulated and completed. Control of noxious weeds shall be implemented as soon as practicable to prevent establishment.
 - 1) The Owner will retain a third-party environmental consultant to monitor restoration progress for a period of three (3) years after construction. Following expiration of the Contractor's one-year warranty period, any required maintenance, reseeded, noxious weed treatment, or other mitigation measures identified through the monitoring program will be evaluated, planned, and contracted separately by the Owner. The Owner will be responsible for any bonding or financial assurances associated with these potential future mitigation activities. The Contractor shall have no responsibility for costs, corrective actions, or additional work beyond the one-year warranty period.
 - h. Fertilizer or other soil amendments shall not be used unless recommended by a revegetation specialist based on site-specific conditions. Their use will be limited because fertilizers can promote the establishment of noxious weeds and may be detrimental to native species included in the revegetation mix.
 - i. Certified weed-free seed and mulch shall be used for revegetation. Weed-free straw shall be used for sediment barriers.

3.9 ODOR CONTROL DURING CONSTRUCTION

A. Odors – General:

- 1. Avoid discharges of unpleasant or noxious odors from construction and related activities. Whether nature of the Work is such that odor generation is unavoidable, provide appropriate temporary controls for odors.
- 2. Give priority to avoiding odor generation, followed by:
 - a. Counteracting (treating the cause of) odors.
 - b. Containing odors.
 - c. Odor masking as the last resort for odor control.

3.10 EROSION AND SEDIMENT CONTROLS

A. Installation and Maintenance of Temporary Erosion and Sediment Controls – General:

1. Comply with all requirements of the approved Construction Stormwater Discharge Permit as described in Section 01 41 24 - Permit Requirements.
2. Stormwater Management Plan and Erosion and Sediment Control Plan
 - a. Contractor is responsible for preparing Storm Water Management Plan (SWMP) and Erosion and Sediment Control Plan required for Permit Application. As required by Larimer County 1041 Permit Conditions of Approval #63 and #66.
 - 1) Plan shall reference the Larimer County 1041 Permit Conditions of Approval #63 and #66.
 - 2) Submit SWMP and Erosion and Sediment Control Plan to Owner's Construction Manager for submittal to Larimer County, within 6 weeks of Notice to Proceed.
 - b. Requirements of Thornton's MS4 Stormwater Quality Permit Terms and Conditions regardless of physical location of the project with respect to the MS4 Boundary.
 - c. BMPs shown in Contract Drawings are a reference for preparation and submittal of necessary documentation for application; however, Contractor shall comply with all permit requirement issued by the jurisdictional authority.
3. Before commencing activities that will disturb soil or soil cover at the Site or other areas to be occupied by Contractor during the Project, provide all appropriate temporary erosion and sediment controls required by the approved Construction Stormwater Discharge Permit as described in Section 01 41 24 – Permit Requirements for the areas where soil or soil cover will be disturbed.
4. Vegetation Removal and Disturbance:
 - a. Remove only those shrubs, grasses, trees, and other vegetation that must be removed for construction.
 - b. Protect undisturbed vegetation. Do not wantonly or unnecessarily drive construction vehicles and equipment over undisturbed vegetation and soil cover.
 - c. Promptly stabilize exposed soil where vegetation or soil cover was unnecessarily disturbed. Fill and restore ruts and damage to vegetation and soil cover caused by wanton or unnecessary passage of construction vehicles and equipment.
5. Access Roads and Parking Areas:
 - a. When possible, locate and construct temporary access roads and parking areas to avoid adverse effects on the environment.
 - b. Provide measures to regulate drainage, avoid erosion and sediment transport in storm water runoff, and minimize damage to vegetation and soil cover.
6. Earthwork and Temporary Controls:
 - a. Perform excavation, fill, and related activities in accordance with Section 31 23 33 – Utilities – Trenching and Backfilling.
 - b. Minimize areas of bare soil exposed at one time. Provide fills and spoil areas by selectively placing fill and spoil materials to reduce or eliminate exposed erodible soils.
 - c. Exercise special care on and above steep slopes, where disturbance of vegetation and soil cover shall be minimized to greatest extent reasonably practicable.
 - d. Protect stockpile storage not in active use by providing suitable, durable covering prevent sediment transport in storm water runoff and windblown transport. Covering shall be suitable for outdoor exposure.
7. Inspection and Maintenance:
 - a. Inspect and maintain temporary erosion and sediment controls in accordance with approved Construction Stormwater Discharge Permit as described in Section 01 41 24 - Permit Requirements.
8. Duration of Temporary Erosion and Sediment Controls:
 - a. Maintain temporary erosion and sediment controls in effective, working condition until soil cover of the associated storm water drainage area has been permanently stabilized and BMP removal is authorized by the conditions of the approved Construction Stormwater Discharge Permit as described in Section 01 41 24 - Permit Requirements.

9. Work Stoppage:

- a. If the Work is temporarily stopped or suspended for any reason, Contractor shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.
- b. When temporary erosion and sediment controls remain in place during periods of stopped or suspended Work, continue to perform Contractor's obligations relative to periodic inspection and maintenance of temporary erosion and sediment controls, including removal of accumulated sediment.

10. Failure to Provide Adequate Temporary Erosion and Sediment Controls:

- a. If Contractor repeatedly fails to satisfactorily control erosion and sediment transport in storm water runoff, Owner reserves the right to use Owner's own forces or employ a third-party contractors for temporary erosion and sediment control. Owner's costs for such work, including engineering and inspection costs, will be deducted from amounts due Contractor, as set-offs in accordance with the Contract Documents.

B. Filter Bag on Dewatering Pump Discharge:

1. Provide dewatering of excavations in compliance with Section 31 23 19 – Dewatering.
2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private and public property, and Owner's and facility manager's operations. Relocate filter bags and appurtenances when necessary or required.
3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roads, driveways, access roads, parking areas, other travelled ways, or overland. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
4. Provide filter bag on discharge of each dewatering pump drawing from an excavation or other area with exposed soil.
5. Securely attach filter bag to pump discharge pipe or hose.
6. Maintain, clean out, and replace filter bags as necessary or required.

3.11 COMPREHENSIVE BMP PLAN

- A. Develop a comprehensive document describing best management practices (BMPs) to be employed for utility planning and construction that potentially affects developed, rural, wetland and riparian land areas or may involve streams. As required by Larimer County 1041 Permit Condition of Approval #51.
- B. Plan shall reference the Larimer County 1041 Permit Conditions of Approval #51.
- C. Document shall include groundwater considerations and protection, topsoil conservation and restoration, and vegetation and revegetation considerations, and adaptive management is necessary.

3.12 TEMPORARY WILDLIFE PROTECTION

A. Wildlife Crossovers:

1. For trenches that are left unattended for more than two consecutive days, install 4:1 sloped wildlife escape ramps to the top or cordon off with construction fencing to prevent wildlife from becoming trapped. For excavations that exceed 1/4 mile, install wildlife escape ramps at a minimum of one ramp per 1/4 mile of trench. As required by Larimer County 1041 Permit Condition of Approval #62.

3.13 REMOVAL OF TEMPORARY CONTROLS

A. Removals – General:

1. Unless otherwise indicated elsewhere in this Section in requirements for respective temporary controls, upon completion of the associated Work and when temporary controls are no longer necessary, remove temporary controls and restore the Site to condition in accordance with the Contract Documents; if condition is not shown or indicated, restore the

Site to pre-construction condition. As required by Larimer County 1041 Permit Condition of Approval #67.

2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

END OF SECTION

SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Common requirements for materials and equipment.
 2. Compatibility of materials and equipment.

1.2 REQUIREMENTS FOR MATERIALS AND EQUIPMENT

- A. Unless otherwise indicated in the Contract Documents, furnish materials and equipment that:
1. have not been previously been incorporated into another project or facility; and.
 2. have not changed ownership after initial shipment from the manufacturer's factory or facility; and.
 3. if stored since their manufacture or fabrication, have, while in storage, been properly maintained and serviced in accordance with the manufacturer's recommendations for long-term storage; submit documentation as required by Engineer that such maintenance and service has been performed; and.
 4. that the item(s) have not been subject to degradation or deterioration since manufacture; and.
 5. are the current model(s) or type(s) furnished by the Supplier.
- B. To the extent possible, furnish from a single source those materials and equipment that are of the same generic kind.
- C. Furnish materials and equipment complete with accessories, trim, finish, fasteners, and other items shown, indicated, or required for a complete installation for the indicated use and performance.
- D. Standard Items: When available, and unless custom or nonstandard options are specified or indicated, furnish standard materials and equipment of types that have been produced and used successfully in similar situations on other projects.
- E. Visual Matching: Where required in the Contract Documents, furnish materials and equipment that match (as determined by Owner's Construction Manager) referenced existing construction, and mock-ups and Sample(s) approved by Owner's Construction Manager .
- F. Where the Contract Documents include the phrase "as selected" for color of materials or equipment, finish pattern, option, or similar phrase, furnish materials and equipment selected by Owner's Construction Manager as follows:
1. Standard Range: Where the Contract Documents include the phrase "standard range of colors, patterns, textures" or similar wording, furnish color, pattern, density, or texture selected by Owner's Construction Manager from manufacturer's product line that does not include premium items.
 2. Full Range: Where the Contract Documents include the phrase "full range of colors, patterns, textures" or similar wording, Owner's Construction Manager will select color, pattern, density, or texture from manufacturer's entire product line, including standard and premium items.

1.3 COMPATIBILITY

- A. Similar materials and equipment by the same Supplier shall be compatible with each other, unless otherwise indicated in the Contract Documents or approved by Engineer.
- B. Furnish materials and equipment compatible with items previously selected or installed on the Project.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

SECTION 01 75 00
CHECKOUT AND START-UP PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Administrative and procedural requirements for checkout and startup of equipment, systems, and facilities.
- B. Scope:
 - 1. Contractor shall initially check out, start up, and place equipment and systems installed under the Contract into successful operation, in accordance with the material and equipment manufacturers' written instructions, Suppliers' recommendations at the Site, and the Contract Documents.
 - 2. Provide the following:
 - a. All labor, tools, materials, and equipment required to complete equipment and system checkout and startup.
 - b. Chemicals, lubricants, and other required operating fluids necessary for checkout, startup, and initial operation of the Work.
 - c. Filters and other temporary or consumable items necessary for checkout, startup, and initial operation of the Work.
 - d. Fuel, electricity, water, and other temporary utilities and temporary facilities necessary for checkout and startup of equipment and systems, unless otherwise specified.
 - 3. The General Conditions, as may be modified by the Supplementary Conditions, and Section 01 77 19 - Closeout Requirements, address requirements for documenting Substantial Completion.
- C. Related Sections include but are not necessarily limited to:
 - 1. Section 01 78 23 - Operation and Maintenance Data
 - 2. Section 01 77 19 - Closeout Requirements.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate checkout and startup with other contractors, as necessary.
 - 2. Subject to the constraints of this Specifications section, Owner will furnish sufficient personnel to assist Contractor in starting up equipment and system(s), but responsibility for proper operation of the Work is Contractor's.
 - 3. Do not start up equipment and system(s), without submitting acceptable preliminary operations and maintenance manuals by Contractor in accordance with the Contract Documents.
- B. Checkout and Startup Planning Meeting:
 - 1. Contractor, with appropriate Subcontractors and Suppliers, shall attend and participate in a meeting with Owner, Owner's Construction Manager, and Engineer to discuss planning, scheduling, and coordination of checkout and startup activities.
- C. Sequencing:
 - 1. Comply with Section 01 14 16 - Coordination with Owner's Operations, regarding staging (phasing) of the Work and allowable shutdowns and tie-ins.
- D. Scheduling:
 - 1. Progress Schedule:

- a. Clearly indicate in the Progress Schedule planned and actual dates for checkout, startup, and field quality control activities, including all demonstration testing activities addressed in this Specifications section and elsewhere in the Contract Documents. Separately indicate checkout, startup, and field quality control activities for each equipment item and system.
- b. Perform startup and field quality control activities on the associated, scheduled dates, unless otherwise acceptable to Owner, Owner's Construction Manager, and Engineer.
2. Restrictions for Scheduling:
 - a. Startup, including initial operation of materials, equipment, and systems, shall not be initiated on: Monday, Friday, Saturday, Sunday, Owen's holidays, the day immediately prior to a holiday, or the day immediately following a holiday, unless otherwise acceptable to Owner, Owner's Construction Manager, and Engineer.
 - b. Unless otherwise indicated in the Contract Documents or acceptable to Owner, Owner's Construction Manager, and Engineer, perform all startup during normal working hours of the day shift.
 - c. Owner reserves the right to require a minimum seven days' notice of rescheduled startup when Contractor cannot perform the associated activities as scheduled.
3. Operation and Maintenance Data:
 - a. Comply with Section 01 78 23 - Operation and Maintenance Data.

1.3 SUBMITTALS

- A. Informational Submittals: Submit the following:
 1. Progress Schedules indicating dates for checkout, startup, and field quality control activities.
 2. Completed checkout and startup log required of this Specifications section.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 STARTUP

- A. Prior to the Startup, complete the Work to the point where it is ready for checkout and startup.
- B. Checkout.
 1. Complete manufacturers required checks for proper installation, including I/O and communication checks, before startup.
- C. Startup:
 1. Prepare the Work so it will operate properly and safely and be ready to demonstrate functional integrity during the startup.
 2. Perform startup to extent possible without introducing flow.
 3. Procedures include but are not necessarily limited to the following:
 - a. Test or check and correct deficiencies of:
 - 1) Power and monitoring circuits for continuity prior to connection to power source.
 - 2) Voltage of all circuits.
 - 3) Valve orientation and position status for manual operating mode.
 - 4) Instrumentation signal generation, transmission, reception, and response.
 - 5) Tagging and identification systems.
 - 6) Proper connections, alignment, calibration and adjustment.
 - b. Checkout and Startup Log:

- 1) Prepare a log showing each equipment item and system requiring checkout and startup. Indicate in the log activities to be accomplished during checkout and startup.
- 2) Provide a place for Contractor to record date and person performing required checkout and startup. Indicate associated date(s), personnel, and employer of each.
- 3) Submit completed checkout and startup log to Engineer and obtain Engineer's acceptance.

END OF SECTION

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SECTION 01 77 19
CLOSEOUT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Administrative and procedural requirements for:

1. Substantial Completion.
2. Final inspection.
3. Request for final payment and acceptance of the Work.

1.2 SUBSTANTIAL COMPLETION

A. Substantial Completion – General:

1. Prior to requesting inspection for Substantial Completion, perform the following for the substantially completed Work:
 - a. Materials and equipment for which Substantial Completion is requested shall be fully ready for their intended use, including full operating and monitoring capability in automatic, manual, and other operating modes set forth in the Contract Documents.
 - b. Permanent provisions for safety and protection, shown and indicated in the Contract Documents and associated with the substantially completed Work or for personnel accessing and using the substantially completed Work, shall be in place and ready for their intended use.
 - c. Complete field quality control Work, including inspections and testing at the Site, indicated in Specifications sections for individual materials and equipment items and related Contract Documents. Submit results of, and obtain Engineer's acceptance of, field quality control tests and inspections required by the Contract Documents.
 - d. Complete checkout and startup in accordance with Section 01 75 00 - Checkout and Startup Procedures, requirements of the Specifications for the various materials and equipment in the substantially completed Work, and related Contract Documents.
 - e. Cleaning for Substantial Completion shall be completed in accordance with requirements of this Specification.
 - 1) Clean installed surfaces according to written instructions of manufacturer or fabricator of installed materials and equipment, using only cleaning agents and methods specifically recommended by material or equipment Supplier.
 - 2) Remove spills and stains or petroleum, oils, solvents, other chemicals, and other foreign and undesirable deposits.
 - 3) Touch-up and otherwise repair and restore chipped, scratched, dented or otherwise marred surfaces to specified finish and match adjacent surfaces.
 - f. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition in accordance with the Contract Documents; if condition is not specified, restore to preconstruction condition.
 - g. Spare parts, tools, and extra materials shall be delivered and accepted in accordance with the Contract Documents and documentation of Owner's acceptance thereof has been submitted to Owner's Construction Manager.

- h. Submit and obtain Engineer's acceptance of final operations and maintenance manuals in accordance with Section 01 78 23 - Operation and Maintenance Data.
 - i. Obtain and submit to Owner's Construction Manager all required permits, inspections, and approvals of authorities having jurisdiction for the substantially completed Work to be occupied and used by Owner.
 - j. Complete other tasks that the Contract requires be completed prior to Substantial Completion.
2. Procedures for requesting and documenting Substantial Completion are in the General Conditions, as may be modified by the Special Conditions.

1.3 REQUEST FOR FINAL PAYMENT AND ACCEPTANCE OF THE WORK

A. Procedure:

1. After successful completion of the final inspection, the procedure for final payment and initial acceptance will be in accordance with the General Conditions, as may be modified by the Supplementary Conditions.

B. Request for final payment shall include:

1. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.
2. Combined Record Drawings in accordance with Specification Section 01 33 51 – Project Record Documents.
3. List, on Contractor's letterhead, of all Change Proposals, Claims, and disputes that Contractor believes are unsettled. If there are no such Change Proposals, Claims, or disputes, so indicate in writing.
4. Consent of Surety to Final Payment:
 - a. Acceptable form includes AIA G707, "Consent of Surety to Final Payment" (1994 or later edition), or other form acceptable to Owner.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION – (NOT USED)

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for Contractor-furnished, manufacturers' operation and maintenance (O&M) data, including:
 - a. Required operation and maintenance data groupings into operation and data manuals and timing of such Submittals.
 - b. Requirements for operation and maintenance data and related Electronic Documents.
 - c. Content of operation and maintenance data Submittals.

B. Scope:

1. Contractor shall submit operation and maintenance data, and related information, in accordance with this Section and requirements elsewhere in the Contract Documents, as instructional and reference information for use by: (a) Owner's operation and maintenance personnel, and (b) others retained by or working for Owner.
2. In addition to operation and maintenance data expressly required elsewhere in the Contract Documents, also submit operation and maintenance data for:
 - a. All equipment and systems, including electrical equipment, communications equipment, and utility equipment.
 - b. Valves, gates, actuators, and related accessories.
 - c. Instrumentation and control devices and systems.

C. Related Requirements:

1. Section 01 33 00 - Submittal Procedures.
2. Section 01 75 00 - Checkout and Startup Procedures.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
 - a. Submit operation and maintenance data, required by the Contract Documents, grouped into operation and maintenance manual Submittals indicated in Table 01 78 23-A.
 - b. Where operation and maintenance data required by the Contract Documents, is not expressly indicated in table 01 78 23-A, obtain written clarification or interpretation from Engineer prior to preparing and transmitting such Submittal.

Table 01 78 23-A
Required Groupings of Operation and Maintenance Data Submittals

Name of O&M Manual/Data	For Materials or Equipment Specified in Section(s)
Electrical System O&M	26 05 00; 26 05 19; 26 05 33; 26 08 13; 26 24 16; 26 28 01; 26 43 13;
Piping and Valve O&M	40 05 51; 40 05 52; 40 05 57; 40 05 61; 40 05 63

B. Timing of Submittals and Quantity Required:

1. Final Operation and Maintenance Manual Submittals: Submit by the earlier of: 90 days following approval of Shop Drawings and product data Submittals or 14 days prior to field quality control testing at the Site.
 - a. Electronic Documents in accordance with this Specification.
 - b. Work will not be eligible for Substantial Completion until associated, required final operation and maintenance data Submittals are accepted by Engineer.

1.3 ELECTRONIC DOCUMENTS O&M MANUALS

A. Electronic Documents of Operation and Maintenance Manuals:

1. Each Electronic Document copy of operation and maintenance data shall include all information included in the corresponding paper copy.
2. Submit Electronic Documents operation and maintenance data in accordance with Section 01 33 00 - Submittal Procedures.
3. File Format:
 - a. Unless otherwise required by Section 01 33 00 - Submittal Procedures, operation and maintenance data Electronic Documents shall be "portable document format" (PDF) files.
 - b. Electronic Documents shall be electronically searchable upon delivery.
 - c. Electronic Documents shall not be password-protected and shall not be protected against Owner's or facility manager's copying and printing such files for Owner's or facility manager's use in operating and maintaining the facility.
 - d. Electronic Documents shall open to its first page.
 - e. Submit each operation and maintenance manual as a single Electronic Document file, unless file size is over-large, in which case divide into as few separate files, each with similar filename, as possible.
 - f. Within each Electronic Document, provide bookmarks for the following:
 - 1) Each chapter and subsection indicated in the corresponding printed copy document's table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix and attachment.

1.4 CONTENT OF OPERATION AND MAINTENANCE MANUALS

A. Operation and Maintenance Manual Content – General:

1. Prepare each operation and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-constructed drawings as applicable, bills of materials, technical information, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.
2. Provisions of this Article were written for equipment. Where operation and maintenance data are required for building products, such as finishes, openings, thermal and moisture protection, and similar items, comply with this Article to the extent practical and reasonable for the associated item.
3. Completeness and Accuracy:
 - a. Operation and maintenance manuals that include language stating or implying that the manual's content may be insufficient or stating that the manual's content is not guaranteed to be complete and accurate are unacceptable.
 - b. Operation and maintenance manuals shall be complete and accurate.

- c. Operation and maintenance manuals shall indicate the specific alternatives and features furnished, and the specific operation and maintenance provisions for the material or equipment furnished.
 4. Identify each equipment item consistent with names and identification numbers shown or indicated in the Contract Documents, rather than manufacturer's model numbers.
 5. Neatly type data not furnished in computer-printed text. Handwriting, except for strikeouts, arrows, and the like, is unacceptable.
 6. Include copy of warranty in accordance with the Contract Documents.
- B. Operation and Maintenance Instructions:
1. Safety Considerations:
 - a. Submit written descriptions of safety considerations relating to operation and maintenance procedures for materials and equipment.
 - b. Indicate procedures for proper, safe operating and maintenance of materials and equipment furnished, including manufacturer's recommended personal protection equipment, apparatus, and devices not furnished under the Contract.
 - c. Engineer's review of operation and maintenance data expressly does not extend to adequacy, completeness, and accuracy of SDS or other safety and protection practices and procedures indicated in the operation and maintenance data.
 2. Operation:
 - a. Include in operation and maintenance data Submittals complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; and regulation and control. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
 - b. Include pre-startup instructions and checklists and complete startup instructions for each material and equipment item.
 - c. Indicate recommended operating instructions for all operating modes and conditions, with associated recommendations for safe operation.
 - d. Explain available controls and instrumentation and associated function(s).
 - e. Troubleshooting instructions.
 3. Maintenance – General:
 - a. Include in operation and maintenance data complete, written instructions for necessary and recommended maintenance, including mechanical maintenance and electrical/instrumentation and controls maintenance, as applicable.
 - b. Include in operation and maintenance data complete instructions for necessary assembly, disassembly, installation, re-installation, storage, and shipping for materials and equipment.
 - c. Tools: Include list of required maintenance tools and equipment.
 - d. Spare Parts and Extra Materials:
 - 1) Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
 - 2) Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
 - 3) Also refer to this Article's provision, "Bills of Materials", below, for additional requirements regarding ordering replacement parts.

4. Routine and Preventative Maintenance:
 - a. Submit complete, detailed, written instructions for routine and preventive maintenance including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
 - 1) Written explanations with illustrations for each routine and preventive maintenance task such as inspection, adjustment, anchor bolt torque checks, lubrication, calibration, cleaning, replacement of filters, and the like.
 - 2) Recommended schedule for each routine and preventive maintenance task.
 - 3) Lubricants:
 - a) Provide lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 - b) Table of alternative lubricants.
- C. Record Copy of Shop Drawings, Product data, and Other Previously Approved and Accepted Submittals:
 1. Submit original-quality copies of each approved and accepted (as applicable) Shop Drawing, product data Submittal, written results of source quality control activities, and other Submittals, updated to indicate as-installed condition. Do not include prior Submittals that were not approved or were not accepted. Reduced drawings are acceptable only when reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
- D. Electrical Schematics, Diagrams, and Information:
 1. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
 2. Include as-constructed drawings of layouts of electrical panels (such as switchgear and motor control centers) and control panels.
- E. NFPA 70 (National Electric Code) Documentation:
 1. Include in operation and maintenance manuals for electrically-powered equipment documented calculations of: (1) arc-fault current, equipment available fault current and (2) short-circuit current rating (SCCR), provided as part of equipment Submittals.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION



DIVISION 03

CONCRETE



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SECTION 03 05 05
CONCRETE TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Contractor requirements for testing of concrete and grout.
 - 2. Definition of Owner provided testing.
 - 3. Acceptance criteria for concrete.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 21 00 - Reinforcement.
 - 2. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 3. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
 - 4. Section 33 05 16 - Precast Concrete Manhole Structures.

1.2 RESPONSIBILITY AND PAYMENT

- A. Owner will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Engineer and Contractor.
 - 1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
 - 2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
 - 3. Strength testing on concrete required by the Engineer or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
 - 4. In-place testing of concrete as may be required by Engineer when strength of structure is considered potentially deficient.
 - 5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may be removed.
 - 6. Owner will pay for services defined in Paragraph 1.2A.1.
 - 7. See Specification Section 01 42 00.
- B. Hire a qualified testing agency to perform the following testing and provide test results to the Engineer.
 - 1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
 - 2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
 - 3. Pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
 - 4. Reimburse Owner for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.
 - 5. See Specification Section 01 42 00.
- C. Duties and Authorities of Testing Agency/Service Provider:
 - 1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Owner for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.

2. Testing Agency/Service Provider shall inform the Contractor and Engineer regarding acceptability of or deficiencies in the work including materials furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.
3. Testing Agency to submit test reports and inspection reports to Engineer and Contractor immediately after they are performed.
 - a. All test reports to include exact location in the work at which batch represented by a test was deposited.
 - b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
4. Owner retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:

1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete.
2. ASTM International (ASTM):
 - a. ASTM Cement and Concrete Reference Laboratory (CCRL).
 - b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - e. C94, Standard Specification for Ready-Mixed Concrete.
 - f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
 - g. C172, Standard Practice for Sampling Freshly Mixed Concrete.
 - h. C1019, Standard Test Method for Sampling and Testing Grout.
 - i. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
 - j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Qualifications:

1. Contractor's Testing Agency:
 - a. Meeting requirements of ASTM E329 and ASTM C94.
 - b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.

- C. Use of Testing Agency and approval by Engineer of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

- A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Owner to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:

1. Product technical data including:
 - a. Concrete materials and concrete mix designs proposed for use.
 - 1) Include results of all testing performed to qualify materials and to establish mix designs.
 - 2) Place no concrete until approval of mix designs has been received in writing.

- 3) Submittal for each concrete mix design to include:
 - a) Sieve analysis and source of fine and coarse aggregates.
 - b) Test for aggregate organic impurities.
 - c) Proportioning of all materials.
 - d) Type of cement with mill certificate for the cement.
 - e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30.
 - f) Slump.
 - g) Brand, type and quantity of air entrainment and any other proposed admixtures.
 - h) Shrinkage test results.
 - i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
 - j) 28-day compression test results and any other data required by Specification Section 03 31 30 to establish concrete mix design.
2. Certifications:
 - a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

A. The following concrete testing will be performed by the Service Provider/Testing Agency:

1. Concrete strength testing:
 - a. Secure concrete samples in accordance with ASTM C172.
 - 1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
 - b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
 - 1) Record any deviations from requirements on test report.
 - 2) Cylinder size: Per ASTM C31.
 - a) 4 inches cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 inch.
 - b) Use the same size cylinder for all tests for each concrete mix.
 - 3) Quantity:
 - a) 6 inches diameter by 12 inches high: [Four] [Five] cylinders.
 - b) 4 inches diameter by 8 inches high: Six cylinders.
 - c. Field cure one cylinder for the seven day test.
 - 1) Laboratory cure the remaining.
 - d. Test cylinders in accordance with ASTM C39.
 - 1) 6 inches diameter cylinders:
 - a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
 - b) Hold remaining cylinder in reserve.
 - 2) 4 inches diameter cylinders:
 - a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
 - b) Hold remaining cylinders in reserve.

- e. Strength test result:
 - 1) Average of strengths of two, 6 inches diameter cylinders or three, 4 inches diameter cylinders from the same sample tested at 28 days.
 - 2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
 - 3) Should all cylinders in any test show any of above defects, discard entire test.
- f. Frequency of tests:
 - 1) Concrete sand cement grout: One strength test for each 4 hour period of grout placement or fraction thereof.
 - a) Test grout in accordance with ASTM C1019.
 - 2) Concrete topping, concrete fill and lean concrete: One strength test for each [10] [60] CUYD of each type of concrete or fraction thereof placed.
 - 3) Precast concrete: Frequency per Specification Section 33 05 16.
 - 4) All other concrete:
 - a) One strength test to be taken not less than once a day, nor less than once for each 60 cubic yards or fraction thereof placed in any one day.
 - b) Once for each 5000 square feet of slab or wall surface area placed each day
 - c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.
- 2. Slump testing:
 - a. Determine slump of concrete sample for each strength test.
 - 1) Determine slump in accordance with ASTM C143.
 - b. If consistency of concrete appears to vary, the Engineer or Owner's Representative shall be authorized to require a slump test for each concrete truck.
 - 1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.
- 3. Air content testing: Determine air content of concrete sample for each strength test in accordance with ASTM C231.
- 4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

- A. See Section 01 45 33.
 - 1. Special Inspections listed are for the Contractor reference only and is not part of the Contract Documents.
 - 2. It is included to assist the Contractor in understanding the Owner-provided Services so that those services may be factored into the Contractor's pricing and schedule.
- B. Formwork Special Inspections:
 - 1. Shape, location, and dimensions.
 - a. Inspect in accordance with dimensions and details on Drawings.
 - b. Frequency: Inspect prior to each concrete pour.
- C. Reinforcing Special Inspections:
 - 1. Reinforcing size, spacing, lap length and concrete cover.
 - a. Inspect in accordance with Drawings and Specification.
 - b. Frequency: Inspect prior to each concrete pour.
 - 2. Reinforcing adhesive anchoring system:
 - a. Inspect in accordance with ICC-ES report.

- b. Frequency:
 - 1) Inspect all adhesive anchors for the first [4] hours of installation.
 - 2) Inspect approximately 25% of adhesive anchors thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
- 3. Mechanical splices:
 - a. Inspect in accordance with ICC-ES report.
 - b. Frequency:
 - 1) Inspect all mechanical splices [prior to placing concrete] [for the first [4 hours] of installation].
 - 2) Inspect approximately 25% of mechanical splices thereafter.
 - 3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
- D. Mixing, Placing, Jointing, and Curing Special Inspections:
 - 1. Perform concrete tests per the requirements of this Specification Section.
 - 2. Verification of proper mix design.
 - a. Frequency: Periodically, prior to [each] concrete pour.
 - 3. Proper concrete placement techniques.
 - a. Inspect per requirements of Section 03 31 31.
 - b. Frequency: During [each] concrete pour.
 - 4. Proper curing temperature and techniques.
 - a. Inspect per requirements of Section 03 31 31.
 - b. Frequency: Periodically, but not less than [every third day].
 - 5. Joints:
 - a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
 - b. Frequency: Prior to each concrete pour.
 - 6. Waterstops:
 - a. Visually inspect waterstops for proper location, continuity, installation to prevent displacement, cleanliness and damage to waterstop.
 - b. Frequency:
 - 1) Prior to each concrete pour.
- E. Anchorage to Concrete Special Inspection:
 - 1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Engineer.
 - a. Frequency: Per ICC-ES Report.
 - 2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
 - a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

- A. To facilitate testing and inspection, perform the following:
 - 1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
 - 2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 hours as required by ASTM C31.
 - 3. Take samples at point of placement into concrete member.

- B. Notify Engineer and Owner's Testing Agency sufficiently in advance of operations (minimum of 24 hours) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

- A. Completed concrete work which meets applicable requirements will be accepted without qualification.
- B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.
- C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
 - 1. In this event, modifications may be required to assure that concrete work complies with requirements.
 - 2. Modifications, as directed by Engineer, to be made at no additional cost to Owner.
- D. Dimensional Tolerances:
 - 1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Engineer.
 - 2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
 - a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
 - 3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.
 - 4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
 - a. Repair or remove and replace if required.
 - 5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
 - a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.
- E. Appearance:
 - 1. Concrete surfaces exposed to view with defects which, in opinion of Engineer, adversely affect appearance as required by specified finish shall be repaired by approved methods.
 - 2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Engineer, the defects impair the long-term strength or function of the member.
- F. High Water-Cement Ratio:
 - 1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
 - 2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Engineer.
- G. Strength of Structure:
 - 1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
 - a. Low concrete strength:
 - 1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.

- a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
 - b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
 - c) A strength test shall be the average of two, 6 inches diameter cylinders or three, 4 inches diameter cylinders from the same sample tested at 28 days.
- 2) Acceptance:
- a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
 - (1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.
 - (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 psi.
 - b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.
 - c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
 - d. Curing time and procedure not meeting requirements of this Specification Section.
 - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
 - g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.
3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
- a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer to determine relative strengths at various locations in the structure or for selecting areas to be cored.
 - 1) Such tests shall not be used as a basis for acceptance or rejection.
 - b. Core tests:
 - 1) Where required, test cores will be obtained in accordance with ASTM C42.
 - a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 degrees F, relative humidity less than 60%) for seven days before test then test dry.
 - b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 hours and test wet.
 - c) Testing wet or dry to be determined by Engineer.
 - 2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
 - a) Location of cores shall be determined by Engineer so as least to impair strength of structure.
 - b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.

- 3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85% of specified strength and no single core is less than 75% of specified strength.
- 4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.
4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 27.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Engineer, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

SECTION 03 11 13

FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formwork requirements for concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 05 05 - Concrete Testing and Inspection.
 - 2. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - 3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 347R, Guide to Formwork for Concrete.
- B. Qualifications:
 - 1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
 - a. Above qualifications apply to slabs and beams not cast on the ground.
- C. Miscellaneous:
 - 1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
 - 2. Design requirements:
 - a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
 - 1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
 - b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
 - 3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores [and installation of reshores] and for calculating the loads transferred to the structure during this process in accordance with ACI 347R.
 - a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon. Calculations shall be performed by a licensed professional engineer.
 - b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
 - 1) The structural system that exists.
 - 2) Effects of all loads during construction.
 - 3) Strength of concrete.

- 4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
- 5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.
- 6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

- A. Words and terms used in these Specifications are defined in ACI CT-13.
- B. SCC: Self-Consolidating Concrete.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Product technical data including:
 - a. Manufacturer and type of proposed form ties.
- B. Samples:
 1. A 12 inches SQ sample of each of the following form finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Forms for Surfaces Exposed to View:
 1. Wood forms:
 - a. 5/8 or 3/4 inches 5-ply [faced] structural plywood of concrete form grade.
 - b. Built-in-place or prefabricated type panel.
 2. Metal forms:
 - a. Metal forms may be used except for aluminum in contact with concrete.
 - b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.
- B. Forms for Surfaces Not Exposed to View:
 1. Wood or metal sufficiently tight to prevent leakage.
 2. Do not use aluminum forms.

2.2 ACCESSORIES

- A. Form Ties:
 1. Commercially fabricated for use in form construction.
 - a. Field fabricated ties are unacceptable.
 2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
 3. Embedded portion of ties to be not less than 1-1/2 inches from face of concrete after ends have been removed.
 4. Cone size:
 - a. 3/4 inches minimum diameter cones on both ends.
 - b. Depth of cone not to exceed the concrete reinforcing cover.
 5. Provide ties with built-in waterstops in all walls that will be in contact with [process liquid during plant operation] [below grade soil].
 6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with liquids during plant operation.

B. Form Release Material:

1. If project contains self-consolidating concrete, provide reactive, vegetable based product, not barrier type.

C. Void Forms:

1. Material: Corrugated paper or corrugated plastic. Where void forms may reasonably be subjected to damp conditions, such as precipitation, groundwater, surface water, or other source of moisture, provide void forms impervious to moisture. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:

1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
 - a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Apply form release material to minimize bugholes and pinholes. Follow manufacturer's printed installation instructions specific to the form facing material.

C. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.

1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 feet apart.

D. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:

1. Conform to ACI 117.
2. Variation from plumb:
 - a. In lines and surfaces of columns, piers, walls, and in risers.
 - 1) Maximum in any 10 feet of height: 1/4 inches.
 - 2) Maximum for entire height: 1/2 inches.
 - b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
 - 1) Maximum in any 20 feet length: 1/4 inches.
 - 2) Maximum for entire length: 1/2 inches.
3. Variation from level or from grades specified:
 - a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
 - 1) Maximum in any 10 feet of length: 1/4 inches.
 - 2) Maximum in any bay or in any 20 feet length: 3/8 inches.
 - 3) Maximum for entire length: 3/4 inches.
 - b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:

- 1) Maximum in any bay or in 20 feet length: 1/4 inches.
- 2) Maximum for entire length: 1/2 inches.
4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
 - a. Maximum in any bay: 1/2 inches.
 - b. Maximum in any 20 feet of length: 1/2 inches.
 - c. Maximum for entire length: 1 inch.
5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 inches.
6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 inches.
7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 inches, +1/2 inches.
8. Footings and foundations:
 - a. Variations in concrete dimensions in plan: -1/2 inches, +2 inches.
 - b. Misplacement or eccentricity:
 - 1) 2% of footing width in direction of misplacement but not more than 2 inches.
 - c. Thickness:
 - 1) Decrease in specified thickness: 5%.
 - 2) Increase in specified thickness: No limit except that which may interfere with other construction.
9. Variation in steps:
 - a. In a flight of stairs:
 - 1) Rise: +1/8 inches.
 - 2) Tread: +1/4 inches.
 - b. In consecutive steps:
 - 1) Rise: +1/16 inches.
 - 2) Tread: +1/8 inches.
10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and benchmarks to be used for reference purposes to check tolerances.
11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.
- C. Make forms sufficiently tight to prevent loss of mortar from concrete.
- D. Place 3/4 inches chamfer strips in exposed to view corners of forms to produce 3/4 inches wide beveled edges.
- E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 inch.
 1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
 2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.
- F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 feet wide.
 1. Brace and tie formwork to maintain correct position and shape of members.

- G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.
- H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.
- I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.
- J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
 - 1. Securely brace forms against lateral deflection.
 - 2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

3.3 REMOVAL OF FORMS

- A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.
- C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
 - 1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.
- D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.
- E. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
- F. Where no reshoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28-day compressive strength.
 - 1. Where a reshoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.
- G. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.

3.4 RESHORING

- A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.
- C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.
- D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.
- E. Tighten reshores to carry their required loads without overstressing.

- F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.
- G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.
 - 1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
 - 2. Locate reshores directly under a shore position above.
- H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.5 FIELD QUALITY CONTROL

- A. Contractor Quality Control:
 - 1. See Section 01 45 16.13
- B. Special Inspection:
 - 1. See Section 03 05 05.

END OF SECTION

SECTION 03 15 19

ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for anchorages in concrete, including cast-in-place anchor bolts, anchor rods, reinforcing anchorage adhesive, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
2. Delegated design requirements for concrete anchors not expressly shown or indicated on the Drawings or elsewhere in the Contract Documents, including, but not limited to, anchorages in concrete for the following structural and nonstructural components:
 - a. Structural members and accessories.
 - b. Metal, wood, and plastic fabrications.
 - c. Architectural Work, including building components, finishes, specials, facility equipment and conveying equipment, furnishings, and special construction Work.
 - d. Mechanical and electrical Work, including process-mechanical Work, site and infrastructure Work, electrical Work, communications Work, electronic safety and security systems Work, and others.
 - e. Fire suppression, plumbing, and HVAC Work.
 - f. Other components requiring anchorages to concrete.

B. Related Requirements: Include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.

1.2 REFERENCES

A. Definitions and Terminology:

1. This provision presents definitions and terminology, which have the meanings indicated in this provision, applied to the singular or plural thereof, and without regard to use of initial capital letters.
 - a. Adhesive Anchors:
 - 1) Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
 - 2) Includes anchors using acrylics, epoxy and other similar adhesives.
 - b. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.
 - c. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.
 - d. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.
 - e. Galvanizing: Hot-dip galvanizing in accordance with ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 ounces of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by reference standard.
 - f. Hardware: As defined in ASTM A153 or ASTM F2329.
 - g. MPIL: Manufacturer's printed installation instructions.
 - h. Mechanical Anchors:
 - 1) Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
 - 2) Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
 - 3) Drop-in anchors and other similar non-ICC ES approved anchors are unacceptable.

- i. Post-Installed Anchor: Adhesive or mechanical anchor installed into previously placed and adequately cured concrete.
- B. Reference Standards:
 - 1. American Concrete Institute (ACI):
 - a. 318, Building Code Requirements for Structural Concrete and Commentary.
 - 2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
 - a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
 - 3. American Institute of Steel Construction (AISC):
 - a. 303, Code of Standard Practice for Steel Buildings and Bridges.
 - b. 355.2, Seismic Testing of Post-Installed Concrete and Masonry Anchors in Cracked Concrete.
 - c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
 - 4. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
 - f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
 - i. F436, Standard Specification for Hardened Steel Washers.
 - j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - k. F594, Standard Specification for Stainless Steel Nuts.
 - l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
 - m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
 - 5. International Code Council Evaluation Service (ICC-ES):
 - a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
 - b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. For post-installed anchors and other anchorages installed in existing concrete, comply with Section 01 73 29 - Cutting and Patching.
 - 2. Comply with coordination requirements in Section 01 35 73 - Delegated Design Procedures.
- B. Pre-Design Conference:
 - 1. Pre-design conference for anchorages to concrete (where such anchorages are delegated design Work) is not required.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Code-required Special Instructions:

- a. Special Inspection is required in accordance with the building code for all concrete anchorages.
- b. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
- c. See the "Field Quality Control" Article in "Part 3 – Execution" of this Section for additional requirements.

B. Qualifications:

- 1. Delegated Design Professional:
 - a. Delegated design professional's qualifications and responsibilities shall be in accordance with Section 01 35 73 - Delegated Design Procedures.
- 2. Installer:
 - a. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Engineer.
 - b. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Submit schedule (table or listing) of types, sizes (diameter, length, embedment length), material, finish, and proposed manufacturers of anchorages to concrete to be provided. Apportion by Project-specific application (for example, "Anchorage for cooling water pumps in basement") and indicate where anchorages are fully-designed by Engineer and those for which final design was prepared by delegated design professional.
 - b. Engineer's approval of such Shop Drawing will be only for anchorages fully designed by Engineer. For anchorages for which final design is by delegated design professional, include on such Shop Drawing delegated design professional's approval stamp.
- 2. Product Data: Submit as Action Submittals product data for anchorages to concrete fully designed by Engineer. For anchorages to concrete for which final design is by delegated design professional, submit as Informational Submittals bearing approval stamp of delegated design professional.
 - a. Manufacturer's express, written acknowledgement that proposed items comply with referenced standards indicated in this Section and, as applicable, by delegated design professional.
 - b. Manufacturer published data and information for each anchor.
 - 1) Clearly indicate items that are proposed for the Work. Neatly strike out or obscure materials and products not proposed.
 - c. Manufacturer's published installation instructions and instructions for code-required special inspections and tests.
 - d. Post-Installed Anchors: In addition, submit for each post-installed anchor system current ICC-ES report, indicating the following:
 - 1) Manufacturer's certification that anchors comply with requirements indicated in the Contract Documents.
 - 2) Performance data indicating that anchor is approved by its manufacturer for use in cracked concrete.
 - 3) Seismic design categories for which anchor system is approved by ICC-ES report.
 - e. Anchorage layout drawings and details:
 - 1) Drawings showing location, configuration, spacing and edge distance.

3. Delegated Design Professional's Instruments of Service Submittals: Submit, in accordance with this Section and Section 01 35 73 – Delegated Design Procedures, for each anchorage to concrete for which final design is by delegated design professional:
 - a. Certification of compliance, in accordance with Section 01 35 73 – Delegated Design Procedures. Indicate design tension and shear loads used for anchor design.
 - b. Delegated design professional's drawings.
 - c. Delegated design professional's specifications, if any, when prepared by delegated design professional.
 - d. Post-Installed Anchors (for which final design is by delegated design professional): Submittal shall also include the following for post-installed anchors for which final design was by delegated design professional:
 - 1) Show diameter, embedment depth and edge distance of each anchor.
 - 2) Indicate compliance with ACI 318 Chapter 17.
 - 3) Type of post-installed anchor system used.
 - a) Provide manufacturer's ICC-ES report for the following:
 - (1) Mechanical anchorage per ICC-ES AC193.
 - (2) Adhesive anchorage per ICC-ES AC308.
 4. Samples:
 - a. Submit representative Samples of anchorages to concrete, when requested by Engineer. Engineer's approval of Samples will be for type and finish only.
- B. Informational Submittals: Submit the following:
1. Shop Drawings and Product Data Approved by Delegated Design Professional:
 - a. Submit with delegated design professional's approval stamp those Shop Drawings and product data Submittals indicated in this Article but for which final design was performed by delegated design professional.
 2. Calculations by Delegated Design Professional:
 - a. Submit sealed and signed calculations for sizing and determining embedment length of anchorages to concrete not fully designed by Engineer.
 - b. Post-Installed Anchors Designed by Delegated Design Professional: In addition, also submit design calculations:
 - 1) Indicate design load to each anchor.
 - 2) When design load is not indicated on the Drawings, include calculations to develop anchor forces based on performance and design criteria indicated in this Section.
 3. Supplier's Instructions:
 - a. Submit manufacturer's published instructions for installation.
 4. Field Quality Control Submittals:
 - a. Submit written results of required field quality control activities indicated in this Section.
 5. Reports of Supplier's Visits to Site:
 - a. Submit each written report of visit to the Site by Supplier's factory trained representative and delegated design professional. For each, indicate date and time of visit, purpose of visit, observations made, decisions made, problems encountered, and other pertinent information.
 6. Qualifications Statements:
 - a. Delegated design professional.
 - b. Each installer.

PART 2 - PRODUCTS

2.1 MATERIALS – ALL ANCHORAGES

A. Materials – General:

1. This Article applies to all anchorages to concrete, regardless of whether fully designed by Engineer or delegated design professional. Requirements for delegated designs are in the following Article.
2. Additional requirements for anchorages fully designed by Engineer are indicated in the Article following requirements for delegated design anchorages.
3. For structural applications, do not use powder actuated fasteners and other types of bolts or fasteners not specified in this Section unless approved by Engineer or otherwise required by the Contract Documents.

B. Description:

1. Provide anchorages to concrete, of the types shown or indicated, to secure to concrete materials, equipment, and appurtenances installed as part of the Work.
2. Locations where anchorages are required are generally shown or indicated on the Drawings. Where not shown or indicated on the Drawings provide anchorages or the types required for materials, equipment, and systems where such materials, equipment, and systems are shown on the Drawings.
3. Anchorages required include those for materials, equipment, and systems shown on the structural Drawings and Drawing other than the structural Drawings.
4. Design loads for concrete anchorages are shown or indicated on the Drawings for anchorages where design responsibility is delegated to Contractor's delegated design professional. For such anchorages, embedment depths are not shown or indicated.

C. Cast-in-place Concrete Anchors:

1. Buildings, non-building structures, and equipment, unless otherwise specified:
 - a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized threaded rods.
 - b. ASTM A307, Grade A for galvanized headed bolts.
2. All other cast-in-place concrete anchors:
 - a. Stainless steel with matching nut and washer.
 - b. Submerged application: ASTM F593, Type 316, minimum yield strength of 45,000 psi.
 - c. Non-submerged application: ASTM F593, Type 304 or Type 316, minimum yield strength of 45,000 psi.

D. Post-Installed Mechanical and Adhesive Concrete Anchors:

1. Submerged application: ASTM F593, Type 316, minimum yield strength of 45,000 psi with matching nut and washer.
2. Non-submerged application: ASTM F593, Type 304 or Type 316, minimum yield strength of 45,000 psi with matching nut and washer.
3. Post-installed anchors and related materials shall be listed by ICC-ES or Engineer-approved equivalent.

E. Reinforcing: Comply with Section 03 21 00 - Reinforcement.

F. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

G. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

H. Washers:

1. ASTM F436 unless indicated otherwise, finish to match bolt.
2. When stainless steel anchorage is provided for cast-in-place anchorages, provide washers of the same material and alloy as in the associated anchorage.
3. Plate washers: Minimum 1/2 inch thick fabricated ASTM A36 square plates as required.
4. Comply with manufacturer's written instructions for all post-installed anchorages.

- I. Nuts:
 - 1. ASTM A563 for cast-in-place anchorages.
 - 2. When stainless steel anchorages are provided for cast-in-place anchorages, nuts shall comply with ASTM F594 and shall match material and alloy of the associated anchorage.
 - 3. Follow manufacturer's requirements if using post-installed anchorage.
- J. Galvanizing Repair Paint:
 - 1. High zinc dust content paint for regalvanizing welds and abrasions.
 - 2. ASTM A780.
 - 3. Zinc content: Minimum 92 percent in dry film.
 - 4. Products and Manufacturers: "ZRC Cold Galvanizing", by ZRC; or "High Performance Zinc Spray", by Clearco; or equal.
- K. Dissimilar Materials Protection: Comply with Section 09 96 05 - Polyurethane Coating.

2.2 DELEGATED DESIGN ANCHORAGES TO CONCRETE

- A. Manufacturers:
 - 1. Post-installed anchor systems for indicated manufacturers are acceptable only when a current ICC-ES evaluation report is furnished as a Submittal and the subject anchorage system is approved by the delegated design professional.
 - a. Hilti.
 - b. Dewalt.
 - c. Simpson Strong-Tie.
 - d. Or equal.
- B. Description: Perform delegated design for anchorages when one or more of the following applies:
 - 1. Design load for concrete anchorage is shown or indicated on the Drawings and anchorage embedment depth is not shown or indicated.
 - 2. When specifically required by the Contract Documents.
 - 3. When an anchorage is necessary but is not shown or indicated on the Drawings.
 - 4. Anchorages shown on the Drawings other than the structural Drawings.
- C. Performance and Design Criteria for Delegated Design Anchorages:
 - 1. Determine design loads, including wind and seismic loads, in accordance with applicable building code and other Laws and Regulations.
 - 2. For anchorage of equipment and non-structural components, use actual dead load and operating loads obtained by Contractor or delegated design professional from manufacturer. Design loads shall include operating conditions when equipment or element of the Work is in operation, dynamic loads, and other loads as appropriate or required by the building code or other Laws or Regulations.
 - 3. Design assuming cracked concrete.

2.3 ANCHORAGES FULLY DESIGNED BY ENGINEER

- A. When size, length, and details of anchorage are shown or indicated on the structural Drawings, such anchorages are considered as fully designed by Engineer and delegated design of such anchorage is not required.
- B. Manufacturers:
 - 1. For post-installed anchor systems regardless of whether proposed manufacturer is indicated below, furnish as Submittal current evaluation agency report and anchor system is certified by ICC-ES for cracked concrete conditions.
 - 2. Mechanical Anchors:

- a. Hilti:
 - 1) Kwik Bolt TZ (ICC-ES ESR-1917).
 - b. Dewalt:
 - 1) Power-Stud+ SD1 (ICC-ES ESR-2818).
 - c. Simpson Strong-Tie:
 - 1) Strong-Bolt 2 (ICC-ES ESR-3037).
 - d. Or equal.
3. Adhesive Anchors for Concrete:
- a. Hilti:
 - 1) HIT RE 500 V3 (ICC ESR-3814).
 - b. Dewalt:
 - 1) PURE110+ (ICC-ES ESR-3298).
 - c. Simpson Strong-Tie:
 - 1) SET-3G (ICC ES 4057)
 - d. Or equal.
4. Screw Anchors for Concrete:
- a. Hilti:
 - 1) Kwik HUS-EZ Screw (ICC-ES ESR-3027).
 - b. Dewalt:
 - 1) Screw-Bolt+ (ICC-ES ESR-3889).
 - c. Simpson Strong-Tie:
 - 1) Titen HD (ICC-ES ESR-2713).
 - d. Or equal.
5. Requests, if any, for Engineer's approval of "or-equals" or substitutes shall indicate proposed anchor has at least the same tension and shear strength as the associated anchorage products indicated by name in this Article.

PART 3 - EXECUTION

3.1 PREPARATION

- A. For cast-in-place concrete anchorages, allow adequate time for proper installation, inspection, and observation prior to placing concrete.
- B. Prior to installation, inspect and verify areas and conditions under which concrete anchorages will be installed.
 - 1. Notify Engineer of conditions detrimental to proper and timely completion of the Work.
 - 2. Do not proceed with the Work until unsatisfactory conditions are properly remedied.

3.2 INSTALLATION

- A. Installation Requirements - General:
 - 1. Install items in accordance with the Contract Documents, manufacturer's written instructions, and Laws and Regulations. Where such requirements conflict, obtain interpretation or clarification from Engineer prior to commencing the associated Work.
 - 2. Perform the following unless shown or indicated otherwise:
 - a. Provide stainless steel anchorages for connecting aluminum and steel members to concrete and masonry. Provide dissimilar materials protection in accordance with Section 09 96 05 – Polyurethane Coating.
 - b. Provide washers for all anchorages.

- c. Where exposed, extend threaded anchorage a minimum of 0.5 inch above top of fully-engaged nut. If anchorage is cut off to required maximum height, dress the threads to allow nuts to be removed without damage to nuts.
 - 3. Tightening of nuts: Do the following after nuts are snug-tightened down:
 - a. Upset anchorage threads to prevent nuts from backing off. Provide double nut or lock nut in lieu of upset threads for items that may require future removal.
 - b. For cast-in-place anchorages (excluding post-installed anchorages), tighten nuts an additional 1/8 turn beyond snug tight to prevent nuts from backing off.
 - c. When two nuts are used per concrete anchor above the base plate, tighten top nut an additional 1/8 turn to "lock" the two nuts together.
 - d. For post-installed anchorages, comply with MPII.
 - 4. Secure architectural components to avoid aesthetic distortion and to avoid overstressing fasteners from expansion, contraction, or installation.
- B. Cast-in-Place Anchorages:
- 1. Provide where anchor rods or anchor bolts are indicated on the Drawings, unless another anchor type is approved by Engineer.
 - 2. Provide concrete anchorages as shown on the Drawings or as required to secure the Work to concrete.
 - 3. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
 - 4. Tack welding of anchorage is prohibited.
 - 5. Chase threads as required and coat projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
 - 6. Anchorage location Tolerance: in accordance with AISC 303.
 - 7. Provide steel or durable wood templates for all column and equipment anchorages. Place templates above top of concrete; do not impede proper concrete placement and consolidation.
- C. Mechanical Anchorages:
- 1. Use only where specifically indicated on the Drawings or when approved for use by the Engineer.
 - 2. Do not use where subjected to vibration.
 - 3. May be used in overhead applications.
 - 4. Contact Engineer for clarification when anchors will not be installed in compliance with manufacturer's printed installation requirements.
- D. Post-installed Anchorages:
- 1. For post-installed anchors, comply with MPII regarding hole diameter and depth required to fully develop the tensile strength of anchor or reinforcing bar.
 - 2. Use hammer drills to create holes.
 - 3. Properly clean out holes in accordance with the associated ICC-ES report using non-metallic, fiber bristle brush and compressed air, or as otherwise necessary to remove all loose material from each hole prior to installing anchor in the presence of Special Inspector.
 - 4. Adhesive Anchorages:
 - a. Provide only where specifically indicated on the Drawings or when approved for use by Engineer.
 - b. May be provided where subjected to vibration or at buried or submerged locations.
 - c. Do not install for overhead applications or sustained tension loading conditions such as utility hangers.
 - d. Install adhesive anchors in concrete aged not less than 21 days.
- E. Finishes:

1. Coat aluminum surfaces in contact with dissimilar materials in accordance with Section 09 96 05 – Polyurethane Coating.
2. Repair of damaged galvanized surfaces:
 - a. Prepare damaged surfaces by abrasive blasting or power sanding.
 - b. Repair damaged galvanized surfaces in accordance with ASTM A780.
 - c. Apply galvanizing repair paint to not less than 6 mils dry film thickness in accordance with galvanizing repair material manufacturer's instructions and ASTM A780.
- F. Ensure that embedded items are protected from damage and are not filled in with concrete or related materials.

3.3 FIELD QUALITY CONTROL

- A. Field Tests and Inspections:
 1. Special Inspections: Comply with Section 01 45 16.13 - Contractor Quality Control.
 2. Comply with Section 03 05 05 - Concrete Testing and Inspection.
 3. Tests and inspections of anchorages shall comply with ACI 355.2 and/or ACI 355.4 as applicable.
 4. Owner reserves the right to inspect and test completed anchorages at a minimum of 25 to 100 percent of provided anchorages.
- B. Supplier's services:
 1. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors.
- C. Defective Work:
 1. Anchorages that do not successfully pass required field tests and inspections or that are otherwise deemed defective by Engineer shall be remedied, in accordance with the Contract Documents, at no cost to Owner.

3.4 CLEANING

- A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.
- B. Provide surface acceptable to receive field applied paint coatings when specified in Specification Section 09 90 04.

END OF SECTION

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SECTION 03 21 00

REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Reinforcing bar requirements for concrete construction.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 05 05 - Concrete Testing and Inspection.
 - 2. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. SP 66, ACI Detailing Manual.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
 - d. 318, Building Code Requirements for Structural Concrete.
 - 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - e. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
 - f. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
 - 3. Concrete Reinforcing Steel Institute (CRSI):
 - a. Manual of Standard Practice.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Mill certificates for all reinforcing.
 - d. Manufacturer and type of proprietary reinforcing mechanical splices.
 - 2. Qualifications of welding operators, welding processes and procedures.
 - 3. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
 - 4. Sufficient reinforcing details to permit installation of reinforcing.
 - 5. Reinforcing details in accordance with ACI SP 66 and ACI 315.
 - 6. Locations where proprietary reinforcing mechanical splices are required or proposed for use.

7. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
 - a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.
 - b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Support and store all reinforcing above ground.
- B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Reinforcing adhesive anchors:
 - a. See Specification Section 03 15 19.
 2. Reinforcing mechanical splices:
 - a. Lenton Rebar Splicing by Erico, Inc.
 - b. Richmond dowel bar splicer system by Richmond Screw and Anchor Co., Inc.
 - c. Bar-Grip Systems by Barsplice Products, Inc.

2.2 MATERIALS

- A. Reinforcing Bars: ASTM A615, grade 60, deformed.
- B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.
- C. Welded Wire Reinforcement: ASTM A1064.
- D. Smooth Dowel Bars:
 1. Water containing structures: ASTM A276, Type 316.
 2. All other locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 inch.
- E. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125% of the yield strength of the reinforcing bars being spliced.
- F. Headed Deformed Bars:
 1. ASTM A970, Class B.
- G. Reinforcing Adhesive Anchors:
 1. See Specification 03 15 19.

2.3 ACCESSORIES

- A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
 1. Metal fabrications with plastic-coated tips in contact with forms.
 - a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
 2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
 - a. 100% non-metallic, non-corrosive.
 - b. Required for all walls and elevated construction exposed to liquid containing structures.

- B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

- A. Tolerances:
 - 1. Conforms to ACI 117, except as modified herein.
 - 2. Sheared lengths: +1 inches.
 - 3. Overall dimensions of stirrups, ties and spirals: +1/2 inches.
 - 4. All other bends: +0 inches, -1/2 inches.
- B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.
- C. Ship reinforcing to jobsite with attached plastic or metal tags.
 - 1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
 - 2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Tolerances:
 - 1. Conform to ACI 117, except as modified herein.
 - 2. Reinforcing placement:
 - a. Clear distance to formed surfaces: +1/4 inches.
 - b. Minimum spacing between bars: -1/4 inches.
 - c. Top bars in slabs and beams:
 - 1) Members 8 inches deep or less: +1/4 inches.
 - 2) Members between 8 inches and 2 feet deep: -1/4 inches, +1/2 inches.
 - 3) Members more than 2 feet deep: -1/4 inches, +1 inches.
 - d. Crosswise of members: Spaced evenly within +1 inches.
 - e. Lengthwise of members: +2 inches.
 - 3. Minimum clear distances between reinforcing bars:
 - a. Beams, walls and slabs: Distance equal to bar diameter or 1 inch, whichever is greater.
 - b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 inches, whichever is greater.
 - c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.
- B. Minimum concrete protective covering for reinforcement: As shown on Drawings.
- C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
 - 1. For reinforcing: Class B splice meeting the requirements of ACI 318.
 - 2. For welded wire reinforcement:
 - a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 x development length nor less than 6 inches.
 - b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318.
 - 3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Engineer.

- a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.
- D. Welding:
- 1. Welding reinforcing is not permitted.
- E. Placing Reinforcing:
- 1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
 - 2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
 - 3. Reinforcing support:
 - a. Uncoated reinforcing:
 - 1) Support reinforcing and fasten together to prevent displacement by construction operations.
 - a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
 - b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
 - c) Reinforcement shown on the Contract Documents may not be repositioned for use a support for reinforcement. Additional drop bars may be provided for support of reinforcing,
 - 2) Reinforcing supported on ground:
 - a) Slab on grade and other members with only one mat of reinforcing:
 - (1) Provide metal bar supports with bottom plate.
 - (2) Do not use concrete blocks to support slab-on-grade reinforcing.
 - b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
 - 3) Reinforcing supported on formwork:
 - a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
 - b) All other formed surfaces:
 - (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
 - (2) Only tips in contact with the forms need to be plastic coated.
 - 4. Support reinforcing over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
 - 5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 inch.
 - a. Place spacer bars at 3 feet maximum centers to maintain the required 1 inch clear distance between layers.
 - 6. Extend reinforcement to within 2 inches of concrete perimeter edges.
 - a. If perimeter edge is formed by earth [or stay-in-place forms], extend reinforcement to within 3 inches of the edge.
 - 7. To assure proper placement, furnish templates for all column vertical bars and dowels.
 - 8. Do not bend reinforcement after embedding in hardened concrete unless approved by Engineer.

- a. Do not bend reinforcing by means of heat.
9. Do not tack weld reinforcing.
10. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
 - a. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

- A. Reinforcement Congestion and Interferences:
 1. Notify Engineer whenever the specified clearances between bars cannot be met.
 2. Do not place any concrete until the Engineer submits a solution to reinforcing congestion problem.
 3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
 4. If bars are moved more than one bar diameter, obtain Engineer's approval of resulting arrangement of reinforcing.
 5. No cutting of reinforcing shall be done without written approval of Engineer.
- B. Contractor Quality Control:
 1. See Section 01 45 16.13
- C. Special Inspection:
 1. See Section 03 05 05.

END OF SECTION

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SECTION 03 31 30
CONCRETE MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for concrete materials, including:
 - a. Materials, including various types of grout, admixtures, cement, sand, aggregate, and other materials.
 - b. Concrete strength and proportioning, including design mixes for:
 - 1) Normal weight concrete.
 - 2) Mass concrete.
 - 3) Grout.

B. Scope:

1. Unless shown or indicated otherwise in the Contract Documents, concrete Work shall comply with:
 - a. ACI 301.
 - b. Laws and Regulations, including applicable building code.
2. In this Section, material is apportioned into the following grouting types:
 - a. Base plates for columns and equipment.
 - b. As otherwise shown or indicated in the Contract Documents.
3. This Section addresses materials for concrete. Other Specifications sections present other requirements for complete concrete Work, including, but not necessarily limited to:
 - a. Section 03 05 05 - Concrete Testing and Inspection.
 - b. Section 03 11 13 - Formwork.
 - c. Section 03 21 00 - Reinforcement.
 - d. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - e. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
 - f. Others as indicated in the Contract Documents.

C. Related Requirements: Include but are not necessarily limited to:

1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 03 21 00 - Reinforcement.
4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
5. Section 33 05 16 – Precast Concrete Manhole Structures.

1.2 REFERENCES

A. Abbreviations and Terminology:

1. Abbreviations: The following abbreviations are used in this Section:
 - a. "AAR" means deleterious "alkali-aggregate reaction", resulting from either alkali-silica reactive (ASR) or alkali-carbonate reactive (ACR) aggregates.
 - b. "SCM" means "supplementary cementitious materials", with the meaning indicated below.
 - c. "CLSM" means controlled low strength material in accordance with requirements of this Section.

2. Terminology: Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meanings indicated below:
 - a. "Supplementary cementitious materials" (SCM) means fly ash, silica fume, and GGBFS.
 - b. "Water-bearing concrete" is concrete surface to be in contact (whether continuously or intermittently) with water, process liquid, or slurries during intended operation of the facility, including, but not limited to, concrete tanks, channels, wet wells, distribution chambers, and secondary containment structures.
 - c. Independent Laboratory:
 - 1) Testing shall be performed by an independent laboratory complying with requirements of the generally recognized accrediting entity for the jurisdiction where the Site is located.
 - 2) Testing laboratory shall obtain all concrete samples and waterproofing product samples from the manufacturer of the associated product or material.

B. Reference Standards:

1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - d. 212.3R, Chemical Admixtures for Concrete.
 - e. 232.2R, Use of Fly Ash in Concrete.
 - f. 301, Specifications for Structural Concrete for Buildings.
 - g. 318, Building Code Requirements for Structural Concrete.
2. ASTM International (ASTM):
 - a. C33, Standard Specification for Concrete Aggregates.
 - b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - d. C125, Terminology Relating to Concrete and Concrete Aggregates.
 - e. C150, Standard Specification for Portland Cement.
 - f. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
 - g. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
 - h. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
 - i. C494, Standard Specification for Chemical Admixtures for Concrete.
 - j. C595, Standard Specification for Blended Hydraulic Cements.
 - k. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
 - l. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
 - m. C1116, Standard Specification for Fiber-Reinforced Concrete.
 - n. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.
 - o. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).
 - p. C1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

- q. C1778, Standard Guide for Reducing Risk of Deleterious Alkali-Aggregate Reaction in Concrete.
- 3. Steel Deck Institute (SDI):
 - a. Design Manual for Composite Decks, Form Decks and Roof Decks.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Schedule (table) of concrete materials proposed, listed by each specified grouping of concrete Work, including, but not limited to, aggregates, sand, cement (by type), SCM, admixtures, synthetic fibers, grouts, and other materials. For each separate material and product, indicate manufacturer and type of material.
 - b. Mix Designs:
 - 1) Proposed mix design for each concrete grouping required. For each, indicate concrete designation (type) indicated in the Contract Documents, proposed materials and proportioning, and intended special uses, such as concrete intended for placement in cold weather or warm weather, concrete to be placed by pumping, concrete intended for specific locations in the Work, and others.
 - 2) Engineer's approval of mix design Shop Drawing is only for limited purposes indicated in the Contract Documents, including the General Conditions, and in no way reduces or mitigates Contractor's responsibility for construction means, methods, techniques, procedures, and sequences.
- 2. Product Data:
 - a. Written affidavit stating materials proposed comply with requirements of reference standards indicated in this Section and, where applicable, compliance with [state department of transportation] standard specifications for highway and bridge construction in the jurisdiction of the Site. Clearly indicate specific reference standards [and department of transportation standard specifications item designation] applicable to each specific material.
 - b. For aggregate and sand, indicate source (quarry) and gradation of materials proposed for use. Indicate the specific concrete mix design(s) proposed for each.
 - c. For cement and SCM, indicate material source and submit manufacturer's technical data (except safety data sheets).
 - d. For each proposed admixture and type of grout material (including non-shrink grouts, epoxy grout, and grout cure/seal compound), submit manufacturer's published technical data (except safety data sheets).

B. Informational Submittals: Submit the following:

- 1. Certifications: Submit concurrent with, but separate from, associated Shop Drawings and product data Submittals:
 - a. Certification of standard deviation, in units of pounds per square inch, for ready mix plant furnishing concrete.
 - b. SCM: Certification that SCM complies with quality requirements of this Section, and SCM Supplier's certified test reports of SCM delivered to concrete Supplier.
 - c. ASTM C33: Certification that class of coarse aggregate complies with ASTM C33 for type and location of concrete Work.
 - d. Aggregate:
 - 1) Certification of aggregate gradation.
 - 2) Certification of coarse aggregate impurities relative to alkali-aggregate reactivity in accordance with ASTM C1778.
 - e. Certification of shrinkage test results.
- 2. Test Reports:

- a. Cement and SCM mill certificates for all materials to be supplied.
- b. Test results for AAR impurities of coarse aggregates within proposed mixes, in accordance with ASTM standards cited in this Section.
- 3. Supplier's Instructions: Submit concurrent with, but separate from, associated product data Submittals:
 - a. Manufacturer's written instructions on proper storage, handling, mixing, and use of materials furnished.

1.4 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:

- 1. Admixtures:
 - a. Store admixtures in manner that avoids contamination, evaporation, and damage.
 - b. For admixtures used in form of suspensions or non-stable solutions, perform agitating as recommended by manufacturer to ensure uniform distribution of ingredients.
 - c. Protect liquid admixtures from freezing and temperature changes that adversely affect admixture characteristics and performance.
- 2. Cement and SCM:
 - a. Store cement and SCM in containers in weathertight space that prevent contamination with moisture and other contaminants.
- 3. Aggregates:
 - a. Store and access aggregates in manner avoiding excessive segregation and preventing contamination with other materials and other sizes of like aggregate.
 - b. Do not use frozen or partially frozen aggregate.
- 4. Sand: Allow natural sand to drain until sand has relatively uniform moisture content, prior to use.
- 5. If stockpiled materials contact the ground, unless such materials are stored on a clean, firm, reasonably impervious surface such as concrete or asphalt paving, do not use in the concrete Work bottom six inches of stockpiled materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

- 1. Provide ASTM C150 Type I/II or ASTM C595 Type IL (MH, HS cement, unless otherwise required by the Contract Documents.
- 2. Cement type provided shall match cement type used in associated approved mix design.

B. SCM:

- 1. Fly Ash:
 - a. ASTM C618, Class F or Class C.
 - b. Non-staining.
 - c. Appropriate for providing hardened concrete of uniform, light-gray color.
 - d. Compatible with all other concrete ingredients. Fly ash shall have no deleterious effect on hardened concrete Work.
 - e. Produced by source approved, by [state department of transportation] in the same jurisdiction as the Site, for use in concrete for highway bridges.
 - f. Evaluate and use in accordance with ACI 232.2R.
- 2. SCM type used shall match SCM type used in associated approved mix design.

C. Admixtures:

- 1. Admixtures – General:

- a. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in mix design approved by Engineer.
 - b. Provide admixtures certified by manufacturers as compatible with other admixtures proposed.
- 2. Air Entraining Admixtures: Comply with ASTM C260.
- 3. Water Reducing Admixtures:
 - a. Provide water-reducing admixtures in all concrete mixes to provide and maintain required water-to-cement ratio without additional cement.
 - b. Water Reducing, Retarding and Accelerating: Comply with ASTM C494 Types A through E, and ACI 212.3R.
 - c. High Range Water Reducers (Superplasticizers):
 - 1) Required for pumped concrete.
 - 2) Comply with ASTM C494 Types F and G.
- 4. Hydration Stabilizer:
 - a. Comply with ASTM C494 Type D.
- 5. Admixture Chlorides – General:
 - a. Provide chloride-free admixtures.
 - b. Do not use calcium chloride.
- D. Crystalline Cementitious Waterproofing:
 - 1. Products and Manufacturers: Subject to compliance with the Contract Documents, the following are acceptable.
 - a. Xypex Chemical Corporation, [C-500] [Bio-San C500].
 - b. Kryton International Inc, Krystol Internal Membrane (KIM).
 - c. Euclid Chemical Company, Eucon Vandex AM-10.
 - d. Or equal.
 - 2. Description: Factory blended dry powder compound consisting of Portland cement, treated aggregate, and active chemicals.
 - 3. Dosage rate shall be not less than 2 percent by weight of cementitious materials or additional as necessary to comply with the performance requirements indicated below.
 - 4. Performance Criteria:
 - a. Mix waterproofing material in proportions recommended by manufacturer.
 - b. Submit to Engineer, together with product data Submittal, results of tests (previously performed for manufacturer) by independent third-party testing entity.
 - c. Crystalline cementitious waterproofing material, identical to that proposed for use in the Work, shall have been tested in accordance with the following:
 - 1) DIN 1048/ EN 12390, Water Impermeability of Concrete:
 - a) Prepare and test untreated samples ("control samples") and treated samples, all of the same concrete mix design. Test not less than three control samples and three treated samples.
 - b) Each sample shall be not less than 120 mm thick.
 - c) Subject samples to test pressure of water not less than design hydrostatic pressure to which concrete will be subject after Substantial Completion, for test duration of not less than 72 hours. However, test duration and pressure shall be sufficient for control samples to have not less than 100 mm of water penetration (average for all control samples tested).
 - d) Treated samples shall demonstrate not less than 90 percent reduction in depth of water penetration (average of all treated samples tested compared with average of all untreated control samples tested).

- 2) Permeability: Supplier shall retain independent testing entity to perform permeability testing in accordance with USCOE CRD-C48 - Mod Permeability of Concrete.
 - a) Test samples of concrete, of identical mix design, using mix design similar to that used for the Work. Test untreated samples ("control samples") and samples treated with the admixture.
 - b) Samples shall each be not greater than two inches thick.
 - c) Subject samples to water at test pressure of 150 psi.
 - d) When compared with control samples, the treated samples shall exhibit no measurable leakage. Control samples shall exhibit full saturation and measurable leakage.

E. Water:

1. Potable in accordance with Laws and Regulations.
2. Clean and free from deleterious substances.
3. Free of oils, acids, and organic matter. Comply with ASTM C1602.

F. Aggregates for Normal Weight Concrete:

1. Comply with ASTM C33.
2. Fine aggregates and coarse aggregates are separate ingredients.
3. Provide aggregates acceptable for bridge construction in accordance with the third-party standard specifications indicated below in this provision.
4. Blended aggregates are acceptable when a combined sieve analysis is performed and indicates compliance with ASTM C33. Submit results of such sieve analysis and obtain Engineer's approval before using such aggregate in the Work.
5. Coarse Aggregate:
 - a. Material shall be well-graded, washed aggregate, free of organic material, recycled material or other deleterious materials.
 - b. Gradation: In accordance with Table 03 31 30-A in this section's "Mixes" Article.
 - c. Mass Concrete:
 - 1) Specific Gravity not less than 2.57.
 - 2) Limestone or granite.
6. Alkali-Reactive Aggregates:
 - a. Aggregates that may be deleteriously reactive, when combined with alkalis in cement, are unacceptable.
 - b. Evaluate proposed aggregates for potential deleterious alkali-aggregate reaction in concrete in accordance with ASTM C1778.
 - 1) Submit to Engineer results of source quality control testing for alkali-aggregate reactivity presenting the following:
 - a) Analysis and classification of aggregates in accordance with ASTM C1778
 - b) Results of source quality control analysis of aggregates.
 - c) Include the flow from Figure 1 of ASTM C 1778 indicating test results sequence.
 - d) Field performance history alone shall not be submitted to document acceptable aggregate performance.
 - e) Size and exposure condition of the Work in Table 2 of ASTM C 1778: dry humid, buried, immersed, or exposed to alkalis in service.
 - f) Structure class for use in Table 3 of ASTM C1778: Class [SC1] [SC2] [SC3] [SC4].

- G. Maximum total water-soluble chloride ion content for concrete mix including all ingredients measured as weight percent of cement in accordance with ASTM C1218:

1. Prestressed concrete: 0.06.
 2. All other concrete: 0.10.
- H. Sand Cement Grout (termed "Grout" on the Drawings):
1. Description: Typical use is for filling keyways in precast construction, and as otherwise required by the Contract Documents.
 2. Performance Criteria:
 - a. Minimum 28 day compressive strength:
 - b. 3,000 PSI.
 - c. Strength shall be not less than strength of adjacent concrete to which grout is applied.
 3. Materials:
 - a. Provide sand cement grout as approximately three parts sand to one part Portland cement, 4.5 percent to 7.5 percent entrained air and water to provide slump allowing grout to completely fill required spaces and surround adjacent reinforcing.
 - b. Provide sand in accordance with requirements for fine aggregate for concrete.
- I. Non-shrink Grout:
1. Manufacturers and Products: Subject to compliance with the contract Documents, the following are acceptable:
 - a. Master Builders Solutions, Masterflow, 713.
 - b. Euclid Chemical Company, NS Grout.
 - c. Sika, Sika Grout 212.
 - d. Or equal.
 2. Description:
 - a. This provision requires non-shrink, non-metallic grout. Unless otherwise shown or indicated in the Contract Documents, references to "non-shrink grout" refer to non-shrink, non-metallic grout required by this provision.
 3. Performance Criteria:
 - a. Non-shrink grout shall produce a positive but controlled expansion.
 - b. Mass expansion shall not be created by gas liberation or by other means.
 - c. Minimum 28-day Compressive Strength: 7,000 PSI.
 4. Material:
 - a. Provide material that is non-shrink, non-metallic, non-corrosive, and non-staining.
 - b. Comply with ASTM C1107, Grade B.
 - c. Premixed with water only. Add water in accordance with manufacturer's written instructions.
- J. Epoxy Grout:
1. Manufacturers and Products: Subject to compliance with the Contract Documents, the following are acceptable:
 - a. Master Builders Solutions, Masterflow 648.
 - b. Five Star Products, DP Five Start Epoxy Grout.
 - c. Euclid Chemical Company, E3 Flowable.
 - d. Sika, Sikadur 42, Grout Pak.
 - e. Or equal.
 - f. One manufacturer shall furnish both aggregate and adhesive.
 2. Description:
 - a. Three-component epoxy resin system, comprised of two liquid epoxy components and one inert aggregate filler component.

- b. Indication of locations where epoxy grout is required are indicated in the grout schedule in Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - c. Furnish each component in separate package for mixing at the Site.
- 3. Performance Criteria:
 - a. Minimum 28-day Compressive Strength: 13,000 psi.
- 4. Materials:
 - a. Aggregate shall be compatible with adhesive.

2.2 MIXES

A. Mixes - General:

- 1. Provide concrete capable of: (a) being placed without segregation of aggregate from other components, and (b) developing all properties necessary and required.
- 2. Provide ready-mix concrete in accordance with ASTM C94/C94M.
- 3. Batching and other tolerances shall be in accordance with ACI 117.
- 4. All concrete shall be normal weight concrete [except where lightweight concrete is expressly shown or indicated on the Drawings], unless otherwise required by the Contract Documents. Normal weight concrete shall weigh approximately 145 to 150 pounds per cubic foot (without reinforcing steel), measured 28 days after placing.

B. Concrete Mixes:

- 1. Mix design requirements are indicated in this Section's Table 03 31 30-A, below.

C. Air Entrainment:

- 1. Provide air entrainment in concrete providing total air content, expressed as percent by volume, in accordance with this Section's Table 03 31 30-A, below.
- 2. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures and concrete placing method.

D. Slump:

1. Slump – General:

- a. Measure slump at point of discharge of wet concrete into final location.
- b. Compensate for slump loss due to placing method.
- c. Concrete with slump less than minimum required may be used provided such concrete can be properly placed and consolidated.

d. Slump of Concrete to be Placed by Pumping:

- 1) Provide water or water-reducing admixture at ready-mix plant for concrete to be placed by pumping, to allow for slump loss due to pumping.
- 2) Provide additional water sufficient only so that slump of concrete at discharge end of pump hose does not exceed: (a) maximum allowable slump indicated, and (b) maximum specified water-to-cement ratio.

e. Slump Adjustment at the Site:

- 1) Slump may be adjusted at the Site by providing water reducers.
- 2) Dosing shall be performed by experienced quality control technician employed by concrete Supplier. Concrete mixing thereafter shall be directed by the same technician.

f. Slump tolerances shall comply with ACI 117.

2. Concrete for Walls and Columns:

- a. 8 inches maximum; 4 inches minimum.
- b. Slump shall be obtained by use of mid-range or high-range water reducer complying with ASTM C494.

3. All Other Members:

- a. Concrete using water reducer in accordance with ASTM C494: 8 inches maximum; 4 inches minimum.
 - b. Concrete without water reducer in accordance with ASTM C494: 5 inches maximum, one inch minimum.
- E. Proportioning:
- 1. Proportioning - General:
 - a. Proportion components of concrete to provide mixture that can be placed: (a) into corners and angles of forms, and around reinforcing, by placing and consolidation methods employed, (b) without component materials becoming segregated, and (c) without excessive, free water to collecting on concrete surface or other surfaces.
 - b. Proportion component elements of concrete to provide proper concrete Work, including concrete durability, strength, and other necessary and required properties.
 - 2. Normal Weight Concrete:
 - a. Normal weight concrete target cementitious materials contents and maximum water to-cementitious ratios shall be in accordance with this Section's Table 03 31 30-A, below.
 - b. Target cementitious materials contents indicated in the Contract Documents are intended to provide crack-free, durable, finished concrete Work, rather than concrete Work of excessive strength.
 - 3. SCM:
 - a. SCM – General:
 - 1) Based on results of AAR testing by Supplier (performed in accordance with ASTM C1778) and alkali content of cement, SCM content (in accordance with this Section) may be adjusted in lieu of the indicated percentages to reduce risk associated with AAR.
 - 2) Use only one type of SCM in a given mix unless expressly required or approved by Engineer.
 - 3) Water-to-cementitious (i.e, total of SCM plus cement) ratio shall not exceed required maximum water-to-cement ratio indicated in this Section.
 - b. Fly Ash:
 - 1) For cast-in-place concrete only, maximum of 25 percent by weight of Portland cement content, per cubic yard, may be fly ash, at rate of one pound fly ash for one pound cement.
 - 2) Do not use fly ash in concrete required in Section 33 05 16 – Precast Concrete Manhole Structures.
 - 4. Water-Reducing, Water-Retarding, and Water-Accelerating Admixtures:
 - a. Provide in accordance with admixture manufacturer's written instructions.
 - b. Add to mix at ready-mix plant.
 - c. Use hydration stabilizer admixture, or AAR-inhibiting admixture, in concrete, as necessary and required, for placing and workability.
 - 1) Water reducers are required to maintain required maximum water-to-cement ratios.
 - 5. High Range Water Reducers (Superplasticizers):
 - a. Superplasticizers are required in:
 - 1) Concrete to be pumped, except slabs-on-grade and mats.
 - 2) Concrete for water-bearing structures.
 - 3) Other concrete Work at Contractor's option.
 - b. Maximum concrete slump, before addition of admixture, shall be three inches. Maximum slump after addition of superplasticizer admixture shall be eight inches.
 - c. Comply with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing, relative to superplasticizers.
 - 6.

7. Normal Weight Concrete Mix Proportioning:

a. Method 1:

- 1) Use Method 1 when combination of concrete component materials and mixes will be evaluated and selected via trial-and-error.
- 2) Provide mixes with suitable proportions and properties in accordance with ACI 211.1, using not less than three different water-to-cementitious ratios providing a range of concrete compressive strengths, including required average compressive strength.
- 3) Trial mixes shall have slump within 0.75 inches of maximum allowed in the Contract Documents. For air-entrained concrete, air content of trial batches shall be within 0.5 percent of air entrainment required by the Contract Documents.
- 4) For each water-to-cementitious ratio:
 - a) Provide not less than three trial compressive strength tests for concrete test age required, and cure in accordance with ASTM C192.
 - b) Cylinder Size: In accordance with ASTM C31.
 - c) Test for compressive strength at 28 days, in accordance with ASTM C39.
 - (1) Quantity of cylinders shall comply with one of the following trial strength test:
 - (a) 6-inch diameter cylinders: Two.
 - (b) 4-inch diameter cylinders: Three.
- 5) From results of such required tests, plot curve showing relationship between water-to-cementitious ratio and compressive strength.
- 6) Based on required curve, select water-to-cementitious ratio for the Work, that will provide concrete of required average compressive strength.
- 7) Provide cementitious content and mixture proportions so maximum water cement ratio is not exceeded when slump is equal to maximum allowed in the Contract Documents.
- 8) Required average compressive strength is indicated below in this Section.

b. Method 2:

- 1) In lieu of trial mixes required by Method 1, field test results from prior projects, for concrete made using identical or substantively identical concrete component materials and proportioning, may be used by concrete supplier in determining proposed mix proportions, provided the test results are within a year of project start date.
- 2) Use of proposed concrete mix proportions based on field test results from prior projects are subject to approval by Engineer. Engineer's decision will be based on information in such Submittals and demonstrated ability, of such concrete successfully provided on such prior projects, to provide required average compressive strength.
- 3) Requirements for Submittals of Concrete Test Results from Prior Projects:
 - a) Submittals of field test results from prior projects shall clearly indicate all materials, proportions, and conditions, and clearly indicate where such matters are similar to those required for the concrete Work on the Project.
 - b) Changes in the materials, proportions, and conditions within submitted test results from prior projects shall have been not more restricted than those for the subject, proposed concrete mix.
 - c) Field test reports from prior projects shall be in accordance with ACI 301 Article 4.2.3.
- 4) Concrete proportions for the concrete Work may be determined from test results of prior projects via interpolation (by Contractor and concrete Supplier) between compressive strengths and proportions of two or more test results from prior

projects, each in accordance with requirements of the Contract Documents for this Project.

8. Required average compressive strength shall exceed required 28-day compressive strength by the extent determined in accordance with ACI 318, Chapter 5 using the standard deviation of concrete ready-mix plant proposed for the Work as described in ACI 318, Chapter 5.

F. Controlled Low-Strength Material (CLSM):

1. Provide mixture of cement, SCM, fine sand, water, and air, with consistency allowing flow under a very low pressure (low head).
2. Approximate quantities of each component per cubic yard of mixed material:
 - a. Cement (Type I or Type II): 50 pounds.
 - b. SCM: 200 pounds.
 - c. Fine Sand: 2,700 pounds.
 - d. Water (approximate): 420 pounds.
 - e. Air Content (approximate): 10 percent.
3. Adjust actual quantities to provide yield of one cubic yard with materials used.
4. Approximate compressive strength shall be 85 to 175 psi.
5. Sand Gradation: Fine sand shall be evenly graded material with not less than 95 percent passing No. 4 sieve and not more than five percent passing No. 200 sieve.

TABLE 03 31 30-A							
Type of Concrete	28-day Compressive Strength	Max. W/C Ratio	Target Total Cement (pounds)	SCM	ASTM C33 Size No.	Air Content (%)	Allowable Shrinkage Limit
Normal weight concrete fill, utility encasement concrete	3000 PSI	0.45	517	Note 1	57	6.00	NA
Normal weight precast concrete	5000 PSI	0.42	611		57	6.00	NA
Normal weight structural concrete (use unless noted otherwise)	4500 PSI	0.42	611	Note 1	57	6.00	0.048 percent

Table 03 31 30-A Notes:

1. If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to comply with total target cement content.
2. Unless otherwise indicated, larger aggregate (No. 467) is required for concrete slabs or foundations on grade; optional elsewhere.
- 3.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Field Testing and Inspections:

1. Code-Required Tests and Special Inspections:
 - a. Section 01 45 33 - Code-Required Special Inspections and Procedures, indicates testing scope for code-required testing and special inspections by testing entity retained by Owner or entity for whom Owner is responsible.
 - b. Section 03 05 05 - Concrete Testing and Inspection, indicates required testing for concrete Work.
2. Contractor-Performed Field Testing and Inspections:
 - a. Where concrete testing and inspection is required by the Contract Documents and is not part of the code-required tests and special inspections by Owner or other entity for whom Owner is responsible, such tests and inspections shall be by Contractor.
 - b. Perform concrete testing and inspections in accordance with Section 03 05 05 - Concrete Testing and Inspection.
 - c. Aggregates and Other Stockpiled Materials: To ensure stockpiles at the concrete mixing location are not contaminated and otherwise comply with Contract requirements, perform tests on such materials at the concrete ready-mix plant.
 - d. Perform strength test on all concrete to which water or superplasticizer, above the amount stated in concrete mix design Submittal approved by Engineer, has been added.
 - 1) Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

END OF SECTION

SECTION 03 31 31
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mixing, placing, jointing, and curing of concrete construction.
- B. Related Requirements: Include but are not necessarily limited to:
 - 1. Section 03 05 05 - Concrete Testing and Inspection.
 - 2. Section 03 11 13 - Formwork.
 - 3. Section 03 21 00 - Reinforcement.
 - 4. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
 - 6. Section 33 05 16 - Precast Concrete Manhole Structures.

1.2 REFERENCES

- A. Terminology:
 - 1. Terminology: Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meanings indicated below:
 - a. Unless obviously meant or intended otherwise, certain words and terms used in this Section have meanings indicated in ACI CT-13.
 - b. "Water-bearing concrete" means concrete surface to be in contact (whether continuously or intermittently) with water, process liquid, or slurries during intended operation of the facility, including, but not limited to, concrete tanks, channels, wet wells, distribution chambers, and secondary containment structures.
- B. Reference Standards: Standards referenced in this Section include, but are not necessarily limited to, the following:
 - 1. American Concrete Institute (ACI):
 - a. CT-13, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
 - d. 304.2R, Placing Concrete by Pumping Methods.
 - e. 305R, Guide to Hot Weather Concreting.
 - f. 305.1, Specification for Hot Weather Concreting.
 - g. 306R, Guide to Cold Weather Concreting.
 - h. 306.1, Standard Specification for Cold Weather Concreting.
 - i. 308.1, Specification for Curing Concrete.
 - j. 309R, Guide for Consolidation of Concrete.
 - k. 318, Building Code Requirements for Structural Concrete and Commentary.
 - l. 360R, Guide to Design of Slabs-on-Ground.
 - 2. ASTM International (ASTM):
 - a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
 - b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

- d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
- e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
- 3. National Ready Mixed Concrete Association (NRMCA):
 - a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
- 4. United States Army Corps of Engineers (USACE):
 - a. CRD-C572, Specifications for Polyvinylchloride Waterstop.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate concrete placement Work with other Work, and work of other contractors (if any), that must be installed prior to placement of concrete.
 - 2. Inform other contractors, if any, affected by the concrete Work of intended date(s) of placement of concrete. Provide sufficient advance notice to allow other contractors to perform their work that is to be completed prior to placing of concrete.

1.4 QUALITY ASSURANCE

- A. Qualifications:
 - 1. Concrete Supplier:
 - a. Ready-mix concrete batch plant shall be certified by NRMCA.
 - b. Ready mix plant shall comply with NRMCA Checklist for Certification of Ready Mixed Concrete Production Facilities.

1.5 SUBMITTALS

- A. Action Submittals: Submit the following:
 - 1. Shop Drawings:
 - a. Scaled (minimum 1/8 inch per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
 - b. Drawing indicating location, size and type of prefabricated waterstop joints.
 - 2. Product Data including:
 - a. Manufacturers and types:
 - 1) Joint fillers.
 - 2) Curing agents.
 - 3) Construction joint bonding adhesive.
 - 4) Prefabricated waterstops.
 - b. Acknowledgement that products submitted meet requirements of standards referenced.
 - 3. Samples:
 - a. Sample of each type of prefabricated waterstop proposed for the Work, when requested by Engineer.
 - 4. Monitoring Procedures:
- B. Informational Submittals: Submit the following:
 - 1. Delivery Tickets:
 - a. Copies of concrete delivery tickets.
 - 2. Supplier Instructions:
 - a. Procedure for adding high-range water reducer at the Site.

- b. Instructions for handling and installing products approved by Engineer.
- 3. Field Quality Control Submittals:
 - a. Results of tests, inspections, and other quality control activities required by the Contract Documents, including Section 03 05 05 - Concrete Testing and Inspections, and this Section's "Field Quality Control" Article performed at the Site.
- 4. Supplier Site Visit Reports:
 - a. Report of each visit to the Site by Supplier, summarizing purpose of visit, activities while onsite, problems encountered, advice given to Contractor or Subcontractor, and actions taken.
- 5. Special Procedure Submittals:
 - a. Description of proposed curing methods.
- 6. Qualifications:
 - a. Ready-mix plant certification, in accordance with this Section's "Quality Assurance" Article.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Concrete Delivery:
 - 1. Prepare a delivery ticket for each load of ready mixed concrete.
 - 2. Truck operator shall hand ticket to Contractor at the time of delivery.
 - 3. Ticket to show:
 - a. Mix identification.
 - b. Quantity delivered.
 - c. Quantity of material in each batch.
 - d. Outdoor temperature in the shade at location of concrete placement.
 - e. Time at which cement was added.
 - f. Time of delivery.
 - g. Time of discharge.
 - h. Quantity of water that may be added at the site without exceeding the specified water-cement ratio.
 - i. Quantity of any water added at the Site.

1.7 PROJECT CONDITIONS

- A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
 - 1. Do not use revised concrete mixes until submitted to and approved by Engineer.

1.8 SEQUENCING AND SCHEDULING

- A. Do not begin concrete production until proposed concrete mix design has been approved by Engineer.
 - 1. Engineer's approval of concrete mix design does not relieve Contractor of responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.
- B. Neoprene Expansion Joint Fillers:
 - 1. Acceptable manufacturers:
 - a. Permaglaze.

- b. Rubatex.
 - c. Williams Products.
 - d. Or equal.
- 2. Materials:
 - a. Closed cell neoprene.
 - b. ASTM D1056, Type 2, Class A or C.
 - c. Grade: Compression deflection as required to limit deflection to 25 percent of joint thickness under pressure from concrete pour height.
- C. Asphalt Expansion Joint Fillers:
 - 1. Acceptable manufacturers:
 - a. W.R Meadows.
 - b. J and P Petroleum Products.
 - c. Or equal.
 - 2. Materials: ASTM D994.
- D. Fiber Expansion Joint Fillers:
 - 1. Materials: ASTM D1751.
- E. Waterstops, PVC Type:
 - 1. Acceptable manufacturers:
 - a. Sika Greenstreak Plastic Products.
 - b. W.R Meadows.
 - c. Vinylex Corporation.
 - d. Bometals, Inc.
 - e. Or equal.
 - 2. Materials:
 - a. Virgin polyvinyl chloride compound not containing scrap or reclaimed materials or pigment.
 - b. Cast-in-place type: USACE CRD-572.
 - 3. Approved profiles as listed.
 - a. Construction joints:
 - 1) Ribbed: 6 inches wide by 3/8 inch.
 - 2) Sika Greenstreak Plastic Products Style #679, or equal.
 - b. Control joints:
 - 1) 6-inch wide by 3/8 inch thick with ribs and center bulb.
 - 2) Sika Greenstreak Plastic Products Style #705, or equal.
 - c. Expansion joint:
 - 1) 9 inches wide by 3/8 inch thick center bulb two inch outside diameter.
 - 2) Sika Greenstreak Plastic Products Style #739, or equal.
 - 4. Provide factory-made waterstop fabrications at all changes in direction, intersections and transitions, leaving only straight butt splices for the field. Butt welds to be a minimum six inches clear of the intersection.
 - 5. Factory prepunched (less than 1.5 feet on centers, each edge, staggered) for wire supports.
 - a. Provide hog rings or grommets at all punched holes along the length of the waterstop.
 - 6. See Drawings for application and other requirements.
- F. Waterstops, Preformed Strip Type:
 - 1. Acceptable manufacturers:

- a. Sika Greenstreak Plastics, Inc. (Hydrotite).
 - b. Adeka Ultra Seal USA (MC-2010MN).
 - c. DeNeef (Swellseal 2010).
 - d. Or equal.
- 2. Hydrophilic, non-bentonite composition.
- 3. Manufactured solely for the purpose of preventing water from traveling through construction joints.
- 4. Volumetric expansion limited to three times maximum.
- 5. See the Drawings for locations, applications, and other requirements.
- G. Water Swelling Sealant:
 - 1. Required adhesive for use with strip-type waterstop.
 - 2. Compatible with strip-type waterstop.
 - 3. Single component, gun applied.
 - 4. Moisture cured.
 - 5. Minimum 70 percent volumetric expansion swelling capability.
- H. Evaporation Retarder:
 - 1. Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 2. Manufacturers and Products:
 - a. BASF, Masterkure ER 50.
 - b. Euclid Chemical Company; Eucobar.
 - c. WR Meadows; EVAPRE.
 - d. Or equal.
- I. Curing Materials shall comply with one or more of the following:
 - 1. Absorbent Covers.
 - a. AASHTO M182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard when dry.
 - 1) Materials must be free of harmful substances, such as sugar or fertilizer, or substances that may discolor the concrete.
 - 2) To remove soluble substances, burlap should be thoroughly rinsed in water before placing it on the concrete.
 - 2. Moisture Retaining Covers.
 - a. Plastic Film: ASTM C171, not less than 10 mils thickness polyethylene film.
 - b. White burlap-polyethylene sheet meeting ASTM C171.
 - c. Reinforced Curing Paper: Complying with ASTM C171.
 - 3. Dissipating curing compound:
 - a. Fugitive dye, waterborne, membrane-forming.
 - b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions to not impair the later addition and performance of applied finishes.
 - c. Products and Manufacturers:
 - 1) Dayton Superior Corporation; Day Chem Rez Cure (J-11-WD).
 - 2) Euclid Chemical Company; Kurez DR VOX.
 - 3) L&M Construction Chemicals, Inc.; L&M Cure R.
 - 4) Or equal.

4. Clear, water or solvent-borne, membrane-forming curing and sealing compound:
 - a. ASTM C1315, Type 1, Class A.
 - b. Moisture loss shall be not more than 0.40 kilograms per square meter when applied at 300 square feet per gallon.
 - c. Manufacturer's certification is required.
 - d. Subject to Project requirements, provide one of the following products:
 - 1) Solvent-based:
 - a) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
 - b) L&M Construction Chemicals, Inc.; Lumiseal Plus.
 - c) W.R. Meadows, Inc.; CS-309/30.
 - d) Or equal.
 - 2) Water-based:
 - a) Euclid Chemical Company; Super Diamond Clear VOX.
 - b) L&M Construction Chemicals, Inc.; Lumiseal WB Plus.
 - c) W.R. Meadows, Inc.; Vocomp-30.
 - d) Or equal.
- J. Sand cement grout, non-shrink grout and epoxy grout: Comply with Section 03 31 30 - Concrete Materials and Proportioning.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installing the Work constitutes Contractor's approval of underlying work, substrates, and field conditions prevailing at the time of the Work.

3.2 PREPARATION

- A. Preparation – General:
 1. Materials and construction shall comply with the tolerances as specified in ACI 117.
 2. Complete formwork.
 - a. Perform formwork in accordance with Section 03 11 13 - Formwork.
 3. Remove earth, snow, ice, water, foreign matter, and other extraneous materials from areas that will receive concrete.
 4. Secure reinforcement in place.
 - a. Provide reinforcing in accordance with Section 03 21 00 - Reinforcement.
 5. Provide expansion joint material, anchors and other embedded items.
 6. Prior to placing concrete, obtain Engineer's concurrence that associated formwork and reinforcing appear to be in accordance with the Contract Documents. However, in no event will Engineer's observations, comments, or concurrence that any part of the Work appears to be in accordance with the Contract Documents modify or reduce Contractor's sole responsibility for providing Work in accordance with the Contract Documents.
 7. Do not place concrete during rain, sleet, snow, or other adverse ambient or environmental conditions unless adequate protection is provided by Contractor and such placement is acceptable to Engineer.
 - a. Provide sufficient quantity of competent, experienced workers with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
 - b. Do not allow precipitation or storm water runoff to increase mixing water nor to damage surface finish.

8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
 9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
 - a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.
- B. Preparation of Subgrade for Slabs On Ground:
1. Subgrade shall be wetted without standing water immediately prior to placing concrete.
 2. Obtain Engineer's acceptance of subgrade compaction density prior to placing slabs on ground.
- C. Edge Forms and Screeds:
1. Set accurately to produce designated elevations and contours of finished surface.
 2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
 3. Use strike off templates, or acceptable vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.3 CONCRETE MIXING

- A. Concrete Mixing - General:
1. Provide concrete materials from one ready-mix batch plant qualified in accordance with this Section's "Quality Assurance" Article.
 2. Batch, mix, and transport in accordance with ASTM C94/C94M.
- B. Control of Admixtures:
1. Control at ready-mix plant:
 - a. Admixtures shall be introduced at the ready-mix plant in accordance with manufacturer's recommendations.
 - b. Charge admixtures into mixer as solutions.
 - 1) Measure by means of an appropriate mechanical dispensing device.
 - 2) Liquid considered a part of mixing water.
 - 3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.
 - c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
 - d. Complete performing addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.
 2. Control of Admixtures at the Site:
 - a. Additional quantities of admixtures (with the exception of retarders) may be added at the Site provided:
 - 1) Addition of admixtures shall be under the supervision of the ready-mix plant's quality control representative.
 - 2) Addition of each admixture shall be documented on the delivery ticket.
 - 3) Provide additional mixing in accordance with ASTM C94.
- C. Tempering and Control of Mixing Water:
1. Mix concrete only in quantities for immediate use.
 2. Discard concrete which has set.
 3. Discharge concrete from ready-mix delivery vehicles within time limit stated in ASTM C94.
 4. Addition of water at the Site:

- a. Comply with Section 03 31 30 - Concrete Materials and Proportioning, for specified water cement ratio and slump.
- b. Do not exceed maximum specified water cement ratio or slump.
- c. Incorporate water by additional mixing equal to at least half of total mixing required.

3.4 PLACING OF CONCRETE

A. Placing of Concrete - General:

1. Place concrete at a rate such that concrete, which is being integrated with fresh concrete, is "workable".
 - a. Provide sufficient, competent, skilled workers for timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
2. Comply with ACI 304R, ACI 304.2R, and ACI 301.
3. Do not begin placing concrete during rain, sleet, snow, or other adverse weather or environmental conditions that may be detrimental to concrete placement.
 - a. Protect fresh concrete from ensuing inclement weather and other environmental conditions that may be detrimental to concrete.
4. Time between concrete batching and final placement shall not exceed 90 minutes, [unless indicated otherwise by the ready-mix plant or noted on the delivery ticket].
 - a. Selection of time limit to end of discharge should consider ambient conditions, types of cementitious materials and admixtures used, placement procedures, and projected transportation time between ready-mix plant and the point of delivery.
 - b. If discharge is acceptable after more than 90 minutes have elapsed since batching, verify that air content of air-entrained concrete, slump, and temperature of concrete are as specified.
5. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
6. Begin work only when work of other trades affecting concrete is complete.
7. When pumping concrete, do not use excess grout or mortar to lubricate concrete conveyance piping.
8. Do not use excess water for workability or any reason when placing concrete by freefall.
9. Deposit concrete continuously to avoid cold joints.
10. Provide construction joints at locations shown or indicated in the Contract Documents, unless otherwise approved by Engineer via Shop Drawing or Contract modification.
 - a. Plan size of crews with due regard for effects of concrete temperature and ambient conditions to avoid unplanned cold joints.
11. Spreaders:
 - a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
 - b. Embedded:
 - 1) Obtain approval of Engineer for their use.
 - 2) Materials: Concrete or metal.
 - 3) Ends of metal spreaders coated with plastic coating two inches from each end.
12. Deposit concrete as nearly as practicable in its final position to avoid segregation.
 - a. Maximum free fall: 4 feet.
 - b. Place concrete by means of hopper, "elephant trunk" or tremie pipe extending to within four feet of surface.
13. Perform the following operations before bleeding water has an opportunity to collect on surface:
 - a. Spread.
 - b. Consolidate.
 - c. Straightedge.

- d. Darby or bull float.
 - 14. No water shall be added to the concrete surface to ease finishing operation.
 - 15. Do not discharge water into forms.
 - 16. Consider use of form vibrators for certain placement situations.
- B. Cold Weather Concrete Placement:
- 1. Comply with ACI 306.1.
 - 2. Do not place concrete on forms or subgrades that are below 32 degrees F or contain frozen material.
 - 3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
 - 4. Temperature of concrete when discharged at site: in accordance with ACI 306.1.
 - 5. Heat subgrade forms, embedments and reinforcement with a cross section area greater than four square inches to between 45 and 70 degrees F, when temperature of surrounding air is 32 degrees F or below, at time concrete is placed.
 - a. Remove frost from subgrade, forms and reinforcement before concrete is placed.
 - 6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 degrees F.
 - 7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 degrees F.
 - 8. Comply with ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.
- C. Hot Weather Concrete Placement:
- 1. Comply with ACI 305.1.
 - 2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
 - 3. Temperature of concrete at point of delivery (i.e. delivery vehicle discharge) when placed:
 - a. Not to exceed 90 degrees F.
 - b. Not so high as to cause:
 - 1) Shrinkage cracks.
 - 2) Difficulty in placement due to loss of slump.
 - 3) Flash set.
 - 4. Temperature of forms and reinforcing when placing concrete:
 - a. Not to exceed 90 degrees F.
 - b. May be reduced by spraying with water to cool below 90 degrees F.
 - 1) Leave no standing water to contact concrete being placed.
 - 5. Prevent plastic shrinkage cracking, slab curling, or both due to evaporation.
- D. Consolidating:
- 1. Consolidate in accordance with ACI 309R except as modified herein.
 - 2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
 - a. Ensure no displacement of reinforcing or other embeds from final position.
 - b. Eliminate:
 - 1) Air or stone pockets.
 - 2) Honeycombing, pitting, or both.
 - 3) Planes of weakness.

3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
 - a. Size and coordinate external vibrators to specifically match forming system used.
 4. Internal vibrators:
 - a. Minimum frequency of 8000 vibrations per minute.
 - b. Insert and withdraw at points approximately 1.5 feet apart.
 - 1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
 - c. Use in:
 - 1) Beams and girders of framed slabs.
 - 2) Columns and walls.
 - 3) Vibrating concrete around all waterstops.
 - d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
 5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other appropriate means.
 6. Do not use vibrators to transport concrete within forms.
 7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the Work.
 8. Provide sufficient spare vibrators at the Site during all concrete placing operations to ensure continuous vibration.
 9. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
 10. Prevent construction equipment and machinery, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.
- E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
 2. Temporary horizontal belt conveyors:
 - a. Mount at a slope which will not cause segregation or loss of ingredients.
 - b. Protect concrete against undue drying or rise in temperature.
 - c. Use an arrangement at discharge end to prevent segregation.
 - d. Do not allow mortar to adhere to return length of belt.
 - e. Discharge conveyor runs into equipment specially designed for spreading concrete.
 3. Temporary metal or metal lined chutes:
 - a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
 - b. Chutes more than 20 feet long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
 - c. Provide end of each chute with a device to prevent segregation.
 4. Temporary pumping or pneumatic conveying equipment:
 - a. Designed for concrete application and having adequate pumping capacity.
 - b. Control pneumatic placement so segregation is avoided in discharged concrete.
 - c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1.5 inches.
 - d. Do not convey concrete through pipe of aluminum or aluminum alloy.

- e. Provide pumping equipment without Y sections.

5.

3.5 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - General:

1. Provide joints at locations as shown or indicated on the Drawings or as shown on approved Shop Drawings approved by Engineer or in an appropriate Contract modification.
 - a. Where construction joint spacing shown on the Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Section.
2. Unplanned construction joints are unacceptable.
 - a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
 - a. At Contractor's option, beam pockets may be formed into concrete walls.
 - b. Size pockets to allow beam reinforcing to be placed as detailed on the Drawings.
5. Place beams, girders, column capitals and drop panels at same time as slabs.
6. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
7. Provide the following joints unless shown or indicated otherwise on the Drawings:
 - a. Roughen joints: horizontal construction joints.
 - b. Keyed joints: vertical construction joints.
8. Roughen construction joints:
 - a. Clean the previously hardened concrete interface and remove all laitance.
 - b. Intentionally roughen the interface to a full amplitude of 0.25 inch.
9. Keyways:
 - a. Construction joint keyways when used shall have the following dimensions, unless shown or indicated otherwise on the Drawings or as directed by Engineer.
 - b. Wall keys:
 - 1) Keyway width, not less than one-third and not more than one-half the wall thickness measured perpendicular to wall faces.
 - 2) Keyway depth shall be not less than 1.5 inches.
 - 3) Continuous along length of wall.
 - 4) Place keyway in wall center unless otherwise shown or indicated on the Drawings.
 - c. Keyways in footings, foundations, base slabs, and structural or elevated slabs:
 - 1) Keyway height not less than one-third and not more than one-half the footing or slab thickness.
 - 2) Keyway depth not less than 1.5 inches.
 - 3) Continuous along footing or slab.
 - 4) Keyway in footing or slab center unless shown otherwise on the Drawings.
 - d. Beam keyways:
 - 1) Full width of beam.
 - 2) Keyway height not less than 5.5 inches.
 - 3) Keyway depth not less than 1.5 inches.

- 4) Keyway located in initial beam pour, directly above the bottom reinforcing, unless shown otherwise on the Drawings.
- 10. Minimum time before placement of adjoining concrete construction:
 - a. Water bearing structure concrete: 72 hours.
 - b. All other concrete: 48 hours, unless otherwise noted.
- B. Construction Joints - Spacing Unless Otherwise Specified:
 - 1. Structures not intended to contain liquid:
 - a. Wall vertical construction joints:
 - 1) 30 feet maximum on centers.
 - 2) At wall intersections, height of wall or ten feet minimum from corner.
 - b. Base slab, floor, and roof slab construction joints:
 - 1) Placements to be approximately square and not to exceed 2,500 square feet.
 - 2) Maximum aspect ratio (length to width) of a slab pour shall not exceed two.
 - c. Wall horizontal construction joints: 20 feet on centers.
 - d. Floor slab, construction joints:
 - 1) Placements to be approximately square and not to exceed 2,000 square feet.
 - 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 40 feet.
 - e. Elevated slab construction joints:
 - 1) Placements to be approximately square and not to exceed 4,000 square feet.
 - 2) Maximum side dimension of a slab pour to be less than:
 - a) Twice the length of the short side.
 - b) 40 feet.
- C. Construction Joints - Bonding:
 - 1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
 - 2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as indicated below:
 - 3. Roughen construction joints:
 - a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 0.25 inch minimum amplitude.
 - 1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
 - 4. Keyed construction joints:
 - a. Thoroughly clean construction joints and remove all laitance.
 - b. Dampen the hardened concrete immediately prior to placing fresh concrete.
- D. Slab On Grade Joints:
 - 1. Locate construction and control joints in slabs on grade as shown or indicated on the Drawings.
 - 2. Time cutting properly with set of concrete, if saw cut joints are required or allowed.
 - a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
 - b. Complete before shrinkage stresses become sufficient to produce cracking.
- E. Expansion Joints:

1. Do not allow reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
2. Use neoprene expansion joint fillers, unless shown or indicated otherwise on the Drawings.
3. Seal expansion joints as shown or indicated on the Drawings.
 - a. Comply with Section 33 05 16 – Precast Concrete Manhole Structures.

F. Waterstops - General:

1. Waterstop shall be continuous with splices in accordance with manufacturer's instructions and create water tight joints.
2. Do not mix different types of waterstop materials in the same structure without approval from the Engineer unless shown or indicated on the Drawings.
3. Preformed strip type:
 - a. Locate waterstop at center of wall, unless shown or indicated otherwise on the Drawings.
 - 1) Maintain at least three inches from edge of concrete or as recommended by manufacturer.
 - b. Install in a bed of swelling sealant on smooth surface of hardened concrete by use of nails, adhesive or other means as recommended by manufacturer to prevent movement of waterstop during placement of concrete.
 - c. Roughened joints shall be specially prepared during concrete placement to provide smooth surface for proper water stop installation.
 - d. Use in joints against existing concrete where shown or indicated on the Drawings.
4. PVC waterstops:
 - a. Pre-position waterstop accurately in joints, with adequate clearance from all reinforcing. Do not push waterstop into wet concrete.
 - b. Secure waterstops in correct position using hog rings or grommets spaced no more than 1.5 feet maximum staggered along each edge full length and passed through the edge of the waterstop.
 - 1) Tie wire to adjacent reinforcing.
 - c. Hold horizontal waterstops in place with continuous supports.
 - d. Install according to manufacturer's instructions.
 - 1) Do not displace reinforcement from required location.
 - e. Splice ends and intersections with perpendicular butt splice using electrical splicing iron in accordance with manufacturer's instructions.
 - 1) Use factory fabricated "T" and corner intersection fittings.
 - 2) Field splice straight runs of material.
 - f. Unless otherwise noted, provide for construction joints in new construction for all structures indicated on the Drawings.

G. Other Embedded Items:

1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.
2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Engineer.

H. Placing Embedded Items:

1. Support against displacement.
2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
3. Provide adequate means for anchoring waterstop in concrete.

- a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.6 FINISHING

- A. Comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
- B. Coordinate mixing and placing with finishing.

3.7 INSTALLATION OF GROUT

- A. Grout Schedule:
 - 1. Sand cement grout:
 - a. Fill keyways in precast HCU.
 - b. Construction joint bedding (base of wall pours with comparable compressive strength to wall).
 - c. General use.
 - d. As shown or indicated on the Drawings.
 - 2. Non-shrinking non-metallic grout:
 - a. Filling form tie holes.
 - b. Under column and beam base plates.
 - c. Other uses shown or indicated on the Drawings.
 - 3. Epoxy grout:
 - a. Patching cavities in concrete.
 - b. Grouting of dowels and anchor bolts into existing concrete.
 - c. Grouting of rotating or oscillating equipment base plates [where driving motor is 500 horsepower and above].
 - d. As shown or indicated on the Drawings.
- B. Grout Installation:
 - 1. Sand cement grout:
 - a. Fill wetted keyways between precast concrete hollow core slabs with sand cement grout.
 - b. Consolidate grout by rodding or by other means to assure complete filling of keyways.
 - c. Cure grout by one of methods specified.
 - 2. Non-shrink non-metallic grout:
 - a. Clean concrete surface to receive grout.
 - b. Saturate concrete with water for 24 hours prior to grouting.
 - c. Mix in a mechanical mixer.
 - d. Use no more water than necessary to produce flowable grout.
 - e. Place in accordance with manufacturer's instructions.
 - f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast-in-place slabs, and in other locations shown or indicated on the Drawings.
 - g. Completely fill spaces and cavities below the top of base plates.
 - h. Provide forms where base plates and bed plates do not confine grout.
 - i. Where exposed to view, finish grout edges smooth.
 - j. Except where a slope is shown or indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
 - k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
 - 3. Epoxy grout:

- a. Mix and place in accordance with manufacturer's written instructions.
- b. Apply only to clean, dry, sound surface.
- c. Completely fill cavities and spaces around dowels and anchors without voids.
- d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
- e. Obtain manufacturer's field technical assistance as necessary to ensure proper placement.

3.8 CURING AND PROTECTION

- A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
 - 1. Comply with ACI 308.1 except as modified herein.
 - 2. Do not impose loads by foot traffic, wheeled traffic, and other loads until concrete has sufficiently cured to carry imposed loads without adversely affecting the concrete. In no event shall concrete be subject to loading or traffic during initial 48 hours of curing, unless otherwise approved by Engineer.
- B. Apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
 - 1. Ponding or continuous sprinkling. Avoid eroding the surface of freshly placed concrete.
 - 2. Application of wet Absorbent Covers:
 - a. Minimum lap: 12 inches.
 - b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as necessary to keep concrete surface continuously wet.
 - c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
 - 3. Continuous application of steam (not exceeding 150 degrees F) or mist spray.
 - 4. Application of Moisture Retaining Cover sheet materials.
 - a. Place as soon as possible after final finishing and without marring the surface.
 - b. Minimum lap: 12 inches.
 - c. Seal edges to make water-tight.
 - d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
 - e. Hold cover and edges in place as necessary to prevent wind from displacing the cover.
 - f. Moisture Retaining Fabric:
 - 1) Install in accordance with manufacturer's written recommendations.
 - 2) Saturate concrete surface and fabric side of cover immediately prior to placing.
 - g. Monitor continuously during the curing period:
 - 1) Repair holes, tears or displaced cover.
 - 2) Rewet as necessary to keep concrete moist under cover.
 - 5. Application of other moisture retaining covering acceptable to Engineer.
 - 6. Water used for curing shall be within 20 degrees F of the concrete temperature.
 - 7. Application of a curing compound.
 - a. Apply curing compound in accordance with manufacturer's written recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
 - b. Do not use on surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.

- c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
 - 1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
 - 2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
 - 3) Allow the preceding coat to completely dry prior to applying the next coat.
 - 4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
 - 8. Surfaces In Contact with Forms:
 - a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
 - 1) See Section 03 11 13 - Formwork.
 - b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
 - c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
 - d. After form removal, cure concrete until end of time prescribed.
 - e. Use one of the methods listed above.
 - f. Forms left in place shall not be used as a method of curing in hot weather.
 - g. The term "hot weather", where used in these Specifications, is defined in ACI 305.1.
 - h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.
- C. Curing Period:
- 1. Continue curing for at least seven days for all concrete except Type III, high early strength concrete for which period shall be at least three days.
 - a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.
- D. Cold Weather:
- 1. Comply with of ACI 306.1.
 - 2. Maintain temperature of concrete in accordance with ACI 306.1 for a minimum of 72 hours after concrete is placed, when outdoor temperature is 40 degrees F, or less.
 - a. Maximum temperature rate of decrease: In accordance with ACI 306.1.
 - 3. Provide temporary heating, covering, insulating, or housing of the concrete Work to maintain required temperature without damage due to concentration of heat.
 - 4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
 - 5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.
- E. Hot Weather:
- 1. Comply with ACI 305.1 and ACI 308.1.
 - 2. Provide as necessary cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
 - 3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
 - 4. Maximum temperature rate of decrease: In accordance with ACI 305.1.
- F. Rate of Temperature Change:

1. Maintain temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing.
- G. Protection from Mechanical Damage:
1. Protect concrete from damage of all types, whether or not mechanically imparted including load stresses, heavy shock, and excessive vibration.
 2. Protect finished concrete surfaces from all types of damage, including damage by construction equipment and machinery, construction means and methods, precipitation, and running water.
 3. Do not load self-supporting structures in such a way as to overstress concrete.

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
1. Special Inspections in accordance with building code:
 - a. Comply with 03 05 05 - Concrete Testing and Inspection.
- B. Supplier's Onsite Services:
1. Waterstop manufacturer's representative shall provide on-site training of waterstop installation, field splicing, welding and inspection procedures prior to construction.

END OF SECTION

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SECTION 03 35 00
CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Concrete finishing and repair of surface defects.
 - 2. Chemical Sealers.
 - 3. Polymer Modified Cementitious Coating.
 - 4. Resurfacing Mortar.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 03 11 13 - Formwork.
 - 2. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 3. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Concrete Institute (ACI):
 - a. CT, Concrete Terminology.
 - b. 117, Specification for Tolerances for Concrete Construction and Materials.
 - c. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
 - d. 308, Standard Practice for Curing Concrete.
 - 2. ASTM International (ASTM):
 - a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
 - b. C150, Standard Specification for Portland Cement.
 - c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
 - i. D4259, Standard Practice for Abrading Concrete.
 - j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
 - k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.
 - 3. International Concrete Repair Institute (ICRI):
 - a. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
 - 4. National Council Highway Research Program (NCHRP):
 - a. 244, Concrete Sealers for the Protection of Bridge Structures.

5. The Society for Protective Coatings/NACE International (SSPC/NACE):
 - a. SP 13/NACE No. 6, Surface Preparation of Concrete.
- B. Qualifications:
 1. Chemical Sealer CS-2:
 - a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
 - b. Applicator shall have a minimum of five years of experience successfully applying materials specified.
- C. Mock-Ups.
 1. General:
 - a. Construct additional mock-ups as required until accepted.
 - b. Mock-ups constitute minimum standard of quality for actual construction.
 - c. Maintain mock-up during construction.
 - d. Remove when directed by Engineer.
 2. Construct mock-up for each type of wall finish specified for review and acceptance by Engineer.
 - a. Minimum 4 x 4 feet area for each different wall finish specified.
 - b. Mock-ups shall include:
 - 1) Sample of patched tie hole.
 - 2) Sample of all jointery being used in the walls.
 - c. Include mock-up of wall having polymer modified cementitious coating.
 - 1) Mock-up shall be stepped to show surface preparation, repairs and coating in all stages of application.
 3. Construct mock-up floor slab for review and acceptance by Engineer.
 - a. Minimum 10 x 10 feet.

1.3 DEFINITIONS

- A. Vertical Surface Defects:
 1. Any void in the face of the concrete deeper than 1/8 inches, such as:
 - a. Tie holes.
 - b. Air pockets (bug holes).
 - c. Honeycombs.
 - d. Rock holes.
 2. Scabbing:
 - a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
 3. Foreign material embedded in face of concrete.
 4. Fins 1/16 inches or more in height.
- B. Installer or Applicator:
 1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
 2. Installer and applicator are synonymous.
- C. Other words and terms used in this Specification Section are defined in ACI CT.

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Product technical data including:

- a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
- 2. Certifications:
 - a. Certification of aggregate gradation.
 - b. Certification of manufacturer experience qualifications and performance history.
 - c. Certification of applicator's qualifications.
 - 1) Refer to Qualifications paragraph.
 - 2) Provide manufacturer's written approval of applicators.
 - 3) Provide references substantiating specialty experience.
- B. Informational Submittals:

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's recommendations and requirements for materials used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Bonding Agents:
 - a. Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - 2. Chemical Sealers:
 - a. Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - d. Tnemec Chemprobe.
 - 3. Polymer Modified Cementitious Coating:
 - a. Aquafin International.
 - b. Master Builders Solutions.
 - c. Euclid Chemical Co.
 - 4. Patching Mortar:
 - a. Master Builders Solutions.
 - b. Euclid Chemical Co.
 - c. Laticrete - L&M Construction Chemicals.
 - d. Sika Corporation.

2.2 MATERIALS

- A. Chemical Sealer CS-1:
- B. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.
 - 1. Portland cement-based, rapid set repair mortar for interior or exterior use.
 - 2. Compressive Strength, ASTM C109:
 - a. Minimum 3000 psi at 7 days.
 - b. Minimum 5000 psi at 28 days.
 - 3. Freeze Thaw Durability, ASTM C666: 96.75% at 300 Cycles.
 - 4. Shrinkage, ASTM C157: 0.069%.

5. Euclid Chemical Speed Crete Red Line.
- C. Bonding Agents:
 1. For use only on concrete surfaces not receiving liquid water repellent coating:
 - a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
 - 1) Master Builders MasterEmaco A 660.
 - 2) Euclid Chemical Co. Flex-Con.
 - 3) Laticrete L&M Everbond.
 2. For use only on concrete surface receiving liquid water repellent:
 - a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
- D. Cement:
 1. ASTM C150, Type II or ASTM C595, Type IL (MH, MS).
- E. Aggregate:
 1. Sand: Maximum size #30 mesh sieve.
 2. For exposed aggregate finish surfaces: Same as surrounding wall.
- F. Water: Potable.
- G. Polymer modified cementitious coating:
 1. Polymer modified Portland cement based coating for concrete and masonry.
 - a. Waterproof.
 - b. Resistant to both positive and negative hydrostatic pressure.
 - c. Breathable.
 2. Master Builders Solutions MasterSeal 581 or Euclid Chemical Tamoseal.
 - a. Color:
 - 1) Interior surfaces: Standard gray.
 - 2) Exterior surfaces: Standard gray.
 - b. Texture: Fine.
- H. Nonshrink Grout: See Specification Section 03 31 30 and Specification Section 03 31 31.

2.3 MIXES

- A. Bonding Grout: One part cement to one part aggregate.
- B. Patching Mortar:
 1. One part cement to 2-1/2 parts aggregate by damp loose volume.
 - a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

- A. For methods of curing, see Specification Section 03 31 31.
- B. Surface Preparation:
 1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
 2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.

- a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
 - 1) Areas to receive Repair Mortar:
 - a) Areas larger than 1 SF or deeper than 1/4 inches Abrasive blast, scarify or needle scale to CSP No. 6-8.
 - b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
 - c. No feathered edges will be permitted.
 - d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.
- C. Preparation of Bonding Grout Mixture:
 - 1. Mix cement and aggregate.
 - 2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
 - 3. Add bonding agent/water mixture to cement/aggregate mixture.
 - 4. Mix to consistency of thick cream.
 - 5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Engineer.
- D. Preparation of Patching Mortar Mixture:
 - 1. Mix specified patching mortar per manufacturer's published recommendations.
 - 2. For repairs exceeding 2 inches in depth, mix with clean, pre-dampened 3/8 inches pea gravel in accordance with the manufacturer's recommendations.
- E. Polymer modified cementitious coating:
 - 1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

3.2 INSTALLATION AND APPLICATION

- A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 degrees F.
 - 1. If necessary, enclose and heat area to between 50 and 70 degrees F during repair of surface defects and curing of patching material.
 - a. Use only clean fuel, indirect fired heating apparatus.
 - b. Exhaust combustion byproducts outside of work area.
- B. Repairing Surface Defects:
 - 1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.
 - a. For surfaces indicated to receive finish or coating other than those specified herein; refer to the applicable Specification Section for surface preparation requirements:
 - 1) Bituminous Dampproofing: See Specification Section 07 11 14.
 - 2) Polyurethane Coating: See Specification Section 09 96 05.
 - 2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.
 - a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.
 - b. Scrub bond coat:
 - 1) Wet substrate to a saturated surface dry (SSD) condition.
 - 2) Mix patching mortar to a scrub coat or slurry consistency per manufacturer's published recommendations and apply to entire area.

- c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer's recommended epoxy primer.
- d. Patching Mortar Application:
 - 1) Mix and apply Patching Mortar per manufacturer's recommendations within the open time of the product scrub coat or any bonding agents.
 - 2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.
- 3. Fill and repair using patching mortar mix specified in the MIXES Article in PART 2 of this Specification Section.
- 4. If required by bonding agent manufacturer, etch surfaces with a muriatic acid solution followed by a thorough rinse with clean water.
 - a. Test concrete to determine pH level and continue flushing with clean water until surface pH is within acceptable limits.
- 5. Dampen area to be patched to a saturated surface dry (SSD) condition prior to application of bonding grout.
- 6. Brush bonding grout into the surface.
- 7. Allow bonding grout to set for period of time required by bonding agent manufacturer before applying patching mortar.
- 8. Fill all defects with patching mortar.
- 9. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
- 10. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
 - a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
- 11. Cure patching mortar in accordance with ACI 308.
- C. Concrete Finishes for Vertical Wall Surfaces:
 - 1. General:
 - a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
 - b. Finish numbers not listed are "Not Used".
 - 2. Finish #1 - As cast rough form finish:
 - a. Selected forming materials are not required.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - c. Repair the following surface defects using patching mortar specified in PART 2:
 - 1) Tie holes.
 - 2) Honeycombs deeper than 1/4 inches.
 - 3) Air pockets deeper than 1/4 inches.
 - 4) Rock holes deeper than 1/4 inches.
 - d. Chip or rub off fins exceeding 1/4 inches in height.
 - e. Provide at unexposed surfaces such as:
 - 1) Foundations.
 - 2) Below-grade walls not to be waterproofed.
 - 3) Concealed surface of concrete back-up wythe in cavity wall construction.
 - 3. Finish #2 - As cast form finish:
 - a. Form facing material shall produce a smooth, hard, uniform texture.
 - 1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.

- b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - 1) Chip or rub off fins exceeding 1/8 inches in height.
 - 2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
 - a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.
 - (1) For contiguous repair areas larger than 1 SF or deeper than 1/4 inches Abrasive blast, scarify or needle scale to CSP No. 6-8.
 - b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
 - c) No feather edges will be permitted.
 - 3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
 - 4) Repair the following surface defects using patching mortar specified in PART 2:
 - a) Tie holes.
 - b) Honeycombs deeper than 1/4 inches or larger than 1/4 inches diameter.
 - c) Air pockets deeper than 1/4 inches or larger than 1/4 inches diameter.
 - d) Rock holes deeper than 1/4 inches or larger than 1/4 inches diameter.
 - e) Scabbing.
 - 5) Brush blast repaired areas to match adjacent surface texture.
- c. Provide this finish for:
 - 1) Interior of site cast concrete vaults and precast concrete vaults and manholes.
 - 2) Underside of horizontal elements adjacent to the finished surface.
 - 3) Exposed surfaces not specified to receive another finish.
- 4. Finish #4 - Polymer modified cementitious coating:
 - a. Form facing material shall produce a smooth, hard, uniform texture.
 - 1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
 - 2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.
 - b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
 - 1) Chip or rub off fins exceeding 1/8 inches in height.
 - 2) Abrasive blast and repair surface defects in accordance with Concrete Finish #2.
 - c. Apply decorative coating to entire surface.
 - 1) As a mixing liquid for the coating, use bonding agent and water mixture as recommended by coating manufacturer.
 - 2) Apply two (2) coats at 2 pounds per square yard per coat.
 - a) During application of first coat, complete fill all voids, depressions or other surface imperfections.
 - d. When second coat is set, float to a uniform texture with a sponge float.
 - e. Provide this finish on all exposed to view:
 - 1) Exterior building surfaces not otherwise indicated to receive [an Architectural Abrasive Blast Finish].
 - 2) Interior walls, columns and similar vertical surfaces where indicated on Room Finish Schedule on the Drawings.
 - 3) Underside of horizontal elements adjacent to the finished surface.

- f. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.
- D. Related Unformed Surfaces (Except Slabs):
1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
 2. Float surface to a texture consistent with that of formed surfaces.
 - a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
 3. Continue treatment uniformly across unformed surfaces.
- E. Concrete Finishes for Horizontal Slab Surfaces:
1. General:
 - a. Tamp concrete to force coarse aggregate down from surface.
 - b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
 - c. Dusting of surface with dry cement or sand during finishing processes not permitted.
 2. Unspecified slab finish:
 - a. When type of finish is not indicated, use following finishes as applicable:
 - 1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
 - 2) Surfaces intended to receive roofing damp proofing or waterproofing membranes: Floated finish.
 - 3) Floors [and roof surfaces which are future floors intended as walking surfaces or for reception of floor coverings]: Troweled finish.
 - 4) Garage floors and ramps: Broom finish.
 - 5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom finish.
 - 6) All slabs to receive a floated finish before final finishing.
 3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
 4. Floated finish:
 - a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
 - b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
 - 1) Use wood or cork float.
 - c. During or after first floating, check planeness of entire surface with a 10 feet straightedge applied at not less than two different angles.
 5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
 - a. Refloat slab immediately to a uniform texture.
 6. Troweled finish:
 - a. Float finish surface to true, even plane.
 - b. Power trowel, and finally hand trowel.
 - c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
 - d. Perform additional trowelings by hand after surface has hardened sufficiently.
 - e. Final trowel when a ringing sound is produced as trowel is moved over surface.
 - f. Thoroughly consolidate surface by hand troweling.

- g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
 - 1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
 - h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.
7. Broom Finish:
- a. Provide broom finish for the following concrete surfaces:
 - 1) Concrete surfaces subject to precipitation, including concrete paving that will be transited by vehicles, stoops, stairs, landings, horizontal concrete surfaces intended for pedestrian traffic (including surfaces that will feature handrails, railings, or guardrails), sidewalks, and horizontal surfaces of cast-in-place concrete retaining walls.
 - b. Immediately after required float finish is provided, provide scored texture of concrete surface by drawing coarse, stiff-bristled broom across surface.
 - c. Provide broomed finish in transverse direction to intended traffic, unless expressly required otherwise elsewhere in the Contract Documents.
 - d. Amplitude: 1/16-inch to 1/8-inch.
 - e. Uniform spacing. Noticeable spacing between broom strokes is unacceptable.
8. Underside of concrete slab finish:
- a. Match finish as specified for adjacent vertical surfaces.
 - b. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

A. Tolerances:

- 1. Finished floor slabs:
 - a. Provide Floor Flatness (F_F) and Floor Levelness (F_L) in accordance with ACI 117.
 - 1) Measure in accordance with ASTM E1155.
 - b. Slabs not indicated to be sloped:
 - 1) F_F : Equal or greater than 35.
 - 2) F_L : Equal or greater than 25.
 - c. Slabs indicated to be sloped or curved:
 - 1) Measure in accordance with ASTM E1486.
 - 2) Provide slopes or curves as indicated on the Drawings.
 - d. Slabs indicated to receive polished concrete floor:
 - 1) F_F : Equal or greater than 45.
 - 2) F_L : Equal or greater than 35.
 - 3) Refer to Room Finish Schedule on Drawings.
- 2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
 - a. Gap between a 10 feet straightedge placed anywhere and the finished surface shall not exceed:
 - 1) Class A tolerance: 1/4 inches.
 - 2) Class B tolerance: 3/8 inches.
 - 3) Class C tolerance: 1/2 inches.
 - b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 inches.

- B. Unacceptable finishes shall be replaced or, if approved in writing by Engineer, may be corrected provided strength and appearance are not adversely affected.
 - 1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.
- C. Provide services of manufacturer's technical representative:
 - 1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
 - 2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.
 - 3. Manufacturer's representative shall be present for installation of:
 - a. Dry-shake Hardener.
 - b. Heavy-duty Metallic Aggregate Topping.

3.4 PROTECTION

- A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 hours following installation of sealer.

END OF SECTION



DIVISION 07

THERMAL AND MOISTURE PROTECTION



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SECTION 07 11 14
BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Asphaltic Emulsion Dampproofing, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.
 - 1. Ensure materials in this Section are compatible with adhesives, sealants, and adjacent materials.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM D41 Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
 - 2. ASTM D1227 Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
 - 3. ASTM D1668 Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.

1.3 QUALITY ASSURANCE

- A. Applicator Qualifications:
 - 1. Approved in writing by manufacturer.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Manufacturers' product data sheets, details and installation instructions including components and accessories, indicating product used to comply with specifications.
- B. Project Information:
 - 1. License or certification in writing by manufacturer of installer qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Asphaltic Emulsion Dampproofing:
 - 1. Base:
 - a. Karnak.
 - 2. Optional:
 - a. Henry.
 - b. WR Meadows.
- B. Protection board:
 - 1. Base:
 - a. Kingspan.
 - 2. Optional:
 - a. DuPont.
- C. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 MATERIALS

- A. Primer: ASTM-D41, compatible with substrate and recommended by dampproofing manufacturer.
- B. Asphaltic Emulsion Dampproofing:
 - 1. Refined asphalt, clay emulsifiers, and selected non-asbestos fiber reinforced emulsion for trowel application.
 - 2. ASTM-D1227, Type II, Class 1.
 - 3. Base Product: Karnak 920AF Fibered Emulsion Mastic (Trowel Grade).
 - 4. Optional Product: 789 Fluid Applied Dampproofing by Henry.
 - 5. Optional Product: Sealmastic Type III by WR Meadows.
- C. Saturated fabric: Woven, glass fiber, ASTM-D1668 Type I.
- D. Protection Board:
 - 1. Minimum 1/4-inch thick extruded polystyrene.
 - 2. Base Product: GreenGuard PB4 Waterproofing Protection Board by Kingspan.
 - 3. Optional Product: Protection Board III by DuPont/R. L. Adams Plastics, Inc.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Clean substrate of projections and substances detrimental to work.
- B. Apply dampproofing to following surfaces:
 - 1. Exterior face of exterior walls below grade.
 - 2. Exterior of walls surrounding elevator pits and areas having lowered floor slabs.
 - 3. Other surfaces indicated.
 - 4. Do not apply to walls scheduled to be waterproofed.
- C. Comply with manufacturers installation instructions.
- D. Prime per manufacturer's instructions.
- E. Coordinate detailing at penetrations made after completion of dampproofing system.
- F. Reinforce corners, cracks, and construction joints with saturated fabric.
 - 1. Extend 9 inches on each side of each corner, crack and joint.
- G. Where walls intersect footings, reinforce with saturated fabric, and extend dampproofing 1 foot onto footing.
- H. Trowel apply in 2 coats to minimum finish thickness of 1/8 inches.
- I. Allow 24-hour cure period between coats.
- J. Allow no dampproofing exposed in finish work.
- K. Install protection board before backfilling.

END OF SECTION



DIVISION 09

FINISHES



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SECTION 09 90 04

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section does not cover polyurethane coating for buried steel water pipelines. See Section 09 90 05 for that work.
- B. This section describes materials, methods and work for surface preparation, pretreatment, coating application, touch-up of factory-coated surfaces, protection of surfaces not to be coated, cleanup, and appurtenances.
- C. Do not apply protective coatings to the following surfaces unless otherwise shown in the Drawings or specified herein or elsewhere in the Contract Documents.
 - 1. Concrete
 - 2. Stainless steel
 - 3. Machined surfaces
 - 4. Grease fittings
 - 5. Manhole frames and covers
 - 6. Equipment nameplates
 - 7. Aluminum, except in contact with concrete
 - 8. Galvanized steel
 - 9. Casing pipe for trenchless crossings
 - a. Casing pipes installed via open cut methods shall be coated as specified herein
- D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show exceptions to the schedules, to show or extend the limits of coating systems, or to clarify or show details for application of the coating systems.

1.2 REFERENCES

- A. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.
- B. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
 - 1. SSPC-Vis 1 Pictorial Surface Preparation Standards for Painting Steel Structures
 - 2. SSPC-SP6 Commercial Blast Cleaning
 - 3. SSPC-SP10 Near White Blast Cleaning
 - 4. SSPC-PA2 Measurement of Dry Paint Thickness
- C. National Sanitation Foundations (NSF) Standard 61
- D. American Water Works Association (AWWA)
 - 1. AWWA C105, Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids
 - 2. AWWA C213, Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Section 01 33 00, Submittal Procedures.
- B. Action Submittals

1. Samples of paint, finishes, and other coating materials specified herein.
2. A minimum of one 4" x 4" steel sample panel, for each Sandblast grade to be used on the project.
3. Coating materials list that indicates the manufacturer and coating number, keyed to the coating systems herein, prior to or at the time of submittal of samples.
4. Submit the following for each paint system to be used at least 30 days prior to painting.
 - a. Data sheet for each product used including statements on the suitability of the material for the intended use.
 - b. Instructions and recommendations on surface preparation and application.
 - c. Colors available for each product (where applicable).
 - d. Compatibility of shop and field applied coatings (where applicable).
 - e. Material Safety Data Sheet for each product used.
 - f. Two sets of color samples to match each color selected by the Engineer from the manufacturer's standard color sheets.
5. Manufacturer's certification for submerged and severe service coating systems certifying the following:
 - a. The manufacturer's representative has provided at least 6 hours of on-site instruction in the proper surface preparation, use, mixing, application, and curing of the coating systems.
 - b. The manufacturer's representative has personally observed the start of surface preparation, mixing, and application of the coating materials.
6. For shop-coated equipment, equipment manufacturer's certification that surface preparation and coatings are in conformance with these Specifications. Provide coating material data sheet.
7. Submit certificates within 7 days of completion of each paint system.
8. Provide the following minimum information for proposed substitutions. Include a minimum of 10 installations of similar service conditions that the proposed substitute product has shown satisfactory performance for at least several years. Include owner's contact name, address, and phone number of each installation.
 - a. Quality
 - b. Durability
 - c. Resistance to abrasion and physical damage
 - d. Life expectancy
 - e. Ability to recoat in future
 - f. Solids content by volume
 - g. Dry film thickness per coat
 - h. Compatibility with other coatings
 - i. Suitability for the intended service
 - j. Resistance to chemical attack
 - k. Temperature limitations in service and during application
 - l. Type and quality of recommended undercoats and topcoats
 - m. Ease of application
 - n. Ease of repairing damaged areas
 - o. Stability of colors

1.4 QUALITY ASSURANCE

- A. Give the Engineer a minimum of 3 days advance notice of the start of field surface preparation work of coating application work and a minimum of 7 days advance notice of the start of shop surface preparation work.
- B. Perform work in the presence of the Engineer, unless otherwise indicated.

- C. Examination by the Engineer, or the waiver of examination of any particular portion of the Work, shall not relieve the Contractor's responsibility to perform the Work in accordance with these Specifications.
- D. Where protective coatings are to be performed by a subcontractor, said subcontractor must possess a valid state license as required for performance of the painting and coating work called for in this specification and must provide 5 references which show that the painting subcontractor has previous successful experience with the specified or comparable coating systems. Include owner's name, address, and the telephone number of each installation for which the painting subcontractor had provided the protective coating.
- E. Erect and locate scaffolding, in compliance with OSHA standards, where requested by the Engineer to facilitate examinations. Provide additional illumination to covered areas to be inspected.
- F. Furnish, until final acceptance of such coatings, inspection devices in good working condition for the detection of holidays and measurement of dry-film thicknesses of protective coatings. Provide dry-film thickness gages for the Engineer's use while coating is being done, until final acceptance of such coatings. Operate holiday detection devices in the presence of the Engineer.
- G. Holiday test coated ferrous surfaces that will be submerged in water or other liquids, or surfaces that are enclosed in a vapor space in such structures and surfaces coated with any of the submerged and severe service coating systems. Mark and repair or re-coat areas that contain holidays in accordance with the coating manufacturer's printed instructions and re-test.
 - 1. Coatings with Thickness Exceeding 20 Mils: Test using a pulse-type holiday detector manufactured by Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20, or approved equivalent. Adjust the unit to operate at the required voltage to cause a spark jump across an air gap equal to twice the specified coating thickness.
 - 2. Coatings with Thickness of 20 Mils or less: Test using a non-destructive type holiday detector manufactured by Tinker & Rasor Model M1, K-D Bird Dog, or approved equivalent. Operate the unit at less than 75-volts. For thicknesses between 10 and 20 mils, add a non-sudsing type wetting agent, manufactured by Kodak Photo-Flo or approved equivalent, to the water prior to wetting the detector sponge.
- H. On ferrous metals, measure the dry film coating thickness in accordance with the SSPC "Paint Application Specification No. 2" using a magnetic-type dry film thickness gage manufactured by Mikrotest Model FM, Elcometer Model 111/1EZ, or approved equivalent. Test each coat for the correct thickness. Do not take a measurement until at least 8 hours after coating application. On non-ferrous metals and other substrates, measure the coating thicknesses at the time of application using a wet film gage.
- I. Evaluation of blast cleaned surface preparation work will be based upon comparison of the blasted surfaces per SSPC-SP5, SSPC-SP6, SSPC-SP7, and SSPC-SP10 as applicable.

1.5 MANUFACTURER'S REPRESENTATIVE

- A. Furnish a qualified technical representative from the protective coating manufacturer to visit the project site for technical support as necessary to resolve field problems attributable or associated with the manufacturer's products.

1.6 MAINTENANCE

- A. A warranty inspection may be conducted following completion of coating and painting work. The Contractor and a representative of the coating material manufacturer shall attend this inspection. Repair defective work in accordance with these specifications and to the satisfaction of Owner. Owner may, by written notice to the Contractor, reschedule the warranty inspection to another date within the one-year correction period, or may cancel the warranty inspection altogether. If a warranty inspection is not held the Contractor is not relieved of its responsibilities under the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Definitions: The term "paint", "coatings", or "finishes" as used herein, include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat. The "DFT" means minimum dry film thickness.
- B. General: Seal coating materials in containers that show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's directions, and name of manufacturer plainly legible at the time of use.
- C. Use coating materials suitable for the intended use and recommended by the manufacturer for the intended service.
- D. Provide paints, coatings, and finishes with no lead content.
- E. Compatibility: In any coating system only compatible materials from a single manufacturer shall be used in the Work. Direct particular attention to compatibility of primers and finish coats. If necessary, subject to the approval of the Engineer, apply a barrier coat between existing prime coat and subsequent field coats to ensure compatibility.
- F. Colors: Owner will specify or select colors and shades of colors of paint from the manufacturer's standard color samples. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat.
- G. Protective Coating Materials: Provide the names of not less than 10 successful applications of the proposed manufacturer's products demonstrating compliance with this specification.

2.2 INDUSTRIAL COATING SYSTEMS

- A. Materials Sources: Each of the following manufacturers is capable of supplying many of the industrial coating materials specified herein. The manufacturers and paint numbers herein establish the minimum type and quality of coatings required.
 - 1. Ameron
 - 2. Carboline Coatings Company
 - 3. Devoe Coatings Company
 - 4. Glidden Coatings and Resins
 - 5. Sherwin Williams Company
 - 6. Pittsburgh Paints
 - 7. Tnemec Company

2.3 COATING SYSTEMS

- A. System Number 100 – Submerged Metal: NSF Epoxy; Polyamide epoxy approved for potable water service and conforming to NSF 61. 3 or more coats, minimum 16 mils DFT total.
- B. System Number 103 – Exterior of buried steel casing pipes installed via open cut methods: MIO Polyurethane, 3 coats 7 mils DFT each.
- C. System Number 105 – Exposed Metal: Epoxy primer, 1 coat 2.5 mils DFT; Polyurethane Enamel, 3 or more coats, minimum 16 mils DFT total (including primer).
- D. System Number 106 – Fusion Bonded Epoxy: The coating material shall be a 100 percent powder epoxy applied in accordance with the ANSI/AWWA C213 "AWWA Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines," except that the surface preparation shall be as specified in the coating system schedule of this Section. The coating shall be applied using the fluidized bed process.
 - 1. Liquid Epoxy: For field repairs, the use of a liquid epoxy will be permitted, applied in not less than 3 coats to provide a DFT of 15 mils. The liquid epoxy shall be a 100 percent solids epoxy recommended by the powder epoxy manufacturer.

2. Coating (DFT = 16 mils)
3. Total system DFT = 16 mils.

2.4 SPECIAL COATING SYSTEMS

- A. Buried Steel Pipelines – Polyurethane: As specified in Specification Section 09 90 05 Polyurethane Coating.
- B. System 205 – Polyethylene Encasement: Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105, minimum 8 mil.
- C. System Number 270 – Aluminum and Dissimilar Metal Insulation: Bituminous paint, 1 coat 10 mils DFT.

PART 3 - EXECUTION

3.1 STORAGE, MIXING, AND THINNING OF MATERIALS

- A. Unless otherwise specified herein, adhere to the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating.
- B. Use protective coating materials within the manufacturer's recommended shelf life.
- C. Protect coating materials from exposure to cold weather. Thoroughly stir, strain, and keep at a uniform consistency during application. Do not mix together coatings from different manufacturers.

3.2 PREPARATION FOR COATING

- A. Clean surfaces to receive protective coatings prior to application of coatings. Examine surfaces to be coated and correct surface defects before application of coating material. Touch-up and restore marred or abraded spots on shop-primed and factory-finished surfaces prior to any coating application.
- B. Protect surfaces not to be coated during surface preparation, cleaning, and coating operations.
- C. Remove, mask, or protect hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearing, nameplates on machinery, and other surfaces not to be painted. Provide drop cloths to prevent coating materials from falling on or marring adjacent surfaces. Protect the working parts of mechanical and electrical equipment from damage during surface preparation and coating operations. Mask openings in motors to prevent entry of coating or other materials.
- D. Exercise care not to damage adjacent work during blast cleaning operations. Conduct spray painting under carefully controlled conditions. The Contractor is fully responsible for and shall promptly repair damage to adjacent work or adjoining property occurring from blast cleaning or coating operations.
- E. Program cleaning and coating such that dust and other contaminants from the cleaning process will not fall on wet newly-coated surfaces.

3.3 SURFACE PREPARATION STANDARDS

- A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification.
 1. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.
 2. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC-SP3): Removal of rust, loose mill scale, loose paint, and other loose detrimental foreign matter by power tool chipping, descaling, sanding, wire brushing, and grinding.
4. White Metal Blast Cleaning (SSPC-SP5): Removal of visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.
5. Commercial Blast Cleaning (SSPC-SP6): Removal of visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.
6. Brush-Off Blast Cleaning (SSPC-SP7): Removal of visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.
7. Near-White Blast Cleaning (SSPC-SP10): Removal of visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

3.4 METAL SURFACE PREPARATION (UNGALVANIZED)

- A. The minimum abrasive blasting surface preparation is specified in the coating system schedules included at the end of this Section. Where there is a conflict between these specifications and the coating manufacturer's recommendations for the intended service, the higher degree of cleaning shall apply.
- B. Conform workmanship for metal surface preparation to current SSPC Standards and this Section.
- C. Remove oil, grease, welding fluxes and other surface contaminants by solvent cleaning per SSPC-SP1 prior to blast cleaning.
- D. Round or chamfer sharp edges and ground smooth burrs, surface defects, and weld splatter prior to blast cleaning.
- E. Select the type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasives for submerged and severe service coating systems shall be clean, hard, sharp cutting crushed slag.
- F. Do not reuse abrasives unless otherwise approved by the ENGINEER. Maintain clean oil-free abrasives for automated shop blasting systems.
- G. Comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.
- H. Supply compressed air for air blast cleaning at adequate pressure from well-maintained compressors equipped with oil/moisture separators that remove at least 95 percent of the contaminants.
- I. Clean surfaces of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.
- J. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
- K. Remove damaged or defective coating by the specified blast cleaning to meet the clean surface requirements before recoating.
- L. Use the SSPC-SP2, hand tool cleaning, or SSPC-SP3, power tool cleaning, if the specified abrasive blast cleaning will damage adjacent work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service.
- M. Remove shop applied coatings of unknown composition before the specified coatings are applied. Examine valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment for the presence of shop-applied temporary coatings. Remove temporary coatings by solvent cleaning per SSPC-SP1 before starting the abrasive blast cleaning work.
- N. Solvent clean shop primed equipment in the field before applying finish coats.

3.5 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS

- A. General: Remove grease, oil, heavy chalk, dirt, or other contaminants by solvent or detergent cleaning prior to abrasive blast cleaning. Determine the generic type of the existing coatings by laboratory testing.
- B. Abrasive Blast Cleaning: Perform the degree of cleaning as specified in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not specified in the schedule, remove deteriorated coatings by abrasive blast cleaning to SSPC-SP6. Clean areas of tightly adhering coatings per SSPC-SP7 with the remaining thickness of existing coating not to exceed 3 mils.
- C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings, apply intermediate coatings per the paint manufacturer's recommendation for the specified coating system or remove the existing coating prior to abrasive blast cleaning. Conduct a small trial application for compatibility prior to painting large areas.
- D. Unknown Coatings: Remove coatings of unknown composition prior to application of new coatings. Dispose of removed material in accordance with local, state, and federal regulations.

3.6 WORKMANSHIP

- A. Use skilled craftsmen and experienced supervision on Work. Certify a minimum of 5 years practical experience in applying the types of coatings specified.
- B. Use clean drop cloths. Clean, repair, and refinish damage to surfaces resulting from the Work to original or better condition.
- C. Apply coatings under dry and dust-free conditions. Produce an even film of uniform thickness. Ensure edges, corners, crevices, and joints have been thoroughly cleaned and receive an adequate thickness of coating material. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. Complete the hiding so that the addition of another coat would not increase the hiding. Ensure that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas and protect installations by drop cloths or other approved precautionary measures.

3.7 SHOP COATING REQUIREMENTS

- A. Unless otherwise indicated, shop-prime equipment items or parts of equipment not submerged in service and then finish coat in the field after installation with the specified or approved color. If the shop primer requires topcoating within a specified period of time, finish coat the equipment in the shop and then touch-up paint after installation.
- B. Except pumps and valves, perform surface preparation and coating work in the field to equipment or parts and surfaces of equipment that are submerged or inside an enclosed hydraulic structure when in service.
- C. For certain pieces of equipment it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the specified quality in the field. For such equipment, prime and finish coat in the shop and touch up in the field with the identical material after installation.
- D. For certain small pieces of equipment the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawings submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.
- E. Protect shop painted surfaces during shipment and handle by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Do not expose primed surfaces to weather for more than 2 months before topcoated or less time if recommended by the coating manufacturer.

- F. Repair damage to shop-applied coatings in accordance with this Section and the coating manufacturer's instructions.
- G. Ensure that shop primers and field topcoats are compatible and comply with these Specifications.

3.8 APPLICATION OF COATINGS

- A. Apply protective coatings to steel substrates in accordance with SSPC-PA1.
- B. Inspect cleaned surfaces and coats prior to each succeeding coat. Schedule such examinations with the Engineer in advance.
- C. Paint blast cleaned ferrous metal surfaces before reusing or other deterioration of the surface occurs. Limit blast cleaning to only those surfaces that can be coated in the same working day.
- D. Apply coatings in accordance with the manufacturer's instructions and recommendations, and this Specification, whichever has the most stringent requirements.
- E. Ensure sufficient film thickness is applied to edges, angles, weld seams, flanges, nuts and bolts. Stripe paint these areas.
- F. Ensure sufficient film thickness to materials that will be joined so closely that proper surface preparation and application are not possible. Coat such contact surfaces prior to assembly or installation.
- G. Apply finish coats, including touch-up and damage repair coats, in a manner that will present a uniform texture and color matched appearance.
 - 1. Abrasive blast clean and prime steel piping before installation.
 - 2. Apply the finish coat on Work after concrete, masonry, and equipment installation is complete and the Work areas are clean and dust free.
- H. Do not apply coatings under the following conditions:
 - 1. Temperature exceeding the manufacturer's recommended maximum and minimum allowable.
 - 2. Dust or smoke laden atmosphere.
 - 3. Damp or humid weather.
 - 4. When the substrate or air temperature is less than 5 degrees F above dewpoint.
 - 5. When air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dewpoint within 8 hours after application of coating.
 - 6. Determine dewpoint by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychrometric tables.
 - 7. Steel piping shall be abrasive blast cleaned and primed before installation.
 - 8. The finish coat on all Work shall be applied after all concrete, masonry, and equipment installation is complete and the Work areas are clean and dust free.

3.9 CURING OF COATINGS

- A. Provide curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Specification, whichever is the highest requirement, prior to placing the completed coating system into service.
- B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.10 COATING SYSTEM SCHEDULES

- A. Coating System Schedule, Ferrous Metal

Item	Surface Prep	System No
Piping and miscellaneous metals in vaults, valve operators and operator extensions, interior face of blind flanges, etc.	White metal blast cleaning SSPC-SP5	100 polyamide cured epoxy
Above grade exterior piping, pipe bollards	White metal blast cleaning SSPC-SP5	105 polyurethane enamel
Buried ductile iron pipe and fittings, buried galvanized pipe, buried pipe couplings and pipe restraint, buried valves, and flanged joints, including epoxy-coated surfaces.	As specified by reference specification	205 polyethylene encasement
Buried steel casing pipes installed via open cut methods	Near white metal blast cleaning SSPC-SP10	103 MIO Polyurethane
Where specified, buried ductile iron fittings, ferrous surfaces in water passages, submerged surfaces, butterfly valves, gate valves, air/vac valves, dismantling joints, and sleeve-couplings.	White metal blast cleaning SSPC-SP5	106 fusion-bonded epoxy
Buried surfaces that are not specified to be coated elsewhere.	Near white metal blast cleaning SSPC-SP10	100 amine-cured epoxy
Buried steel pipe and fittings, including outlets, blind flanges, and mating flanges.	Solvent Cleaning SSPC-SP1 Commercial Blast Cleaning SSPC-SP6	201-polyurethane

B. Coating System Schedule, Non-Ferrous Metal

Item	Surface Prep	System No
Aluminum in contact with concrete surfaces	SSPC-SP1	270 - Bituminous Paint

END OF SECTION

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SECTION 09 90 05

POLYURETHANE COATING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The Work of this section includes the materials, installation, and testing of a polyurethane pipe coating system.
- B. Except as described in this section, the coating system shall be in accordance with ANSI/AWWA C222 for straight pipe sections and fittings and ANSI/AWWA C216 for specials and field joints.
- C. Related Requirements: Include, but are not necessarily limited to:
 - 1. Section 33 05 24 – Steel Utility Piping

1.2 REFERENCES

- A. Commercial Standards
 - 1. AWWA C216, Heat-Shrinkable, Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
 - 2. AWWA C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
 - 3. AWWA C222, Polyurethane Coatings for Interior and Exterior of Steel Water Pipe and Fittings.
 - 4. AWWA C604, Installation of Steel Water Pipe 4-inches and Larger.
 - 5. ASTM D4541, Standard Test Method for Pull Off Strength of Coatings Using Portable Adhesion Testers.
 - 6. NACE SP-0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates
 - 7. Society for Protective Coatings (SSPC):
 - a. SP-1, Solvent Cleaning Surface Preparation.
 - b. SP-2, Hand Tool Cleaning Surface Preparation.
 - c. SP-3, Power Tool Cleaning Surface Preparation.
 - d. SP-6, Commercial Abrasive Blast Surface Preparation.
 - e. SP-10, Near White Metal Abrasive Blast Surface Preparation.
 - f. PA-2, Measurement of Dry Coating Thickness with Magnetic Gages

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Section 01 33 00, Submittal Procedures.
- B. Action Submittals
 - 1. Coating manufacturer certifications:
 - a. Shop applied coating system applicator is an approved applicator.
 - b. Shop applied coating system applicator's equipment meets the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings.
 - c. Shop applied coating system applicator's personnel are trained by the coating manufacture in the application and use of equipment for the coating material being applied. Identify the shop applied coating system applicator personnel certified by the coating manufacturer.

2. Certification of training from the heat shrink sleeve coating manufacturer or steel pipe manufacturer for exterior field coating of pipe joint applicators. Provide list of certified personnel proposed to be utilized on this project. Certification shall be effective within 12 months of starting the exterior field coating application.
3. Catalog cuts and other manufacturer's information for materials provided on a system-by-system basis.
4. Safety Data Sheet's (SDS), the manufacturer's technical data sheets, and paint colors available (where applicable) for each product used in coating system.
5. Technical and performance information that demonstrate coating system materials compliance with Specification.
6. Manufacturer's coating application quality assurance manual prior to beginning coating application.
7. Weld After Backfill Plan (if WAB is proposed for use), including, at a minimum:
 - a. Heat shrinkable sleeve manufacturer, model, and underlayment, if any.
 - b. Special installation techniques required for this application, including, at a minimum:
 - 1) Low heat welding procedure, including welding process, welding materials, number of passes, voltage, amperage, travel speed, and calculated heat input.
 - 2) Method of measuring pipe wall temperature.
 - 3) Method of controlling heat flow through pipe joint gap.
 - c. Written concurrence from heat shrinkable sleeve manufacturer of the Weld After Backfill Plan.
 - d. Names of previously completed projects and contact information where this product(s) and method(s) have been successfully used for this type of application.

1.4 QUALITY ASSURANCE

- A. Shop Applied Coating System Applicator's Experience and Certification: Coating applicator shall have not less than 5 years successful experience applying AWWA C222 polyurethane coating on AWWA C200 steel pipe and fittings. Coating applicator shall be certified by the coating manufacturer as an approved applicator. Coating applicator's personnel shall be trained in the coating material being applied by the coating manufacturer. Shop equipment shall be certified by the coating manufacturer to meet the requirements for material mixing, temperature control, application rate, and ratio control for multi-part coatings. Equipment not meeting the coating manufacturer's written requirements will be rejected for coating application until repairs or replacement of the equipment is made to the satisfaction of the coating manufacturer and Engineer.
- B. The coating manufacturer shall provide a qualified technical representative, employed by the coating manufacturer, at the shop applied coating facility for 1 day, minimum, at the start of coating application. During this visit, the manufacturer's representative shall conduct inspections as required to ensure that coating application is in conformance with their recommended methods and conditions.
- C. Additional visits by the manufacturer's representative shall be made at sufficient intervals during surface preparation and coating application as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions, and as may be necessary to resolve problems attributable to, or associated with, manufacturer's products furnished for this Project.
- D. Heat Shrink Sleeve Field Coating Applicator's Certification or Experience: Heat shrink sleeve field coating applicators shall be certified and trained by the heat shrink sleeve coating manufacturer or steel pipe manufacturer, if the steel pipe manufacturer is qualified by the heat shrink sleeve coating manufacturer.
 1. Furnish heat shrink qualified technical representative on-site at beginning of field coating operations and as necessary to resolve field problems for technical support and to inspect that heat shrink installation is in accordance with manufacturer's recommendations.

2. Furnish heat shrink qualified technical representative on-site at the demonstration of the Weld After Backfill procedure and as necessary to resolve field problems for technical support and to inspect that heat shrink installation is in accordance with manufacturer's recommendations.
- E. Provide the Engineer a minimum of 7 days advance notice of the start of any shop coating work and a minimum of 3 days advance notice for field work.
- F. Inspection Devices: Furnish inspection devices that are calibrated and in good working condition for the detection of holidays and measurement of coating film thickness.
- G. Inspection: At a minimum, tests shall include holiday detection, adhesion testing, and coating film thickness. Perform adhesion testing on each pipe coated during the first full day of coating application and as requested by the Engineer if surface preparation or coating application is suspect.
- H. Perform complete holiday detection of field coatings and repair defects.
- I. Immediately before the coated pipe is lowered into the trench, provide a visual and field electrical holiday inspection of the pipe coating as specified in Paragraph 3.9.
- J. Provide a log of visual and electric holiday inspections.

1.5 DELIVERY, HANDLING, AND STORAGE

- A. Handle pipe in accordance with AWWA C222 and in such a manner as to protect the pipe and coating from damage.
- B. Do not install coated pipe until the coating has developed full adhesion and cure.
- C. Take precaution during coating application, storage, loading, transportation, unloading, laying and installation to protect and prevent damage to pipe and coating. Lift pipe in accordance with AWWA C604 and pipe manufacturer's instructions in a manner that will not damage the coating. Metal chains, cable, tongs, forklifts or other equipment likely to damage the coating will not be permitted. Dragging or skidding of pipe on grade or in the trench will not be permitted.
- D. Provide transportation vehicles with padded bolsters between each layer of pipe and heavy padding under load ties. Bolsters shall be curved to fit the outside of the pipe and 12 inches wide, minimum. Heavily pad pipe contact locations with carpet during shipment to the Project Site and from the storage yard to the point of installation.
- E. Do not store pipe on rocks, gravel, or other hard materials that might damage the coating. Provide padded 12 inch wide skids and chucks, sand bags, select loamy or sand berms, or suspended from cutback ends, where possible, to minimize coating damage. Do not lay pipe on asphalt without suitable padding at contact points.
- F. Inspect pipe at the Project Site for damage. Repair damage to the pipe or coating as directed if, in the opinion of the Engineer, a satisfactory repair can be made; otherwise, replace the damaged section at the sole expense to the Contractor.
- G. No metal tools or heavy objects shall be permitted to come into contact unnecessarily with the finished coating. Workmen shall not be permitted to walk on the coating except when absolutely necessary and approved by the Engineer. When permitted, use shoes with rubber or composition soles and heels or other suitable footwear that will not damage coating.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Store, handle, and apply coatings per the manufacturer's written directions. Clean and coat exterior pipe surfaces in accordance with referenced AWWA Standards, written directions of the coating manufacturer, and these Specifications, whichever is more stringent. Prepare other surfaces to be coated as required for steel pipe, as applicable.
- B. Provide polyurethane coating from a single manufacturer. Substitutions will not be permitted.

2.2 EXTERIOR SHOP APPLIED COATINGS

A. Plural Component Polyurethane

1. Apply plural component polyurethane coating system (referred to hereafter as polyurethane system) in accordance with AWWA C222, except as modified herein.
2. Coating: Self-priming, plural component, 100 percent solids, polyurethane, suitable for burial or immersion, and the product of one of the following approved manufacturers:
 - a. The Sherwin Williams Company
 - b. LifeLast Incorporated
 - c. Carboline Company
 - d. Chemline Inc

B. Coating Thickness

1. Exterior Surface: Minimum 30 mil DFT
2. Application Requirements per AWWA C222.4.5.
3. Quality control per AWWA C222.5.5.

2.3 FIELD EXTERIOR JOINT COATING

A. Field coat pipe joints with heat shrink sleeves after pipe assembly in accordance with Section 33 05 24 and AWWA C216. Heat Shrinkable Sleeves:

1. Filler Tape: Extruded butyl rubber compound compatible with heat shrink sleeve. Polyken 939 or approved equivalent.
2. See Section 33 05 24.

2.4 FIELD REPAIR OF COATINGS

A. General

1. Field coating shall be compatible with the shop-applied coating system or shall be provided by the same manufacturer.
2. Apply coating to field joints using only personnel trained by the field coating manufacturer or steel pipe manufacturer.

B. Polyurethane Coating

1. Repair polyurethane coating system in accordance with the coating manufacturer's recommended procedures.
2. Coating material for repairs greater than 6 inches diameter shall be the same as the existing coating, or for repairs less than 6 inches diameter, repair coating as recommended by the polyurethane coating manufacturer, subject to Engineer approval. Repair coating shall have adhesion and performance characteristics equal to the existing coating.

2.5 FIELD COATING OF ACCESS MANWAYS, COUPLINGS, AND FLANGES

- A. Field coat buried access manways, flanges and couplings with wax tape in accordance with AWWA C217. Apply manufacturer's filler to eliminate voids and provide smooth surfaces for tape.
- B. Field coat flanges and blind flanges in accordance with Specification Section 09 90 04, Painting, System No. 105, and wax tape in accordance with AWWA C217. Apply manufacturer's filler to eliminate voids and provide smooth surface for tape.

PART 3 - EXECUTION

3.1 GENERAL

- A. Inspect and provide substrate surfaces prepared in accordance with these Specifications and the printed directions and recommendations of coating manufacturer whose product is to be applied.

3.2 ENVIRONMENTAL CONTROLS

A. General

1. Provide heating, cooling, or dehumidification equipment as required to meet the surface preparation and coating application environmental requirements as specified and recommended by the coating manufacturer.
2. Products shall comply with federal, state, and local requirements limiting the emission of volatile organic compounds and worker exposure.
3. Comply with applicable federal, state, and local, air pollution and environmental control regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, and coating application.
4. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.
5. Do not apply coatings when:
 - a. Surface and ambient temperatures exceeds the maximum or minimum temperatures recommended by the paint manufacturer or these Specifications,
 - b. In dust or smoke laden atmosphere, blowing dust or debris, damp or humid weather, or under conditions that could cause icing on the metal surface.
6. Where weather conditions or Project requirements dictate, provide and operate heaters and/or dehumidification equipment to allow pipe surfaces be abrasive blasted and coated as specified and in accordance with the manufacturer's coating application recommendations.

B. Temperature Control

1. When temperatures are above or below the coating manufacturer's recommended application temperatures, provide temperature controls to permit Work to proceed within the temperature limitations of the Project.
2. Heat with indirect fired heaters that do not increase humidity levels within the Work area. Size heaters for the area to be heated.
3. Provide tenting, baffles, or bulkheads as required to zone and control the heating or cooling effectiveness.

3.3 SHOP APPLIED COATING SYSTEM

A. General

1. Strict conformance to the requirements of the manufacturer's coating application manual will be required. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating. Remove rejected coating to bare metal and reapply using proper application methods in accordance with the quality assurance manual and the requirements of these Specifications.
2. Coating applied under improper environmental conditions will be rejected and removed to bare metal and reapplied under proper environmental conditions.
3. Pipes and other items that exceed the allowable quantity of coating defects, regardless of size or cause, shall be rejected and the coating removed to bare metal and recoated.

B. Surface Preparation

1. Remove visible oil, grease, dirt, and contamination in accordance with SSPC-SP1, solvent cleaning.
2. Remove surface imperfections such as metal slivers, burrs, weld splatter, gouges, or delaminations in the metal by filing or grinding prior to abrasive surface preparation.
3. In cold weather or when moisture collects on the pipe and the temperature of the pipe is less than 45 degrees F, preheat pipe to a temperature above 50 degrees F and 5 degrees F above dew point.

4. Clean pipe by abrasive blasting with a mixture of steel grit and shot to produce the surface preparation cleanliness as specified. Clean recycled abrasive of debris and spent abrasive.
5. Protect prepared pipe from humidity, moisture, and rain. Keep pipe clean, dry, and free of flash rust. Remove flash rust, imperfections, or contamination on cleaned pipe surface by reblasting prior to primer application.
6. Complete priming and coating of pipe the same day as surface preparation.
7. Surface Preparation: SSPC-SP10, Near White Metal blast, 3.0 mil profile, minimum, or as required by the manufacturer, whichever is greater.

C. Polyurethane Coating Application

1. Maintain pipe temperature in accordance with coating manufacturer's recommendation. Perform coating application in an environmentally controlled area that meets or exceeds the written environmental application requirements of the coating manufacturer.
2. Thickness: Additional thickness may be required to pass the holiday and coating defects limitations as specified in this section.
3. Test coating adhesion and holiday testing as specified in this section.
4. Complete coating repairs as specified in this section.

D. Holdbacks and Cutbacks

1. 6 inches, or as shown on the drawings, whichever is greater.
2. Make coating cutbacks or holdbacks straight and cut through the full thickness of the coating. Complete cutbacks in a manner that permits field coating of joints in accordance with the manufacturer's recommendations and as specified herein.

3.4 FIELD COATING OF PIPE JOINTS - EXTERIOR

- A. Coat exterior pipe joints with heat-shrinkable sleeves in accordance with Section 33 05 24 , AWWA C216 and as specified herein. Apply heat shrinkable sleeves to field joints using personnel trained by the heat shrink manufacturer or steel pipe manufacturer.
 1. Prepare pipe surface as follows:
 - a. Adhere to OSHA and EPA regulations and coating manufacturer's recommendations for surface preparation and coating application.
 - b. Power tool clean in accordance with SSPC-SP3 for shop blasted surfaces that have been coated with storage primer.
 - c. Hand tool clean areas to be coated in accordance with SSPC-SP2 that cannot be cleaned with power tool cleaning.
 - d. Solvent clean surfaces to be coated in accordance with SSPC-SP1.
 - e. Remove burrs, sharp edges, and weld spatter prior to abrasive blasting.
 2. Apply filler tape at lap joints, step downs, and other discontinuities. Lap joints containing 1:1 sloped full fillet welds do not require filler tape.
 3. Fit coating material to area as recommended by manufacturer based on type and recovery of material.
 4. Shrink the coating material to tightly conform to pipe joint and overlap shop coating using manufacturer's recommended heat sources and methods.
- B. Completely remove and replace finish coatings having wrinkles, gaps, holes, or burns until acceptable coverage is achieved.
- C. Coating application is prohibited when there is water or slurry in bell holes.
- D. Holiday Testing
 1. Clean and dry the pipe surface when tested.
 2. To avoid damage to the coating, the electrode should always be kept in motion while test voltage is being applied. Always keep the electrode in firm contact with the coated surface. Move the electrode in an even manner over the surface at an approximate rate of 0.5 to 1

foot of travel per second. Do not exceed 1 foot of travel per second as the maximum rate of speed during holiday testing.

3. Mark location of detected holidays for repair. Retest after repair.

E. Comply with the special requirements of the Weld After Backfill Plan.

3.5 FIELD REPAIR OF COATING

A. General

1. Repair areas where holidays are detected or coating is visually damaged, such as blisters, tears, rips, bubbles, wrinkles, cuts, or other defects. Repair areas where no holidays are detected, but are visually damaged.
2. Clean area to be repaired for a minimum distance of 6 inches in all directions from the damaged area by solvent wiping.

B. Polyurethane Coating Repairs

1. Complete shop and field coating repairs in accordance with the manufacturer's written instructions and these Specifications, whichever is more stringent.
2. Unless otherwise accepted by Engineer, do not provide coating repairs on any joint of pipe greater than an average of 2 per 100 square feet of surface area per joint of pipe or an individual defect greater than 6 inches in diameter. Holidays within a 4 inch radius of a holiday shall be counted as a single holiday.
3. Unless otherwise accepted by Engineer, blast pipes exceeding the maximum number or size of coating defects to bare metal and recoat.
4. Unless otherwise accepted by Engineer, pipe arriving in the field with defects or repairs exceeding the maximum number or size of coating defects will be returned to the shop for recoating at no additional cost to the Owner.
5. Repair surface defects, that do not expose the metal substrate by power tool sanding with coarse sandpaper to roughen the coating surface and feathering the edges of the defect for a minimum of 3 inches around the defect. Apply a single coat of the specified patch coating material to a properly prepared surface at the specified coating thickness.
6. Prepare deep defects, defined as defects which penetrate to the metal substrate or expose the metal substrate to the metal substrate by power tool sanding to expose the metal and feather the coating edges a minimum of 6 inches. Reblast the metal surface and surrounding coating to equal cleanliness and profile as the original surface preparation. Roughen existing coating to the equivalent of coarse sandpaper by abrasive blasting. Apply one coat of the specified coating material over the repaired surface at the specified thickness.

3.6 WAX TAPE COATING INSTALLATION

A. Coat bolts and nuts of all buried or exposed flanges, blind flanges, couplings, dismantling joints, etc. with three-part, cold-applied wax tape coating system consisting of primer, wax tape, and tape outerwrap.

B. Wax Tape Application

1. Ensure surfaces are free from loose rust, scale, paint, dirt, and other foreign matter in accordance with SSPC-SP2.
2. Apply primer by hand or brush to surfaces to be coated. Work primer into crevices, around studs and nuts, and completely cover exposed metal surfaces.
3. Extend primer a minimum of 3-inches onto adjacent surfaces of the pipe.
4. Apply wax tape immediately after primer application.
 - a. Cut short lengths of tape and place around each bold head and nut.
 - b. Work tape into crevices around studs and nuts.
 - c. Cover entire primed area with wax tape using minimum overlap of 55% of tape width.

- d. Work tape into crevices and contours of irregular shaped surfaces and smooth out to obtain continuous protective layer with no voids or spaces under tape.
5. Apply tape outerwrap to wax tape installation. Extend plastic wrap a minimum of 3-inches beyond wax tape using a minimum overlap of 55% of plastic material width to apply two layers of overwrap.

3.7 SHOP QUALITY CONTROL

A. General

1. Owner may conduct additional quality assurance inspection and testing for final acceptance of the pipeline coatings. Coating repairs for quality assurance testing shall be repaired by the applicator as specified herein.

B. Adhesion Testing

1. Provide a minimum of four adhesion tests on four separate pipe joints for every production day.
2. Repair coating damage from adhesion testing.
3. Perform adhesion tests not less than 24 hours after coating application.
4. Pipe joints will be randomly selected for adhesion testing. If any one of the pipe joints tested fails the adhesion test, two additional tests shall be performed on that pipe joint. If any one of the additional tests fails, that pipe joint shall be rejected. An additional two pipe joints from that day's production shall be tested for every rejected pipe joint.
5. Polyurethane coatings shall have an adhesion to steel of 1,500 pounds per square inch, minimum.
6. Test polyurethane coating adhesion to steel substrates using pneumatic pull off equipment, such as HATE equipment or equal, in accordance with ASTM D4541 and AWWA C222, except as modified in this section.
7. Glue dollies for adhesion testing to the coating surface and allow to cure for a minimum of 12 hours. Score coating around the dolly prior to conducting the adhesion test. Dollies shall be concave or convex to fit the pipe surface on any pipe less than 30 inches in diameter.
8. Failure shall be by adhesive failure only. Adhesive failure is defined as separation of the coating from the steel substrate on over 20 percent of the bonded surface. Glue failures in excess of the minimum required tensile adhesion are acceptable as meeting the specified adhesion requirements.
9. Randomly select repair patches on the polyurethane coating for adhesion testing in a manner as described herein and at the discretion of the person conducting the adhesion tests. Inter coat adhesion of repairs shall be not less than 50 percent of the specified polyurethane coating adhesion requirements to steel.

C. Holiday Testing

a. Polyurethane Coatings

- i. Conduct holiday tests on the completed coating in accordance with coating manufacturer's recommendation.
 - 1) Perform holiday testing in accordance with AWWA C222-25..
 - 2) Use the average dry film thickness testing results to determine the coating thickness used for holiday testing.

D. Dry Film Thickness Testing: Per AWWA C222.

3.8 FIELD QUALITY CONTROL

- A. Provide a visual and field electrical holiday inspection of the pipe coating immediately before the coated pipe is lowered into the trench.

B. Weld After Backfill Inspection and Testing

1. Prior to beginning pipe laying of each wall thickness, demonstrate the performance of the weld after backfill method.

2. Using test pipe of same thicknesses as project pipe, install the pipe, heat shrinkable sleeve, and weld the joint in accordance with these specifications and the Weld After Backfill Plan. Prior to welding, install bedding, pipe zone, and trench backfill in accordance with these specifications to simulate anticipated field conditions. Excavate joint and test, including destructive tests, the heat shrinkable sleeve to demonstrate compliance with AWWA C216. Specific testing to include:
 - a. Visual inspection: No burns or excessive wrinkles.
 - b. Holiday Test: Zero holidays.
 - c. Adhesion: No areas of disbonded coating.
 3. Perform successful demonstration test on each pipe wall thickness on the project.
 4. East welder must successfully pass the above demonstration test.
 5. Engineer will select production joints to be excavated and tested and may require destructive testing if visual or electrical holiday test indicates a compromised coating.
 6. Upon completion of testing, repair joint coating and install specified pipe zone and trench zone backfill materials.
- C. Electrical Coating Inspection
1. Electrically test field applied coatings and pipe coating repairs with a portable high-voltage holiday detector. Test areas as directed by the Engineer. Provide equipment and conduct testing in accordance with AWWA C222, and the coating manufacturer's written directions for type and thickness of coating being tested. Furnish one portable high-voltage detector for each pipe laying crew.
 2. The voltage setting shall adhere to manufacturer's recommended setting or a minimum voltage of 100 volts per mil of the average coating thickness, which is greater.
 3. Provide the type of detector with the minimum and maximum voltage setting, inspection speed, and holiday detector electrode type (wire brush or electrically conductive silicone or coil spring) as recommended by the coating manufacturer for the coating type and thickness being tested. Maintain the holiday test equipment in good working condition per detector manufacturer's recommendations.
 4. Adjust the holiday detector during testing to the correct voltage setting and operate in accordance with holiday detector manufacturer recommendations. Recheck voltage setting at start of each day and a minimum of two times during the day and when requested by Engineer.
 5. Provide the holiday detector with an audible signal when electrical contact is made between the pipeline and the electrode at holidays (defects) in the coating. Provide a good ground and a low electrical resistance between the holiday detector and the pipeline. Make only direct connections to uncoated areas or to the pipe ends at the pipe joint cut back areas.
 6. Clean and dry the pipe surface when testing. To avoid damage to the coating, the electrode always be kept in motion while test voltage is being applied. Always keep the electrode in firm contact with the coated surface. Move the electrode in an even manner over the surface at an approximate rate of 0.5 to 1 foot of travel per second. Do not exceed 1 foot of travel per second as the maximum rate of speed during holiday testing.
 7. Mark location of detected holidays for repair. Retest after repair.

END OF SECTION

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DIVISION 10

SPECIALTIES



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SECTION 10 14 00
IDENTIFICATION DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tag, tape and stenciling systems for equipment, piping, valves, and similar items.
 - 2. Underground Utility Marking Tape
 - 3. Utility Locate Ball Markers
 - 4. Utility Marker Posts
 - 5. Underground Tracer Wire.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 31 23 33 - Utilities - Trenching and Backfilling

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. A13.1, Scheme for the Identification of Piping Systems.
 - 2. The International Society of Automation (ISA).
 - 3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
 - a. Z535.1, Safety Color Code.
 - b. Z535.2, Environmental and Facility Safety Signs.
 - c. Z535.3, Criteria for Safety Symbols.
 - d. Z535.4, Product Safety Signs and Labels.
 - 4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 5. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Catalog information for all identification systems.
 - b. Acknowledgement that products submitted meet requirements of standards referenced.
 - 2. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.
 - 3. Schedule of Hazard and Safety Signage indicating text and graphics.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. W.H. Brady Co.
 - 2. Panduit.

3. Seton.
4. National Band and Tag Co.
5. Carlton Industries, Inc.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:

1. Materials:
 - a. Aluminum or stainless steel.
 - b. Stainless steel shall be used in corrosive environments.
2. Size:
 - a. Diameter: 1-1/2 inches minimum.
 - b. Thickness: 0.035 inches (20 GA) minimum.
3. Fabrication:
 - a. 3/16 inches minimum mounting hole.
 - b. Legend: Stamped and filled with black coloring.
4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:

1. Materials: Stainless steel.
2. Size:
 - a. 3-1/2 inches x 1-1/2 inches minimum.
 - b. Thickness: 0.036 inches (20 GA) minimum.
3. Fabrication:
 - a. 3/16 inches minimum mounting hole.
 - b. Legend: Stamped and filled with black coloring.
4. Color: Natural.

C. Type A3 - Metal Tape Tags:

1. Materials: Aluminum or stainless steel.
2. Size:
 - a. Width 1/2 inches minimum.
 - b. Length as required by text.
3. Fabrication:
 - a. 3/16 inches minimum mounting hole.
 - b. Legend: Embossed.
4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:

1. Materials: Fiberglass reinforced plastic.
2. Size:
 - a. Surface: 2 x 2 inches minimum.
 - b. Thickness: 100 mils.
3. Fabrication:
 - a. 3/16 inches mounting hole with metal eyelet.
 - b. Legend: Preprinted and permanently embedded and fade resistant.
4. Color:
 - a. Background: Manufacturer standard or as specified.
 - b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:

1. Materials: Fiberglass reinforced or durable plastic.
2. Size:
 - a. Surface: As required by text.
 - b. Thickness: 60 mils minimum.
3. Fabrication:
 - a. Rounded corners.
 - b. Drilled holes in corners with grommets.
 - c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
4. Color:
 - a. Background: Manufacturer standard or as specified.
 - b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Laminated Name Plates:

1. Materials: Phenolic or DR (high impact) acrylic.
2. Size:
 - a. Surface: As required by text.
 - b. Thickness: 1/16 inches.
3. Fabrication:
 - a. Outdoor rated and UV resistant when installed outdoors.
 - b. Two layers laminated.
 - c. Legend: Engraved through top lamination into bottom lamination.
 - d. Two drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:

1. Materials: Vinyl tape or vinyl cloth.
2. Size:
 - a. Surface: As required by text.
 - b. Thickness: 5 mils minimum.
3. Fabrication:
 - a. Indoor/Outdoor grade.
 - b. Weather and UV resistant inks.
 - c. Permanent adhesive.
 - d. Legend: Preprinted.
 - e. Wire markers to be self-laminating.
4. Color: White with black lettering or as specified.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:

1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
 - a. Legend: Preprinted.

4. Color: White background, black printing.
- I. Type F - Stenciling System:
 1. Materials:
 - a. Exterior type stenciling enamel.
 - b. Either brushing grade or pressurized spray can form and grade.
 2. Size: As required.
 3. Fabrication:
 - a. Legend: As required.
 4. Color: Black or white for best contrast.
 - 5.
- J. Underground Pipeline Marking Tape:
 1. Materials: Polyethylene.
 2. Size:
 - a. 6 inches wide (minimum).
 - b. Thickness: 3.5 mils.
 3. Fabrication:
 - a. Legend: See Section 31 23 33.
 - b. Message continuous printed.
 - c. Tensile strength: 1750 psi.
 4. Color: As specified.
- K. Utility Locate Ball Markers
 1. General:
 - a. Provide ball type markers capable of precisely locating the underground waterline.
 - b. Provide self-leveling ball resulting in accurate horizontal positions regardless of ground placement.
 - c. Ball shall be capable of accurate locating when using a 3M Dynatel Locator.
 - 1) The marker shall return a signal to the locator, indicating the marker's exact position.
 - 2) Locator shall indicate presence of the utility with both a visual and audible tone.
 - d. Acceptable Manufacturers:
 - 1) 3M™ Electronic Marker System (EMS) 1403 Water XR.
 - e. Design:
 - 1) 4" Diameter ball.
 - 2) Color: Blue
 - 3) Provide passive antenna encased in water-resistant polyethylene shell
 - 4) Must work without any external power source
 - 5) Extended range capability:
 - a) Passive detection range: 5 feet, minimum
- L. Utility Marker Posts
 1. General:
 - a. UV stabilized fiberglass composite material.
 - b. Nominal 4" width
 - c. Designed for 2-sided message stickers
 - d. Color: Blue
 - e. Thickened outer edges and central section for rigidity.

- f. Height above grade and bury depth as shown on drawings
- g. Custom utility information detail decal, one each side, as shown on drawings
- h. Anchor barb as shown on drawings
- i. Acceptable Manufacturers:
 - 1) Carsonite – Tuff-Flex CTFM or approved equal.

M. Underground Tracer Wire:

- 1. Materials:
 - a. Wire:
 - 1) 12 GA AWG.
 - 2) Solid.
 - b. Test Station
 - 1) Copperhead Industries Snakepit Test Station or approved equal.
 - 2) Blue lid
 - 3) Wire nuts: Waterproof type.
 - 4) Split bolts: Brass.

2.3 ACCESSORIES

A. Fasteners:

- 1. Bead chain: #6 brass, aluminum or stainless steel.
- 2. Plastic strap: Nylon, urethane or polypropylene.
- 3. Screws: Self-tapping, stainless steel.
- 4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

- A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Install identification devices at specified locations.
- B. All identification devices to be printed by mechanical process, hand printing is not acceptable.
- C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.
- D. Attach tags with 1/8 inches round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.
 - 1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.
- E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.
 - 1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

3.2 SCHEDULES

A. Process Systems:

- 1. General:
 - a. Provide arrows and markers on piping.
 - 1) At 20 feet maximum centers along continuous lines.

- 2) At changes in direction (route) or obstructions.
- 3) At valves, risers, "T" joints, machinery or equipment.
- 4) Where pipes pass through floors, walls, ceilings, cladding assemblies and like obstructions provide markers on both sides.
- b. Position markers on both sides of pipe with arrow markers pointing in flow direction.
 - 1) If flow is in both directions use double headed arrow markers.
- c. Apply tapes and stenciling in uniform manner parallel to piping.
2. Trenches with piping:
 - a. Tracer Wire:
 - 1) Attach to pipe at a maximum of 10 feet intervals with tape.
 - 2) Install adjacent to fiber optic conduit
 - 3) Terminate at test stations next to fiber optic pull boxes.
 - 4) Continuous pass from each valve box and above grade at each structure.
 - 5) Coil enough wire at each test station or valve box to extend wire a foot above the ground surface.
 - 6) 1,000 feet maximum spacing between test stations.
 - 7) If split bolts are used for splicing, wrap with electrical tape.
 - 8) If wire nuts are used for splicing, knot wire at each splice point leaving 6 inches of wire for splicing.
 - 9) Use continuous strand of wire between test stations where possible.
 - a) Continuous length shall be no shorter than 100 feet.
 - b. Underground Warning Tape
 - 1) Location: See trench details on Drawings.
 - 2) Letter height: 1-1/4 inches minimum.
 - 3) See Section 31 23 33 for legend and colors
 - c. Utility Locate Ball Markers
 - 1) Location:
 - a) Approximately 3 ft below grade
 - b) Spaces at 250 on center for straight pipe runs
 - c) One directly above each horizontal deflection (elbow)
 - d) One at each right-of-way boundary crossing.
 - e) One at each buried manway
 - f) One at each buried fiber optic manhole
 - d. Utility Marker Posts
 - 1) Location:
 - a) As depicted on the drawings, and,
 - (1) One at each right-of-way boundary crossing.
 - (2) One at each manhole or vault
 - (3) One at each buried valve
 - (4) One at each blowoff vault
 - (5) One at each buried fiber optic manhole
 - 2) Install as depicted on the drawings and per manufacturer's instructions
3. Yard valves, buried, with valve box and concrete pad:
 - a. Tag type: Type A2 - Rectangle Metal Tags.
 - b. Fastener: 3/16 inches x 7/8 inches plastic screw anchor with 1 inch #6 stainless steel pan head screw.
 - c. Legend:

- 1) Letter height: 1/4 inches minimum.
- 2) Valve designation as indicated on the Drawings (e.g., "V-xxx").
4. Valves and slide gates:
 - a. Tag type:
 - 1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
 - 2) Indoor noncorrosive:
 - a) Type A1 - Round Metal Tags.
 - b) Type B1 - Square Nonmetallic Tags.
 - 3) Indoor corrosive:
 - a) Stainless steel Type A1 - Round Metal Tags.
 - b) Type B1 - Square Nonmetallic Tags.
 - b. Fastener:
 - 1) Type A1: Chain of the same material.
 - 2) Type B1: Stainless steel chain.
 - c. Color: Per ASME A13.1 corresponding to the piping system.
 - d. Legend:
 - 1) Letter height: 1/4 inches minimum.
 - 2) Valve designation as indicated on the Drawings (e.g., "V-xxx").
5. Process equipment (e.g., pumps, pump motors, blowers, air compressors, bar screens, clarifier drive mechanism, etc.):
 - a. Tag type:
 - 1) Type B2 - Nonmetallic Signs.
 - 2) Type D - Self-Adhesive Tape Tags and Signs.
 - 3) Type G - Stenciling System.
 - b. Fastener:
 - 1) Self.
 - 2) Screws.
 - 3) Adhesive.
 - c. Legend:
 - 1) Letter height: 1/2 inches minimum.
 - 2) Equipment designation as indicated on the Drawings (e.g., "Primary Sludge Pump P-xxx").
6. Piping systems:
 - a. Tag type:
 - 1) Outdoor locations: Type G - Stenciling System.
 - 2) Indoor locations:
 - a) Type D - Self-Adhesive Tape Tags and Signs.
 - b) Type G - Stenciling System.
 - b. Fastener: Self.
 - c. Color: Per ASME A13.1.
 - d. Legend:
 - 1) Letter height: Manufacturers standard for the pipe diameter.
 - 2) Mark piping in accordance with ASME A13.1.
 - 3) Use piping designation as indicated on the Drawings.
 - 4) Arrow: Single arrow.

B. Instrumentation Systems:

1. Instrumentation Equipment (e.g., flow control valves, primary elements, etc.):
 - a. Tag type:
 - 1) Outdoor locations: Type B1 - Square Nonmetallic Tags.
 - b. Fastener:
 - 1) Type A1: Chain of the same material.
 - 2) Type B1: Stainless steel chain.
 - c. Legend:
 - 1) Letter height: 1/4 inches minimum.
 - 2) Equipment ISA designation as indicated on the Drawings (e.g., "FIT-xxx").
 2. Enclosure for instrumentation and control equipment, (e.g., PLC control panels, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/2 inches minimum.
 - 2) Equipment name (e.g., "PLC CONTROL PANEL PCP-xxx").
 3. Components inside equipment enclosure, (e.g., PLC's, control relays, contactors, and timers):
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 3/16 inches minimum.
 - 2) Description or function of component (e.g., "PLC-xxx" or "CR-xxx").
 4. Through enclosure door mounted components (e.g., selector switches, controller digital displays, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 inches minimum.
 - 2) Component ISA tag number as indicated on the Drawings (e.g., "HS-xxx").
- C. Electrical Systems:
1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
 - a. Tag type: Type F - Underground Warning Tape.
 - b. Letter height: 1-1/4 inches minimum.
 - c. Location:
 - 1) Where trench is 12 inches or more below finished grade: In trench 6 inches below finished grade.
 - 2) Where trench is less than 12 inches below finished grade: In trench 3 inches below finished grade.
 - d. Electrical power (e.g., low and medium voltage):
 - 1) Color: Red with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION".
 - b) Second line: "BURIED ELECTRIC LINE BELOW".
 - e. Communications (e.g., telephone, instrumentation, LAN, SCADA):
 - 1) Color: Orange with black letters.
 - 2) Legend:

- a) First line: "CAUTION CAUTION CAUTION".
 - b) Second line: "BURIED COMMUNICATION LINE BELOW".
- 2. Panelboards and transformers:
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height:
 - a) First line: 3/8 inches minimum.
 - b) Subsequent lines: 3/16 inches minimum.
 - 2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").
 - 3) Second line (panelboards only): System voltage and phase (e.g., "208/120V, 3PH").
 - 4) Third line:
 - a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
 - b) Include the building name or number if the source is in another building.
 - 5) Fourth line: Date installed (e.g., "INSTALLED JULY 20xx").
- 3. Safety switches, separately mounted circuit breakers and motor starters, VFD's, etc.:
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 inches minimum.
 - 2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").
 - 3) Second line:
 - a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").
 - b) The source of power room number is only required when there are multiple electrical rooms, if the source is in another building, the building name or number shall be used.
- 4. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/2 inches minimum.
 - 2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").
- 5. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):
 - a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 3/16 inches minimum.
 - 2) Description or function of component (e.g., "M-xxx", "CR-xxx" or "TR-xxx").
- 6. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):
 - a. Tag type: Type C - Phenolic Name Plates.
 - b. Fastener: Screws.
 - c. Legend:
 - 1) Letter height: 1/4 inches minimum.

- 2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., "HS-xxx").
7. Conductors in control panels and in pull or junction boxes where multiple circuits exist.
 - a. Tag type: Type D - Self-Adhesive Tape Tags or Type E - Heat Shrinkable Tape Tags.
 - b. Fastener: Self.
 - c. Tag conductor at both ends.
 - d. Legend:
 - 1) Letter height: 1/8 inches minimum.
 - 2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.
8. Conductors in handholes and manholes.
 - a. Tag type: Type A3 - Metal Tape Tags.
 - b. Fastener: Nylon strap.
 - c. Tag conductor at both ends.
 - d. Legend:
 - 1) Letter height: 1/8 inches minimum.
 - 2) Circuit number or wire number as scheduled on the Drawings.
9. Grounding conductors associated with grounding electrode system in accordance with the following:
 - a. Tag type: Type D - Self-Adhesive Tape Tags.
 - b. Fastener: Self.
 - c. Legend:
 - 1) Letter height: 1/8 inches minimum.
 - 2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").
10. Flash protection for switchboards, panelboards, industrial control panels and motor control centers:
 - a. Tag type: Type D - Self-Adhesive Tape Signs.
 - b. Fastener: Self.
 - c. Legend: Per NFPA 70.
11. Poles:
 - a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.
 - b. Fastener:
 - 1) Metal pole: Self.
 - 2) Wood pole:
 - a) Self mount tag on aluminum utility panel.
 - b) Panel thickness: 20 mils.
 - c) Two mounting holes.
 - d) Screw or nail panel to pole.
 - c. Color: Yellow with black letters.
 - d. Legend:
 - 1) Letter height: 1 inch minimum.
 - 2) Pole number as scheduled on the Drawings.

END OF SECTION



DIVISION 26

ELECTRICAL



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SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic requirements for electrical systems.
- B. Related Requirements:
 - 1. Section 03 15 19 - Anchorage to Concrete.
 - 2. Section 10 14 00 - Identification Devices.
 - 3. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 4. Section 26 05 33 - Raceways and Boxes for Electrical Systems.

1.2 REFERENCES

- A. Definitions
 - 1. For the purposes of providing materials and installing electrical work the following definitions shall be used.
 - a. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
 - b. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.
- B. Referenced Standards:
 - 1. Aluminum Association (AA):
 - a. ADM, Aluminum Design Manual.
 - 2. American Institute of Steel Construction (AISC):
 - a. Steel Construction Manual.
 - 3. American National Standards Institute (ANSI).
 - 4. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C2, National Electrical Safety Code (NESC).
 - 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 7. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. ICS 6, Industrial Control and Systems Enclosures.
 - 8. Underwriters Laboratories, Inc. (UL).
- C. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.
 - 1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.

2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination

1. Coordinate installation of the service transformer and metering with the serving utility.
 - a. The serving utility for this Project is Xcel Energy.
 - 1) Contact:
Breanna Kreager
970-225-7819
Breanna.N.Kreager@xcelenergy.com.
 - b. Provide the transformer secondary conduit and wire, meter socket, space on the electrical equipment enclosure for mounting of the meter, a 1-inch conduit from the meter socket to the service disconnect and a 1-inch conduit from the cold-sequence disconnect to the meter socket.
 - c. The utility will furnish the transformer, primary service conduit and wire, meter to be mounted on the electrical equipment cabinet, and make all connections at the transformer primary, and meter.
 - 1) Coordinate the electrical equipment enclosure supplier and the utility for the meter socket.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Section 01 33 00 and individual specification sections for submittal requirements for products defined as equipment.
2. General requirements:
 - a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
 - b. Include data sheets that include manufacturer's name and product model number.
 - 1) Clearly identify all optional accessories.
 - c. Acknowledgement that products are NRTL listed or are constructed utilizing NRTL recognized components.
 - d. Manufacturer's delivery, storage, handling and installation instructions.
 - e. Product installation details.
 - f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
 - g. See individual specification sections for any additional requirements.
3. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Section.
4. Fabrication and/or layout drawings:
 - a. Concrete and reinforcing steel, per Division 03 requirements.
 - b. Provide a conductor identification schedule for all power, control, communication and protective circuits.
 - 1) Schedule to include the following information:
 - a) Conductor identification number.
 - b) Conductor size.
 - c) Number of conductors.
 - d) Type of conductor.
 - e) Size of conductor.

- f) Size of conductor usage descriptions.
 - g) Conductor run (to and from).
 - h) Conduit size and type.
 - c. Provide circuit schedules for all power, control, communication, and protective circuits.
 - 1) Include a detailed description, list of individual loads per circuit and a total estimated load per circuit.
- B. Operation and Maintenance Manuals:
 - 1. See Section 01 78 23 for requirements for:
 - a. The mechanics and administration of the submittal process.
 - b. The content process of Operation and Maintenance Manuals.
- C. When a Section includes products specified in another Section, each Section shall have the required Shop Drawing transmittal form per Section 01 33 00 and all Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

- A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
 - 1. Outdoor areas:
 - a. Wet.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, refer to specific Electrical Sections and specific material paragraphs below for acceptable manufacturers.
- B. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

- A. Electrical Equipment Support Pedestals and/or Racks:
 - 1. Manufacturers:
 - a. Modular strut:
 - 1) Unistrut Building Systems.
 - 2) B-Line by Eaton.
 - 3) Globe Strut.
 - 4) Superstrut by Thomas & Betts.
 - 2. Material requirements:
 - a. Modular strut:
 - 1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
 - 2) Stainless steel: AISI Type 316.
 - 3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.
 - 4) Aluminum: AA Type 6063-T6.
 - b. Structural members (e.g., I beams, L and C channels):
 - 1) Galvanized steel: ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
 - 2) Aluminum: AA Type 6061-T6 or 6063-T6.
 - c. Mounting plates:

- 1) Aluminum: AA Type 6063-T6.
 - d. Mounting hardware:
 - 1) Galvanized steel.
 - 2) Stainless steel.
 - e. Anchorage per Section 03 15 19.
 - f. Concrete and reinforcing steel: See Division 03 specifications.
- B. Equipment pads:
- 1. Concrete and reinforcing steel: See Division 03 specifications.
- C. Field touch-up of galvanized surfaces.
- 1. Zinc-rich primer.
 - a. One coat, 3.0 mils, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Maintain System Operation:
- 1. Comply with Section 01 14 16 – Coordination with Owner's Operations.
- B. Shutdowns - General Preparation:
- 1. Coordinate shutdowns with Owner and Engineer.
 - 2. Submit shutdown planning Submittals and shutdown notification Submittals in accordance with this Specifications section's "Submittals" Article.
 - 3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to Engineer's satisfaction that Contractor has complied with such requirements before commencing the shutdown.
 - 4. Engineer shall have no duty to Contractor to advise Contractor of inadequate preparations by Contractor; Contractor is solely responsible for the means, methods, procedures, techniques, and sequences of construction.
- C. Shutdowns Tie-In to of Electrical Systems:
- 1. Comply with Laws and Regulations, including the National Electric Code.
 - 2. Contractor shall lock out and tag circuit breakers and switches operated by Owner and shall verify that affected cables and wires are de-energized to ground potential before starting other Work associated with the shutdown.
 - 3. Upon completion of shutdown Work, remove the locks and tags and advise Engineer or Resident Project Representative (RPR) that facilities are available for use.

3.2 INSTALLATION

- A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Sections and ensure that equipment is ready and safe for energization.
- B. Install equipment in accordance with the requirements of:
- 1. NFPA 70.
 - 2. IEEE C2.
 - 3. The manufacturer's instructions.
- C. In general, conduit routing is not shown on the Drawings.

1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams.
 2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.
- D. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.
- E. Install equipment plumb, square and true with construction features and securely fastened.
- F. Install electrical equipment, including pull and junction boxes, minimum of 6 inches from process, air and water piping and equipment.
- G. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.
- H. Device Mounting Schedule:
1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
 - a. Panelboard (to top): 72 inches above grade.
- I. Avoid interference of electrical equipment operation and maintenance with structural members and equipment of other trades.
1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 6 inches in equipment location with the Engineer's approval.
 2. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Engineer's approval:
 - a. 1 foot at grade in any direction in the horizontal plane.
 - b. 1 foot on walls in a horizontal direction within the vertical plane.
 - c. Changes in equipment location exceeding those defined above require the Engineer's approval.
- J. Provide electrical equipment support system per the following area designations:
1. Wet areas:
 - a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
 - b. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
 - c. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
- K. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
1. See Section 03 15 19.
 2. Properly brace electrical equipment enclosure to accept mounting of external equipment such as cold-sequence disconnect, utility meter, and service disconnect.
- L. Provide non-metallic corrosion resistant spacers to maintain 1/4 inches separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas and on below grade walls.
- M. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

- N. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.
- O. Identify electrical equipment and components in accordance with Section 10 14 00.
- P. Provide field markings and/or documentation of available short-circuit current (available fault current) and related information for equipment as required by the NFPA 70 and other applicable codes.
- Q. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
 - 1. Determine the SCCR rating by one of the following methods:
 - a. Method 1: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
 - b. Method 2: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
 - 2. The source equipment is the panelboard or similar equipment where the equipment or control panel circuit originates.
 - 3. For Method 2, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

3.3 FIELD QUALITY CONTROL

- A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
 - 1. Secure Shop Drawings for equipment furnished by Others and installed by Contractor.
- B. Replace equipment and systems found inoperative or defective and re-test.
- C. The protective coating integrity of support structures and equipment enclosures shall be maintained.
 - 1. Repair galvanized components utilizing a zinc rich paint.
 - 2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
 - 3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
 - 4. Repair surfaces which will be inaccessible after installation prior to installation.
 - 5. See Section 26 05 33 for requirements for conduits and associated accessories.
- D. Replace nameplates damaged during installation.

3.4 DEMONSTRATION

- A. Demonstrate equipment in accordance with Section 01 75 00.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:
 - a. Power cable.
 - b. Control cable.
 - c. Instrumentation cable.
 - d. Fiber optic cable.
 - e. Wire connectors.
 - f. Insulating tape.
 - g. Pulling lubricant.

B. Related Requirements:

1. Section 26 05 00 - Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Insulated Cable Engineers Association (ICEA):
 - a. S-58-679, Standard for Control Cable Conductor Identification.
 - b. S-76-474, Neutral-Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation Rated 600 Volts.
2. National Electrical Manufacturers Association (NEMA):
 - a. ICS 4, Industrial Control and Systems: Terminal Blocks.
3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
 - a. WC 57/S-73-532, Standard for Control Cables.
 - b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
5. Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA):
 - a. 598-C, Optical Fiber Cable Color Coding.
6. Underwriters Laboratories, Inc. (UL):
 - a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
 - b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
 - c. 467, Standard for Safety Grounding and Bonding Equipment.
 - d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
 - e. 486C, Standard for Safety Splicing Wire Connections.
 - f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
 - g. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.3 DEFINITIONS

- A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
- B. Instrumentation Cable:
 - 1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
 - 2. The following are specific types of instrumentation cables:
 - a. Analog signal cable:
 - 1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 VDC) signals, using No. 16 AWG and smaller conductors.
 - 2) Commonly used types are defined in the following:
 - a) TSP: Twisted shielded pair.
 - b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.
- C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.
- D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.
- E. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Section except:
 - 1) Wire connectors.
 - 2) Insulating tape.
 - 3) Cable lubricant.
 - b. See Section 26 05 00 for additional requirements.
 - 2. Test reports:
 - a. Fiber optic cable test reports.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Building wire, power and control cable:
 - a. Aetna Insulated Wire.
 - b. Alphawire.
 - c. Cerrowire.
 - d. Encore Wire Corporation.

- e. General Cable.
- f. Okonite Company.
- g. Southwire Company.
- 2. Instrumentation cable:
 - a. Analog cable:
 - 1) Alphawire.
 - 2) Belden Inc.
 - 3) General Cable.
- 3. Wire connectors:
 - a. Burndy Corporation.
 - b. Buchanan.
 - c. Ideal.
 - d. Ilsco.
 - e. 3M Co.
 - f. Teledyne Penn Union.
 - g. Thomas and Betts.
 - h. Phoenix Contact.
- 4. Insulating and color-coding tape:
 - a. 3M Co.
 - b. Plymouth Bishop Tapes.
 - c. Red Seal Electric Co.

2.2 MANUFACTURED UNITS

A. Building Wire:

- 1. Conductor shall be copper with 600 V rated insulation.
- 2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
- 3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
- 4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:

- 1. Conductor shall be copper with 600 V rated insulation.
- 2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
- 3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
- 4. Number of conductors as required, including a bare ground conductor.
- 5. Individual conductor color coding:
 - a. ICEA S-58-679, Method 4.
 - b. See PART 3 of this Section for additional requirements.

C. Control Cable:

- 1. Conductor shall be copper with 600 V rated insulation.
- 2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
- 3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.

4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
 - a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
 5. Individual conductor color coding:
 - a. ICEA S-58-679, Method 1, Table E-2.
 - b. See PART 3 of this Section for additional requirements.
- D. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
 2. Analog cable:
 - a. Tinned copper conductors.
 - b. 300 V or 600 V PVC insulation with PVC jacket.
 - c. Twisted with 100% foil shield coverage with drain wire.
 - d. Six (6) twists per foot minimum.
 - e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
 3. Digital cable:
 - a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
- E. Wire Connectors:
1. Twist/screw on type:
 - a. Insulated pressure or spring type solderless connector.
 - b. 600 V rated.
 - c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
 - d. Phase and neutral conductors: Conform to UL 486C.
 2. Compression and mechanical screw type:
 - a. 600 V rated.
 - b. Ground conductors: Conform to UL 467.
 - c. Phase and neutral conductors: Conform to UL 486A.
 3. Terminal block type:
 - a. High density, screw-post barrier-type with white center marker strip.
 - b. 600 V and ampere rating as required, for power circuits.
 - c. 600 V, 20 ampere rated for control circuits.
 - d. 300 V, 15 ampere rated for instrumentation circuits.
 - e. Conform to NEMA ICS 4 and UL 486A.
- F. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
 2. Premium grade.
 3. Heat, cold, moisture, and sunlight resistant.
 4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
 5. For cold weather or outdoor location, tape must also be all-weather.
 6. Color:
 - a. Insulating tape: Black.
 - b. Color coding tape: Fade-resistant color as specified herein.
 7. Comply with UL 510.

- G. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types:

1. Type XHHW-2:
 - a. Building wire and power and control cable in conduit in outdoor areas and below grade.
2. Type USE-2/RHH/RHW-2:
 - a. Direct buried service entrance cable.
 - b. Building wire and power and control cable underground.

B. Conductor Size Limitations:

1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

C. Color Code All Wiring as Follows:

1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

- a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
2. Power cables ICEA S-58-679, Method 4 with:
 - a. Phase and neutral conductors identified with 3 inches of colored tape, per the Table herein, applied at the terminations.
 - b. Ground conductor: Bare.
3. Control cables ICEA S-58-679, Method 1, Table E-2:
 - a. When a bare ground is not provided, one of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
 - b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 inches of colored tape, per the Table herein, applied at the terminations.
- D. Install all wiring in raceway unless otherwise indicated on the Drawings.
- E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, junction or pull box, except as permitted in the following:
 1. Where specifically indicated on the Drawings.

2. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
 - a. The combinations shall comply with the following:
 - 1) AC control circuits shall be isolated from all DC circuits.
 3. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
 - a. The combinations shall comply with the following:
 - 1) Analog signal circuits may be combined.
 - 2) Digital signal circuits may be combined but isolated from analog signal circuits.
- F. Ground the drain wire of shielded instrumentation cables at one end only.
1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).
- G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
1. Feeder and branch power circuits:
 - a. Junction and pull boxes and wireways:
 - 1) Twist/screw on type connectors for use on No. 8 and smaller wire.
 - 2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
 - b. Manholes or handholes:
 - 1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
 - 2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
 2. Control circuits:
 - a. Junction and pull boxes: Terminal block type connector.
 - b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
 - c. Control panels: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
 3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
 - a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
 - b. Junction and pull boxes: Terminal block type connector.
 - c. Control panels: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.
 4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.
- H. Insulating Tape Usage:
1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
 2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
 3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.
- I. Color Coding Tape Usage: For color coding of conductors.
- J. Fiber Optic Cable:
1. Unless indicated otherwise, all fiber optic cable by others.
 2. Splicing:
 - a. Optical fibers shall not be spliced.

3. Utilize dust tight wall-mounted interconnect center to provide the following:
 - a. Interconnect fiber optic cable to jumper cable assemblies for connection to the opto-electronic interface.
4. Where exposed to contact with electric light or power conductors, the noncurrent carrying metallic members (if applicable) of optical fiber cables entering electrical enclosures shall be grounded as close to the point of entrance as practicable in accordance with NFPA 70.
5. Install cables in accordance with the requirements of NFPA 70.

3.2 FIELD QUALITY CONTROL

- A. Acceptance Testing:
 1. See Section 26 08 13.
- B. Test installed fiber optic cable system to verify the following:
 1. Continuity of all installed fibers and associated connectors.
 2. Maximum attenuation requirements of specification are not exceeded.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for grounding and bonding system(s).
- B. Related Requirements:
 - 1. Section 10 14 00 - Identification Devices.
 - 2. Section 26 05 00 - Common Work Results for Electrical.
 - 3. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 - 4. Section 26 05 33 - Raceways and Boxes for Electrical Systems.
 - 5. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
 - 3. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 4. Underwriters Laboratories, Inc. (UL):
 - a. 467, Grounding and Bonding Equipment.
- B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Section.
 - b. See Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Ground rods and bars and grounding clamps, connectors and terminals:
 - a. ERICO by Pentair.
 - b. Harger Lightning & Grounding.
 - c. Heary Bros. Lightning Protection Co. Inc..
 - d. Burndy by Hubbell.
 - e. Robbins Lightning, Inc.
 - f. Blackburn by Thomas & Betts.
 - g. Thompson Lightning Protection, Inc.

2. Exothermic weld connections:
 - a. ERICO by Pentair - Cadweld.
 - b. Harger Lightning & Grounding - Ultraweld.
 - c. Burndy by Hubbell - Thermoweld.
 - d. FurseWELD by Thomas & Betts.

2.2 COMPONENTS

- A. Wire and Cable:
 1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
 2. Insulated conductors: Color coded green, per Section 26 05 19.
- B. Conduit: As specified in Section 26 05 33.
- C. Ground Bars:
 1. Solid copper:
 - a. 1/4 inches thick.
 - b. 2 or 4 inches wide.
 - c. 24 inches long minimum in main service entrance electrical rooms, 12 inches long elsewhere.
 2. Predrilled grounding lug mounting holes.
 3. Stainless steel or galvanized steel mounting brackets.
 4. Insulated standoffs.
- D. Ground Rods:
 1. 3/4 inches x 10 feet.
 2. Copper-clad:
 - a. 10 mil minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
 - b. Corrosion resistant bond between the copper and steel.
 - c. Hard drawn for a scar-resistant surface.
- E. Grounding Clamps, Connectors and Terminals:
 1. Compression type suitable for direct burial in earth or concrete:
 - a. Standards: UL 467, IEEE 837.
 - b. High copper alloy content.
 - c. Non-reversible.
 - d. Factory filled with oxide inhibiting compound.
- F. Exothermic Weld Connections:
 1. Copper oxide reduction by aluminum process.
 2. Molds properly sized for each application.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install products in accordance with manufacturer's instructions.
 2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.

3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
4. Do not splice grounding electrode conductors except at ground rods.
5. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
 - a. Provide excavation required for installation of ground rods and conductors.
 - b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
 - c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
 - d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
 - e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
6. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:

1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
2. Grounding electrode conductor terminations:
 - a. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
 - b. Piping systems: Use mechanical type connections.
 - c. Ground rod: Compression type or exothermic weld, unless otherwise specified.
 - d. At all above grade terminations, the conductors shall be labeled per Section 10 14 00.
3. Single ground rod grounding system:
 - a. Single ground rod system consists of a single ground rod.
 - b. Place ground rod a minimum of 4 inches from the electrical equipment enclosure foundation and 2 feet-6 inches below grade.
 - c. Grounding conductor: Bare conductor, sized as indicated on the Drawings.

C. Transformer Separately Derived Grounding System:

1. Install the System Bonding Jumper at the first disconnect means.
2. See Grounding Electrode System paragraph for conductor termination requirements.

D. Raceway Bonding/Grounding:

1. Install all metallic raceway so that it is electrically continuous.
2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

E. Equipment Grounding:

1. Ground all utilization equipment with an equipment grounding conductor.

F. Manhole and Handhole Grounding:

1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
 - a. Expose a minimum of 4 inches of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

3.2 FIELD QUALITY CONTROL

- A. Leave grounding system uncovered until observed by Owner.

END OF SECTION

SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Material and installation requirements for:
 - a. Conduits.
 - b. Conduit fittings.
 - c. Conduit supports.
 - d. Pull and junction boxes.
- B. Related Requirements:
1. Section 26 05 00 - Common Work Results for Electrical.
 2. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
 3. Section 26 05 43 - Underground Work for Electrical Systems.
 4. Section 26 27 26 - Wiring Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
1. Aluminum Association (AA).
 2. American Iron and Steel Institute (AISI).
 3. ASTM International (ASTM):
 - a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - c. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
 - d. D3350, Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.
 - e. D3485, Standard Specification for Coilable High Density Polyethylene (HDPE) Cable in Conduit (CIC).
 - f. F512, Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation.
 - g. F2160, Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outer Diameter (OD).
 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
 - c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
 - d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - e. TC 6 & 8, Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations.
 - f. TC 7, Solid-Wall Coilable and Straight Electrical Polyethylene Conduit.
 5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
 - a. C80.3, Steel Electrical Metallic Tubing (EMT).

- b. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
- 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
- 7. Underwriters Laboratories, Inc. (UL):
 - a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - b. 360, Standard for Liquid-Tight Flexible Metal Conduit.
 - c. 467, Grounding and Bonding Equipment.
 - d. 514B, Conduit, Tubing, and Cable Fittings.
 - e. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
 - f. 651A, Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
 - g. 797, Electrical Metallic Tubing - Steel.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Section except:
 - 1) Conduit fittings.
 - 2) Support systems.
 - b. See Section 26 05 00 for additional requirements.
 - 2. Fabrication and/or layout drawings:
 - a. Proposed location and details of construction for openings in slabs and walls for raceway runs.
 - b. Identify dimensional size of pull and junction boxes to be used.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Electrical metallic tubing:
 - a. Allied Tube and Conduit.
 - b. Western Tube and Conduit Corporation.
 - c. Wheatland Tube.
 - d. Patriot Aluminum Products, LLC.
 - 2. PVC coated rigid metal conduits:
 - a. Robroy Industries.
 - b. Atkore - Calbond
 - 3. Rigid nonmetallic conduit:
 - a. Prime Conduit.
 - b. Cantex, Inc.
 - c. Osburn Associates, Inc.

4. Flexible conduit:
 - a. AFC Cable Systems.
 - b. Anamet, Inc.
 - c. Electri-Flex Company.
 - d. International Metal Hose Company.
 - e. Southwire Company, LLC.
5. Conduit fittings and accessories:
 - a. Appleton by Emerson Electric Co.
 - b. Carlon by Thomas & Betts.
 - c. Cantex, Inc.
 - d. Crouse-Hinds by Eaton.
 - e. Killark by Hubbell.
 - f. Osburn Associates, Inc.
 - g. O-Z/Gedney by Emerson Electric Co.
 - h. Raco by Hubbell.
 - i. Steel City by Thomas & Betts.
 - j. Thomas & Betts.
6. Support systems:
 - a. Unistrut by Atkore International, Inc.
 - b. B-Line by Eaton.
 - c. Kindorf by Thomas & Betts.
 - d. Minerallac Company.
 - e. CADDY by Pentair.
 - f. Superstrut by Thomas & Betts.
7. Pull and junction boxes:
 - a. Appleton by Emerson Electric Co.
 - b. Crouse-Hinds by Eaton
 - c. Killark by Hubbell.
 - d. O-Z/Gedney by Emerson Electric Co.
 - e. Steel City by Thomas & Betts.
 - f. Raco by Hubbell
 - g. Bell by Hubbell.
 - h. Hoffman Engineering.
 - i. Wiegmann by Hubbell.
 - j. B-Line by Eaton.
 - k. Adalet.
 - l. RITTAL North America LLC.
 - m. Stahlin by Robroy Enclosures.

2.2 RIGID METAL CONDUITS

- A. PVC-Coated Rigid Steel Conduit (PVC-RGS):
 1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
 - a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
 - b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
 2. Nominal 2 mil, minimum, urethane interior coating.

3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
 - a. Have a plastic sleeve extending a minimum of one pipe diameter or 2 inches, whichever is less beyond the opening.
 - b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Pass high temperature water PVC coating adhesion test and be ETL Verified PVC-001.
7. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6, NEMA RN 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

- A. Mild steel with continuous welded seam.
- B. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
- C. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
- D. Standards: NFPA 70 Type EMT, NEMA/ANSI C80.3, UL 797.

2.4 RIGID NONMETALLIC CONDUIT

- A. Schedule 80 (PVC-80):
 1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
 2. Rated for direct sunlight exposure.
 3. Fire retardant and low smoke emission.
 4. Shall be suitable for use with 90 degrees C wire and shall be marked "maximum 90 degrees C".
 5. Standards: NFPA 70 Type PVC, NEMA TC 2, UL 651.

2.5 FLEXIBLE CONDUIT

- A. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
 1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
 2. Extruded PVC outer jacket positively locked to the steel core.
 3. Liquid and vaportight.
 4. Standard: NFPA 70 Type LFMC, UL 360.
- B. Flexible High-Density Polyethylene (HDPE) Conduits:
 1. Extruded from virgin High Density Polyethylene (HDPE) resin, in accordance to the requirements of ASTM D3350 with cell classification 345440C.
 2. Stabilized against thermal and UV degradation.
 3. Conduit to be of a continuous length, smooth walled with a low friction internal surface containing no welds or joints and coiled on a reel.
 4. Dimensions: SDR-11, EPEC-11, EPEC-A.
 5. Suitable for the following installation methods: Direct bury, plow, directional bore, concrete encased and pulling in existing conduit.
 6. As indicated on the Drawings, the conduit to be provided:
 - a. Empty.
 - b. Containing a pull string.
 - c. Pre-installed with cables: Cable type and quantity as indicated on the Drawings and as specified in Section 26 05 19.
 7. Conduit color:

- a. Telecommunication and instrumentation applications: Orange.
- 8. Standards: NFPA 70 Type HDPE, ASTM D3350, ASTM D3485, ASTM F2160, UL 651A.

2.6 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS:

1. General:
 - a. Finish: Electrostatically applied epoxy powder coat.
 - b. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
 - a. Threaded steel or malleable iron.
 - b. Gasketed or non-gasketed.
 - c. Grounding or non-grounding type.
3. Bushings:
 - a. Threaded, insulated metallic.
 - b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
 - a. Threaded straight type: Same material and finish as the conduit with which they are used on.
 - b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
 - a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
 - b. Standard and mogul size.
 - c. Cover:
 - 1) Clip-on type with stainless steel screws.
 - 2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
 - a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
 - b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
 - a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
 - b. Standard and mogul size.
 - c. With or without drain and breather.
 - d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Service entrance head:
 - a. Malleable iron, galvanized steel or copper free aluminum.
 - b. Insulated knockout cover for use with a variety of sizes and number of conductors.
11. Expansion couplings:
 - a. 2 inches nominal straight-line conduit movement in either direction.
 - b. 4 inches nominal straight-line conduit movement in either direction.
 - c. Galvanized steel with insulated bushing.
 - d. Gasketed for wet locations.
 - e. Internally or externally grounded.
12. Expansion/deflection couplings:

- a. 3/4 inches nominal straight-line conduit movement in either direction.
 - b. 30 degrees nominal deflection from the normal in all directions.
 - c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
 - d. Internally or externally grounded.
 - e. Watertight, raintight and concrete tight.
- 13. Standards: UL 467, UL 514B, UL 1203.
- B. Fittings for Use with PVC-RGS:
 - 1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS " and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."
- C. Fittings for Use with EMT:
 - 1. Connectors:
 - a. Straight, angle and offset types furnished with locknuts.
 - b. Zinc plated steel.
 - c. Insulated gland compression type.
 - d. Concrete and raintight.
 - 2. Couplings:
 - a. Zinc plated steel.
 - b. Gland compression type.
 - c. Concrete and raintight.
 - 3. Conduit bodies (ells and tees):
 - a. Body: Copper free aluminum with threaded hubs.
 - b. Standard and mogul size.
 - c. Cover:
 - 1) Screw down type with steel screws.
 - 2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
 - 4. Standard: UL 514B.
- D. Fittings for Use with FLEX-LT:
 - 1. Connector:
 - a. Straight or angle type.
 - b. Metal construction, insulated and gasketed.
 - c. Composed of locknut, grounding ferrule and gland compression nut.
 - d. Liquid tight.
 - 2. Standards: UL 467, UL 514B.
- E. Fittings for Use with Rigid Nonmetallic PVC Conduit:
 - 1. Coupling, adapters and conduit bodies:
 - a. Same material, thickness, and construction as the conduits with which they are used.
 - b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
 - c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
 - 2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
 - 3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.
- F. Weather and Corrosion Protection Tape:
 - 1. PVC based tape, 10 mils thick.

2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

A. Mark Products:

1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.8 PULL AND JUNCTION BOXES

A. NEMA 3R Rated:

1. Body and cover: 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Drip shield top and seam-free sides, front and back.
3. With or without concentric knockouts on bottom.
4. Slip-on removable cover fastened on bottom edge with screws or continuous hinged cover fastened with screws.

B. Miscellaneous Accessories:

1. Weldnuts for mounting optional panels and terminal kits.
2. Tamper proof screws.
3. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

C. Standards: NEMA 250, UL 50.

2.9 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:

1. Material requirements.
 - a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:

1. NFPA 70.
2. Manufacturer instructions.

B. Size of Raceways:

1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
2. Unless specifically indicated otherwise, the minimum raceway size shall be:
 - a. Conduit: 3/4 inches.

C. Field Bending and Cutting of Conduits:

1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
2. Do not reduce the internal diameter of the conduit when making conduit bends.
3. Prepare tools and equipment to prevent damage to the PVC coating.
4. Degrease threads after threading and apply a zinc rich paint.
5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

- E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
 - 1. Repair galvanized components utilizing a zinc rich paint.
 - 2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
 - 3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
 - a. Total nominal thickness: 40 mil.
 - 4. Repair surfaces which will be inaccessible after installation prior to installation.
- F. Remove moisture and debris from conduit before wire is pulled into place.
 - 1. Pull mandrel with diameter nominally 1/4 inches smaller than the interior of the conduit, to remove obstructions.
 - 2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
 - 3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.
- G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.
- H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.
- I. Fill openings in walls, floors, and ceilings and finish flush with surface.

3.2 RACEWAY ROUTING

- A. Raceways shall be routed in the field unless otherwise indicated.
 - 1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
 - 2. Run in straight lines parallel to or at right angles to building lines.
 - 3. Do not route conduits:
 - a. Through areas of high ambient temperature or radiant heat.
 - b. In suspended concrete slabs.
 - c. In concrete members including slabs, slabs on grade, beams, walls, and columns unless specifically located and detailed on structural Drawings.
 - 4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
 - 5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.
- B. All conduits within a structure shall be installed exposed except as follows:
 - 1. As indicated on the Drawings.
- C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 feet:
 - 1. Between instrumentation and telecommunication: 2 inch.
 - 2. Between instrumentation and 24 VDC, 2 inches.
 - 3. Between instrumentation and 600 V and less AC power or control: 12 inches.
 - 4. Between telecommunication and 24 VDC, 2 inches.
 - 5. Between telecommunication and 600 V and less AC power or control: 12 inches.
 - 6. Between 24 VDC and 600 V and less AC power or control: 12 inches.

- 7. Between process, air, and water pipes: 6 inches.
- D. Conduits shall be installed to eliminate moisture pockets.
 - 1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.
- E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.
- F. Provide all required openings in structures for conduit penetration.

3.3 RACEWAY APPLICATIONS

- A. Permitted Raceway Types Per Wire or Cable Types:
 - 1. Power wire or cables: All raceway types.
 - 2. Control wire or cables: All raceway types.
 - 3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
 - 4. Telecommunication cables: HDPE.
- B. Permitted Raceway Types Per Routing Locations:
 - 1. Direct buried conduits:
 - a. PVC-80.
 - b. HDPE.
 - c. 90 degrees elbows for transitions to above grade:
 - 1) RGS wrapped with factory applied weather and corrosion protection tape.
 - 2) PVC-RGS.
- C. FLEX-LT conduits shall be installed as the final conduit connection to instrumentation primary elements.
 - 1. The maximum length shall not exceed 2 feet.
- D. Underground Conduit: See Section 26 05 43.

3.4 CONDUIT FITTINGS AND ACCESSORIES

- A. Conduit Seals:
 - 1. Fill plug and drain shall be accessible.
 - 2. Pour the conduit seals in a two-step process.
 - a. Pour the seal and leave cover off.
 - b. After seal is dry, inspect for proper sealing, install cover and mark (for example, paint or permanent marker) as complete.
- B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
 - 1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.
- C. Install Expansion Fittings:
 - 1. Where conduits are exposed to the sun and conduit run is greater than 200 feet.
 - 2. Elsewhere as identified on the Drawings.
- D. Install Expansion/Deflection Fittings:
 - 1. Where conduits enter a structure.
 - a. Except electrical manholes and handholes.
 - 2. Elsewhere as identified on the Drawings.
- E. Threaded connections shall be made wrench-tight.

- F. Conduit joints shall be watertight:
 - 1. Underground.
- G. Terminate Conduits:
 - 1. In NEMA 3R rated enclosures:
 - a. RGS:
 - 1) Conduit hub and locknut.
 - 2) Insulated bushing and two locknuts.
 - 3) Use grounding type locknut or bushing when required by NFPA 70.
 - b. EMT: Compression type connector and locknut.
- H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

- A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
 - 1. Dry or wet areas:
 - a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.
 - b. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.
 - 2. Conduit type shall be compatible with the support system material.
 - a. Galvanized steel system may be used with RGS and EMT.
 - b. PVC coated galvanized steel system may be used with PVC-RGS and PVC-80.
 - c. Aluminum system may be used with PVC-RGS.
- B. Permitted single conduit support fasteners per conduit types:
 - 1. Dry or wet areas:
 - a. Material: Zinc plated steel, stainless steel and malleable iron.
 - b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
 - 2. Conduit type shall be compatible with the support fastener material.
 - a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS and EMT.
 - b. PVC coated fasteners may be used with PVC-RGS and PVC-40 and PVC-80.
 - c. Nonmetallic fasteners may be used with PVC-40 and PVC-80.
- C. Conduit Support General Requirements:
 - 1. Maximum spacing between conduit supports per NFPA 70.
 - 2. Support conduit from the building structure.
 - 3. Do not support conduit from process, air, or water piping; or from other conduits.
 - 4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 pounds.
 - a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
 - b. Conduit hangers:
 - 1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.

- c. Do not use suspended ceiling support systems to support raceways.
- 5. Conduit support system fasteners:
 - a. Do not use concrete nails and powder-driven fasteners.

3.6 PULL AND JUNCTION BOX INSTALLATION

A. General:

- 1. Install products in accordance with manufacturer's instructions.
- 2. See Section 26 05 00 and the Drawings for area classifications.
- 3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
- 4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Pull and Junction Boxes:

- 1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
 - a. Make covers of boxes accessible.
- 2. Permitted uses of NEMA 3R enclosure:
 - a. Pull or junction box surface mounted in exterior locations.

END OF SECTION

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SECTION 26 05 43
UNDERGROUND WORK FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Handhole.
 - b. Underground conduits and ductbanks.
- B. Related Requirements:
 - 1. Section 03 11 13 - Formwork.
 - 2. Section 03 21 00 - Reinforcement.
 - 3. Section 03 31 30 - Concrete, Materials and Proportioning.
 - 4. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
 - 5. Section 10 14 00 - Identification Devices.
 - 6. Section 26 05 26 - Grounding.
 - 7. Section 26 05 33 - Raceways and Boxes for Electrical Systems.
 - 8. Section 31 23 33 – Utilities - Trenching and Backfilling.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. Society of Cable Telecommunications Engineers (SCTE):
 - a. 77, Specifications for Underground Enclosure Integrity.

1.3 DEFINITIONS

- A. Direct-Buried Conduit(s):
 - 1. Individual (single) underground conduit.
 - 2. Multiple underground conduits, arranged in one or more planes, in a common trench.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Section.
 - 2. Fabrication and/or layout drawings:
 - a. Provide cross-section sketch of each direct-buried ductbank.
 - 1) Dimension from grade to direct buried ductbank.
 - 2) Dimension from direct buried ductbank to other utilities in the route.
 - 3. Certifications.
 - 4. Test reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Prefabricated composite handholes:
 - a. Armorcast Products Company.
 - b. Quazite by Hubbell.
 - c. Synertech by Oldcastle Enclosure Solutions.
 - 2. Precast manholes and handholes:
 - a. Lister Industries Ltd.
 - b. Oldcastle Enclosure Solutions.
 - c. Jensen Precast and Utility Concrete Products.
 - 3. Manhole and handhole and ductbank accessories:
 - a. Cantex, Inc.
 - b. Condux International, Inc.
 - c. Neenah Enterprises, Inc.
 - d. Prime Conduit.
 - e. Thomas and Betts.
 - f. Underground Devices, Inc.
 - g. Unistrut by Atkore International, Inc.

2.2 HANDHOLES

- A. Precast Handholes:
 - 1. Fiberglass reinforced polymer concrete structures:
 - 2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
 - 3. Mating edges: Tongue and groove type.
 - 4. Solid bottom with a 30 inches x 48 inches or 12 inches diameter french drain in the bottom of each manhole.
 - 5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
 - 6. Cover extension rings as required.
 - 7. Cable pulling eyes opposite all conduit entrances.
 - a. Coordinate exact location with installation contractor.

2.3 CONCRETE HANDHOLE ACCESSORIES

- A. Cover and Frame:
 - 1. Cast ductile iron: ASTM A536.
 - 2. AASHTO live load rating: H-20.
 - 3. Diameter: 30 inches.
 - 4. Cast the legend "COMMUNICATIONS" into handhole covers.
 - a. Stainless steel penta-head bolts.
- B. Cable Racks and Hooks:
 - 1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
 - 2. Hook loading capacity: 400 pounds minimum.
 - 3. Rack loading capacity: Four hooks maximum.
 - 4. Hook deflection: 0.25 inches maximum.
 - 5. Hooks: Length, as required, with positive locking device to prevent upward movement.

- 6. Mounding hardware: Stainless steel.
- C. Cable Pulling Irons:
 - 1. 7/8 inches diameter hot-dipped galvanized steel.
 - 2. 6000 pound minimum pulling load.
- D. Ground Rods and Grounding Equipment: See Section 26 05 26.

2.4 UNDERGROUND CONDUIT AND ACCESSORIES

- A. Concrete and reinforcing steel: See Division 03 Specifications.
- B. Concrete and reinforcing steel: See Section 03 05 05, Section 03 11 13, Section 03 21 00, Section 03 31 30 and Section 03 35 00.
- C. Duct Terminators:
 - 1. Window type.
 - 2. ABS plastic.
 - 3. Provide for conduit entrance.
 - 4. Designed for installation into manhole or handhole walls for a watertight seal.
 - 5. Sufficient space between terminator walls to allow for placement of rebar and concrete.
- D. Conduit: See Section 26 05 33.
- E. Duct Spacers/Supports:
 - 1. High density polyethylene or high impact polystyrene.
 - 2. Interlocking web or mesh design.
 - 3. Provide 3 inches minimum spacing between conduits.
 - 4. Accessories, as required:
 - a. Hold down bars.
 - b. Ductbank strapping.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERGROUND ELECTRICAL SYSTEMS - GENERAL

- A. Drawings indicate the intended location of handholes and routing of direct buried conduit.
 - 1. Field conditions may affect actual routing.
- B. Handhole Locations:
 - 1. Approximately where shown on the Drawings.
 - 2. As required for pulling distances.
 - 3. As required to keep pulling tensions under allowable cable tensions.
 - 4. As required for number of bends in ductbank routing.
 - 5. Shall not be installed in a swale or ditch.
 - 6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
 - 7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.
- C. Install products in accordance with manufacturer's instructions.
- D. Install handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.
- E. Comply with Specification Section 31 23 33 – Utilities - Trenching and Backfilling

3.2 HANDHOLES

A. Prefabricated Composite Material Handholes:

1. For use in areas subjected to occasional non-deliberate vehicular traffic.
2. Provide handhole on eight-inch compacted layer of fill material in accordance with Section 31 23 33 - Trenching and Backfilling and six inches larger than handholes footprint on all sides.
3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 inches wide x 12 inches deep).
4. Install so that the surrounding grade is 1 inch lower than the top of the handhole.
5. Size: As indicated on the Drawings or as required for the number and size of conduits.
6. Provide cable rails and pulling eyes as needed.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:

1. Do not place required fill materials until conduits have been observed by Engineer.
2. Ductbanks shall be sloped a minimum of 4 inches per 100 feet or as detailed on the Drawings.
3. During construction and after conduit installation is complete, plug the ends of all conduits.
4. Provide conduit supports and spacers.
 - a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
 - 1) 1 inches and less: 3 feet.
 - 2) 1-1/4 to 3 inches: 5 feet.
 - b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:
 - 1) 1 inches and less: 10 feet.
 - 2) 1-1/4 to 2-1/2 inches: 14 feet.
 - c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or other required fill materials.
5. Stagger conduit joints at intervals of 6 inches vertically.
6. Make conduit joints watertight and in accordance with manufacturer's recommendations.
7. Accomplish underground changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 10 feet.
 - a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
8. Furnish manufactured elbows at end of runs as the conduit transitions to above grade.
 - a. Minimum radius of 18 inches for conduits less than 3 inches trade size.
9. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
10. After the conduit run has been completed:
 - a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
 - 1) Test mandrel:
 - a) Length: Not less than 12 inches.
 - b) Diameter: Approximately 1/4 inches less than the inside diameter of the conduit.
 - b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.
11. Pneumatic rodding may be used to draw in lead wire.

- a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
- b. Extend cord 3 feet beyond ends of conduit.
- 12. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Section 26 05 33, prior to entering a structure or going above ground.
 - a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, underground electrical structures, and exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
 - b. Terminate rigid PVC conduits with end bells.
- 13. Place warning tape in trench directly over direct-buried conduit.
- 14. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.
- B. Direct-Buried Conduit(s):
 - 1. Install so that the top of the uppermost conduit, at any point:
 - a. Is not less than 30 inches below grade.
 - 2. Provide a uniform minimum clearance of 3 inches between conduits or as required in Section 26 05 33 for different cabling types.
 - a. Maintain the separation of multiple planes of conduits by one of the following methods:
 - 1) Provide multilevel conduits with conduit supports and separators to maintain required separations, and backfill with flowable fill in accordance with 31 23 33 – Utilities – Trenching and Backfilling or concrete in accordance with the Specifications of Division 03 - Concrete.
 - 2) Install multilevel conduits one level at a time.
 - a) Each level shall be backfilled with required materials and compacted in accordance with Section 31 23 33 – Utilities - Trenching and Backfilling, while maintaining required separations.

END OF SECTION

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SECTION 26 08 13
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Basic requirements for acceptance testing.
- B. Related Requirements:
 - 1. 01 33 00 – Submittal Procedures.
 - 2. 26 05 00 – Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. InterNational Electrical Testing Association (NETA):
 - a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
 - 2. Nationally Recognized Testing Laboratory (NRTL).
 - 3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
 - a. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.
- B. Qualifications:
 - 1. Testing firm:
 - a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
 - b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
 - 2. Field personnel:
 - a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
 - b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
 - c. Supervisor certified by NETA or NICET.
 - 1) As an alternative, supervising technician may be certified by the equipment manufacturer
 - 3. Analysis personnel:
 - a. Minimum three years combined field testing and data analysis experience.
 - b. Supervisor certified by NETA or NICET.
 - 1) As an alternative, supervising technician may be certified by the equipment manufacturer.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Equipment Monitoring and Testing Plan.
- B. Informational Submittals:

1. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
 - a. Single report containing information including:
 - 1) Summary of Project.
 - 2) Information from pre-energization testing.
 - 3) Testing and monitoring reports.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

- A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.
- B. Factory testing will not be accepted in lieu of specified field acceptance testing requirements.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. General:
 1. Perform testing in accordance with this Section and NETA ATS.
 2. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
 - a. Contract Drawings and Specifications.
 - b. Related construction change documentation.
 - c. Approved Shop Drawings.
 - d. Approved Operation and Maintenance Manuals.
 - e. Other pertinent information as required.
- B. Equipment Monitoring and Testing Plan:
 1. Approved in accordance with Shop Drawing submittal schedule.
 2. Included as a minimum:
 - a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
 - b. List and description of testing and analysis equipment to be utilized.
 - c. List of all equipment to be testing, including:
 - 1) Name and tag numbers identified in the Contract Documents.
 - 2) Manufacturer's serial numbers.
 - 3) Other pertinent manufacturer identification,
- C. Instruments Used in Equipment and Connections Quality Control Testing:
 1. Minimum calibration frequency:
 - a. Field analog instruments: Not more than 6 months.
 - b. Field digital instruments: Not more than 12 months.
 - c. Laboratory instruments: Not more than 12 months.
 - d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
 2. Carry current calibration status and labels on all testing instruments.
 3. See individual testing programs for additional instrumentation compliance requirements.
- D. Testing and Monitoring Program Documentation:
 1. Provide reports with tabbed sections for each piece of equipment tested.

2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
 - a. Include legible copies of all forms used to record field test information.
 3. Prior to start of testing, submit one copy of preliminary report format for Engineer review and comment
 - a. Include data gathering and sample test report forms that will be utilized.
 4. In the final report, include as a minimum, the following information for all equipment tested:
 - a. Equipment identification, including:
 - 1) Name and tag numbers identified in the Contract Documents.
 - 2) Manufacturer's serial numbers.
 - 3) Other pertinent manufacturer identification,
 - b. Date and time of each test.
 - c. Ambient conditions including temperature, humidity, and precipitation.
 - d. Visual inspection report.
 - e. Description of test and referenced standards, if any, followed while conducting tests.
 - f. Results of initial and all retesting.
 - g. Acceptance criteria.
 - h. "As found" and "as left" conditions.
 - i. Corrective action, if required, taken to meet acceptance.
 - j. Verification of corrective action signed by the Contractor, equipment supplier, and Owner's representative.
 - k. Instrument calibration dates of all instruments used in testing.
 5. Provide three (3) bound final reports prior to Project final completion.
- E. Electrical Equipment and Connections Testing Program:
1. See individual Division 26 Sections for equipment specific testing requirements.
 2. Test all electrical equipment.
 - a. Perform all required NETA testing.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

- A. Cable - Low Voltage:
1. Perform inspections and tests per NETA ATS 7.3.2.
 - a. Insulation resistance testing is limited to conductors #4 AWG and larger.
- B. Cable - Optical Fiber:
1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
 - a. Optical time domain reflectometer test.
 - b. Power attenuation test.
 - c. Gain margin test.
- C. Low Voltage Molded Case Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.1.
 2. Components:
 - a. Test all components per applicable paragraphs of this Section and NETA ATS.
 - b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
 - c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
 3. Record as-left settings.
- D. Grounding:

1. Perform inspections and tests per NETA ATS 7.13.
 2. Components: Test all components per applicable paragraphs of this Section and NETA ATS.
- E. Ground Fault Protection:
1. Perform inspections and tests per NETA ATS 7.14.
 2. Components: Test all components per applicable paragraphs of this Section and NETA ATS.
 3. Perform the following optional tests per NETA ATS:
 - a. Control wiring insulation resistance.
- F. Control System Functional Test:
1. Perform test upon completion of equipment acceptance tests.
 2. The test is to prove the correct interaction of all sensing, processing and action devices.
 3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
 4. Perform the following tests:
 - a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
 - b. Verify the correct operation of all sensing devices, alarms and indicating devices.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Branch circuit panelboards.
- B. Related Requirements:
 - 1. Section 10 14 00 – Identification Devices.
 - 2. Section 26 05 00 - Common Work Results for Electrical.
 - 3. Section 26 28 01 - Low-Voltage Circuit Protective Devices.
 - 4. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. PB 1, Panelboards.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - b. 67, Standard for Panelboards.

1.3 DEFINITIONS

- A. Branch Circuit Panelboard: Bus rating of 400A and less or where labeled as Branch Circuit Panelboard on the Drawings.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data.
 - a. Provide submittal data for all products specified in PART 2 of this Section.
 - b. See Section 26 05 00 for additional requirements.
 - 2. Fabrication and/or layout drawings:
 - a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. Panelboard schedules with as-built conditions.
- C. Informational Submittals:
 - 1. Service equipment marking and documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Eaton.
 - 2. GE by ABB.
 - 3. Square D by Schneider Electric.
 - 4. Siemens Corporation.

2.2 MANUFACTURED UNITS

- A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.
- B. Ratings:
 - 1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
 - 2. Short Circuit Current Rating (SCCR) and/or Ampere Interrupting Current (AIC) ratings equal to or greater than the interrupting rating indicated on the Drawings or in the schedule.
 - a. Series rating is not acceptable.
 - b. When fault current or minimum interrupting rating is not indicated, use rating of upstream equipment or infinite bus calculation of transformer secondary.
- C. Construction:
 - 1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- D. Bus Bars:
 - 1. Main bus bars:
 - a. Tin plated aluminum or tin-plated copper sized to limit temperature rise to a maximum of 65 degrees C above an ambient of 40 degrees C.
 - b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
 - 2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
 - 3. Neutral bus bars: Insulated 100% rated and with solderless mechanical type connectors.
- E. Overcurrent and Short Circuit Protective Devices:
 - 1. Main overcurrent protective device:
 - a. Molded case circuit breaker.
 - 2. Branch overcurrent protective devices:
 - a. Molded case circuit breaker.
 - 3. See Section 26 28 01 for overcurrent and short circuit protective device requirements.
 - 4. Factory installed.
- F. Enclosure:
 - 1. Boxes: Code gage galvanized steel, furnish without knockouts.
 - 2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
 - 3. Branch circuit panelboard:
 - a. Trims for surface mounted panelboards, same size as box.
 - b. Nominal 20 inches wide and 5-3/4 inches deep with gutter space in accordance with NFPA 70.
 - c. Clear plastic cover for directory card mounted on the inside of each door.
 - d. Where NEMA 3R: Door gasketed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.
- B. Support panelboard enclosures from wall studs or modular channels support structure, per Section 26 05 00.
- C. Provide NEMA rated enclosure as indicated on the Drawings.
- D. Equipment Marking and Documentation:
 - 1. Provide labeling per NFPA 70 and other applicable codes.
 - 2. Service equipment:
 - a. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
 - 3. Other than service equipment:
 - a. Available fault current label. (Ref. NFPA 70 Article 408.6)
 - 4. Identify (tag) all equipment and equipment components.
 - 5. Provide labels and tags in accordance with Section 10 14 00.
 - 6. Available fault current and other required label data as indicated on the Drawings with overcurrent device clearing times provide by the manufacturer of the installed device.
- E. Provide each panelboard with a typed directory:
 - 1. Identify all circuit locations in each panelboard with the load type and location served.
 - 2. Identify spare overcurrent devices.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Material and installation requirements for:
 - a. Receptacles.
- B. Related Requirements:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 05 33 - Raceways and Boxes for Electrical Systems.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. WD 1, General Color Requirements for Wiring Devices.
 - c. WD 6, Wiring Devices - Dimensional Requirements.
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 498, Standard for Attachment Plugs and Receptacles.
 - b. 943, Ground-Fault Circuit-Interrupters.
 - c. 1310, Standard for Class 2 Power Units.
 - d. 1449, Standard for Surge Protective Devices.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Section.
 - b. See Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Receptacles:
 - a. Bryant Electric.
 - b. Cooper Wiring Devices by Eaton.
 - c. Hubbell Incorporated Wiring Device-Kellems.
 - d. Leviton Manufacturing Company.
 - e. Legrand/Pass & Seymour.
 - f. Eaton Crouse-Hinds.
 - g. Appleton Electric Co.
 - h. Hubbell Killark.

2.2 RECEPTACLES

- A. Basic requirements unless modified in specific requirements paragraph of receptacles and per designated areas:
 - 1. Industrial Specification Grade.
 - 2. Straight blade.
 - 3. Brass triple wipe line contacts.
 - 4. One-piece grounding system with double wipe brass grounding contacts and self-grounding strap with grounding terminal.
 - 5. Back and side wired.
 - 6. Rating: 20 A, 125 VAC.
 - 7. High impact nylon body.
 - 8. Receptacle body color:
 - a. Normal power: White.
 - 9. Duplex or simplex as indicated on the Drawings.
 - 10. Configuration: NEMA 5-20R.
 - 11. Standards: UL 498, UL 514A, NEMA WD 1, NEMA WD 6.
- B. Receptacle Type Specific Requirements:
 - 1. Basic receptacles:
 - a. Weather-resistant when located in exterior locations.
 - 1) Identification: Letters "WR" on face of receptacle.
- C. Exterior Locations Specific Requirements:
 - 1. Coverplate:
 - a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 inches minimum cover depth for #12 AWG cord.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Mount devices where indicated on the Drawings and as scheduled in Section 26 05 00.
- C. See Section 26 05 33 for device outlet box requirements.

END OF SECTION

SECTION 26 28 01
LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Low voltage circuit breakers.
- B. Related Requirements:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
 - 2. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
 - 3. Underwriters Laboratories, Inc. (UL):
 - a. 248-1, Low-Voltage Fuses - Part 1: General Requirements.
 - b. 248-12, Low-Voltage Fuses - Part 12: Class R Fuses.
 - c. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
 - d. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
 - e. 1053, Standard for Ground-Fault Sensing and Relaying Equipment.
 - f. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data including:
 - a. Provide submittal data for all products specified in PART 2 of this Section.
 - b. See Section 26 05 00 for additional requirements.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Circuit breakers:
 - a. Eaton.
 - b. GE by ABB.
 - c. Square D Company.

- d. Siemens.
- 2. Fuses:
 - a. Eaton Bussmann, Inc.
 - b. Littelfuse, Inc.
 - c. Mersen

2.2 CIRCUIT BREAKERS

A. Molded Case Type:

- 1. General:
 - a. Standards: UL 489.
 - b. Unit construction.
 - c. Over-center, toggle handle operated.
 - d. Quick-make, quick-break, independent of toggle handle operation.
 - e. Manual and automatic operation.
 - f. All poles open and close simultaneously.
 - g. Three position handle: On, off and tripped.
 - h. Molded-in ON and OFF markings on breaker cover.
 - i. One-, two- or three-pole as indicated on the Drawings.
 - j. Current and interrupting ratings as indicated on the Drawings.
- 2. Thermal magnetic type:
 - a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
 - b. Frame size 150 amp and below:
 - 1) Non-interchangeable, non-adjustable thermal magnetic trip units.
 - c. Ground Fault Circuit Interrupter (GFCI) Listed:
 - 1) Standard: UL 943.
 - 2) One- or two-pole as indicated on the Drawings.
 - 3) Class A ground fault circuit.
 - 4) Trip on 5 mA ground fault (4-6 mA range).
 - d. Switching Duty (SWD) Listed:
 - 1) 15 and 20 amp rated at 347 V and less.
 - 2) Suitable for switching fluorescent lighting loads on a regular basis
- 3. Solid state trip type:
 - a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.

2.3 FUSES

A. UL Class RK-1 fuses:

- 1. Standard: UL 248-1 and UL 248-12.
- 2. Single-element fast-acting and current limiting rejection type.
- 3. Dual-element time-delay and current limiting rejection type.
- 4. Ratings: 250 and 600 V, 1/10-600 amps and 200,000 RMS AIC symmetrical.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Current and interrupting ratings as indicated on the Drawings.
- B. Series rated systems not acceptable.

- C. Devices shall be ambient temperature compensated.
- D. Circuit Breakers:
 - 1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
 - a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
- E. Fuses:
 - 1. UL Class J: Use for feeder devices 600 amps and smaller.

3.2 FIELD QUALITY CONTROL

- A. Ground Fault Protection System:
 - 1. Single source system:
 - a. Main breaker using the residual sensing method system coordinated with individual feeder breakers using the residual sensing method.

END OF SECTION

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SECTION 26 28 16.16

ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Safety switches.
- B. Related Requirements:
 - 1. Section 26 05 00 - Common Work Results for Electrical.
 - 2. Section 26 28 01 - Low-Voltage Circuit Protective Devices.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
 - 2. Underwriters Laboratories, Inc. (UL):
 - a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Product technical data:
 - a. Provide submittal data for all products specified in PART 2 of this Section.
 - b. Provide a Summary Table or use Exhibit A that associates the safety switch features with connected equipment tag number. Exhibit A indicates minimum data required.
 - c. See Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
 - 1. Eaton.
 - 2. GE by ABB.
 - 3. Square D by Schneider Electric.
 - 4. Siemens Corporation.
 - 5. Appleton by Emerson Electric Co.
 - 6. Crouse-Hinds by Eaton.
 - 7. Killark by Hubbell.

2.2 SAFETY SWITCHES

- A. General:
 - 1. Fusible as indicated on the Drawings.
 - 2. Suitable for service entrance.
 - 3. NEMA Type HD heavy-duty construction.
 - 4. Switch blades will be fully visible in the OFF position with the enclosure door open.
 - 5. Quick-make/quick-break operating mechanism.

6. Deionizing arc chutes.
 7. Manufacture double-break rotary action shaft and switchblade as one common component.
 8. Clear line shields to prevent accidental contact with line terminals.
- B. Ratings:
1. Voltage and amperage: As indicated on the Drawings.
 2. Short circuit withstand:
 - a. Fused: 200,000A.
- C. Accessories, when indicated in PART 3 of this Section or on the Drawings:
1. Neutral kits.
 2. Ground lug kits.
 3. Auxiliary contact kits:
 - a. Opens before main switch.
 - b. Rated 10A at 125/250 VAC.
 - c. One N.O. and one N.C. contact.
- D. Enclosures:
1. NEMA 3R rated:
 - a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
 - b. With or without knockouts, hinged and lockable door.
- E. Overcurrent and short circuit protective devices:
1. Fuses.
 2. See Section 26 28 01 for overcurrent and short circuit protective device requirements.
- F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install as indicated and in accordance with manufacturer's instructions and recommendations.
- B. Install switch on the exterior of the electrical equipment cabinet as indicated on the Drawings.

END OF SECTION

EXHIBIT A

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SECTION 26 42 17
IMPRESSED CURRENT CATHODIC PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes the procurement, installation, and testing of a cathodic protection system components utilizing an impressed current system(s) (ICCP). The ICCP deep well anode beds and rectifier systems will be installed by others under separate contract. The pipeline will be electrically bonded to connecting segments.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 03 - Concrete
- B. Division 26 - Electrical
- C. Section 31 23 33 - Utilities - Trenching, and Backfilling
- D. Section 33 05 19 – Ductile Iron Utility Pipe
- E. Section 33 05 24 – Steel Utility Pipe

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. American Concrete Institute (ACI)
 - 1. 229R Report on Controlled Low-Strength Materials
- B. American National Standards Institute (ANSI)
 - 1. C80.1 Electric Rigid Steel Conduit
- C. American Petroleum Institute (API)
 - 1. 13A Section 9 Specification for Drilling Fluid
- D. American Society for Testing and Materials (ASTM)
 - 1. B3 Soft or Annealed Copper Wire
 - 2. B338 Seamless and Welded Titanium and Titanium Alloy Tubes for Condensers and Heat Exchangers
 - 3. B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 4. C94 Ready Mix Concrete
 - 5. D1248 Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
 - 6. D3032 Standard Test Methods for Hookup Wire Insulation
 - 7. F480 Standard Specification for Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), SCH 40 and SCH 80
 - 8. ASTM B843 Standard Specification for Magnesium Alloy Anodes for Cathodic Protection
- E. NACE International (formerly the National Association of Corrosion Engineers)

1. SP0100 Cathodic Protection to Control External Corrosion of Concrete Pressure Pipelines and Mortar-Coated Steel Pipelines for Water or Waste Water Service
2. SP0169 Control of External Corrosion on Underground or Submerged Metallic Piping Systems
3. SP0286 Electrical Isolation of Cathodically Protected Pipelines
4. SP0572 Recommended Practice for Design, Installation, Operation and Maintenance of Impressed Current Deep Ground beds
5. TM0113 Standard Test Method Evaluating the Accuracy of Field-Grade Reference Electrodes
6. TM0497 Measurement Techniques Related to Criteria for Cathodic Protection on Underground or Submerged Metallic Piping Systems

F. National Electrical Manufacturer's Association (NEMA)

1. 250 Enclosures for Electrical Equipment (1000-Volts Maximum)
2. FU 1 Low Voltage Cartridge Fuses
3. ST 1 Specialty Transformers
4. ST20 Dry Type Transformers for General Applications
5. TC 2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
6. TC 3 Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

G. National Fire Protection Association (NFPA)

1. 70 National Electric Code

H. Colorado Division of Water Resources Department of Natural Resources

1. GWS-01 – GWS-78 Water Well Permitting
2. 2 CCR 402-2 Construction Rules
3. Title 37 Article 91 Water Well Installation Licensing

I. Underwriters Laboratories, Inc. (UL)

1. 6 Electrical Rigid Metallic Conduit, Steel
2. 83 Thermoplastic-Insulated Wires and Cables
3. 467 Grounding and Bonding Equipment
4. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
5. 489 Molded-Case Circuit Breakers and Circuit-Breaker Enclosures
6. 506 Specialty Transformers
7. 510 Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
8. 514 Outlet Boxes and Fittings
9. 651 Sch. 40 and Sch. 80 Rigid PVC Conduit

1.4 GENERAL REQUIREMENTS

- A. The Plans indicate the general arrangement of the cathodic protection facilities to be constructed. Where no dimensions are indicated on the Plans, the locations cathodic protection test stations, and conduits may be changed up to 5-feet without the approval of the Engineer to avoid interference with other utilities and unforeseen obstacles. Where specific dimensions are

shown on the Plans, or where proposed changes are greater than 5-feet, written approval by the Engineer is required. Where applicable, materials and equipment shall bear evidence of UL approval and conform to the requirements of all applicable federal, state and local laws, codes, and regulations.

1.5 SUBMITTALS

- A. Manufacturer's information for each item listed below. Include sufficient information to show that the materials meet the requirements provided herein, including references to specific sections and details shown on the Plans.
 - 1. Pipe Lead Electrical Wire
 - 2. Connectors and weld for wire to pipe connections.
 - 3. Shunts
 - 4. Resistors
 - 5. Cathodic Protection Test Station Box and terminal boards
 - 6. Concrete (see Division 3 Specifications)
 - 7. Magnesium anodes, if specified for stray-current mitigation.
- B. As-builts of installed system including dimensions as needed to locate facilities. Properly identify all items of equipment and material. Show the exact locations of all buried wires, stray current mitigation anodes and CP test boxes using dimensional ties to existing structures or survey monuments.
- C. Cathodic Protection System Activation Report. Report shall be signed and certified by the Corrosion Engineer stating that the corrosion protection criteria in this specification have been met following the complete construction and activation of the cathodic protection system(s). Certification by the Corrosion Engineer stating that the corrosion protection criteria in these specifications have been met.
- D. Notifications:
 - 1. Provide five days written notice to the Engineer and Owner before testing of reference electrodes to allow tests to be witnessed.
 - 2. Provide five days written notice to the Engineer and Owner before installing stray current mitigation anodes to allow final location to be verified and tests to be witnessed.
 - 3. Provide two days prior written notice to the Engineer and Owner before backfilling around anodes, wires, and welded wire-to-pipe connections to verify that anodes, buried pipe lead wires, and anode lead wires are properly installed and identified.
 - 4. Provide two days prior written notice to the Engineer and Owner before the removal and relocation of the existing equipment.
 - 5. Provide a minimum of five days advance written notice to the Engineer and Owner before testing of the corrosion protection facilities to allow for coordination and observance of tests.

1.6 QUALITY ASSURANCE

- A. The criteria used to indicate adequate corrosion protection welded steel pipe with well bonded coating shall be in accordance with NACE Standard SP0169. Testing of structure-to-soil potentials shall be in accordance with NACE TM0497.
- B. The installation and operation of the cathodic protection system's electrical components shall conform to the National Electrical Code, applicable local codes, and the Recommended Practices of NACE Standards SP0169/SP0100 and SP0572.

- C. Provide all materials, equipment, labor, and supervision necessary for the completion of all installations.
- D. Maintain record drawings for the cathodic protection system throughout the installation of the equipment. Properly identify all items of equipment and material. Show the exact locations of all anodes, buried wires, and CP test boxes using dimensional ties to existing structures or survey monuments. Record all changes by using a red pen or red pencil on full size drawings.

PART 2 - MATERIALS

2.1 GENERAL

- A. All materials to be installed shall be new and comply with the regulations and codes as specified in Article entitled "Reference Specifications, Codes, and Standards" herein. Nothing in the Drawings and Specifications shall be construed as permitting work not conforming to these regulations and codes. Where above mentioned regulations and codes allow smaller size or lower grade materials, these Drawings and Specifications shall have precedence.
- B. Products used in the work shall be produced by manufacturers regularly engaged in the manufacture of similar items.
- C. Where materials are not specified, the Contractor shall provide corrosion-resistant materials suitable for long-term service life in the conditions and locations of the site.

2.2 CONNECTORS

- A. Cable connection lugs for rectifiers, resistor and anode junction boxes shall be constructed from high conductivity high strength copper alloy such as IlSCO Type SLU or CP (-250 or sized for a single conductor) or LU 2 or MU 2 (sized for dual conductors), or equal. Cable connection lugs shall not have any aluminum or steel subcomponents. All current carrying bolts and hardware shall be copper alloy.
- B. Cable terminations within the test station shall utilize one-hole ring-tongue terminals without any aluminum or steel subcomponents. All electrical current carrying bolts and hardware shall be copper alloy or those supplied and recommended by Manufacturer. All crimped connections shall be soldered prior to applying heat shrink sleeve.

2.3 TEST STATION TERMINAL BOX

- A. The test station terminal box shall be Big Fink or approved equal with a 3 inch galvanized steel pipe and WITH "COTTMARK" pipe label system. The No. 10 AWG stranded XLPE insulated test leads shall be exothermically welded to the pipe joint's bell and spigot.

2.4 PLASTIC WARNING TAPE

- A. Plastic warning tape for horizontal runs of buried leads in open-cut cable trenches shall be a minimum of 4 mils thick and 6-inches wide, inert yellow plastic film designed for prolonged use underground. The tape shall have the words, "CAUTION CATHODIC PROTECTION CABLE BELOW," or similar, clearly visible in repeating patterns along its entire length.

2.5 CONCRETE

- A. Concrete used for rectifier and cathodic protection test station installations shall be per Division 03 - Concrete.

2.6 MAGNESIUM ANODES

- A. Anodes used for stray-current mitigation shall be magnesium high potential per ASTM –B843. Anodes shall have the following chemistry:
 - 1. Aluminum 0.01% maximum
 - 2. Manganese 0.5 – 1.3%
 - 3. Copper 0.02% maximum
 - 4. Silicon 0.05% maximum
 - 5. Iron 0.03% maximum
 - 6. Nickel 0.001% maximum
 - 7. Others each 0.05% maximum
 - 8. Magnesium remainder
- B. Anodes shall have an open circuit potential between 1.650 and 1.750 V to a saturated copper-copper sulfate electrode.
- C. Lead wires shall be factory installed #10AWG stranded copper with black insulation, and a minimum length of 20 ft..
- D. Anodes shall be prepackaged in permeable cloth bag with backfill material with the following chemical composition:
 - 1. Gypsum: 75%
 - 2. Bentonite: 20%
 - 3. Sodium sulfate: 5%

PART 3 - EXECUTION

3.1 WIRE-TO-PIPE CONNECTIONS

- A. Exothermically weld the CP test wires to structure as indicated on the Plans. Special care shall be taken to make this weld to the pipe joint's bell and spigot.
- B. Install the cables with sufficient slack so that the cable insulation and conductors will not be damaged during the pipe backfilling process. Protect the cables by running them in schedule 40 PVC electrical conduit. Begin the PVC conduit within 3-feet of the welded wire connections to the structure.
- C. For dielectrically coated steel, cover the exothermically welded connection with a polyethylene weld cap. Seal all around the weld cap and any other areas of exposed steel with a bitumastic coating or a two part high build fast cure epoxy coating. For mortar coated pipe, cementitious patching compound or approved alternative.

3.2 EXOTHERMIC WELDS

- A. Make wire connections to the pipeline or other structure with an exothermic weld process in strict accordance with the manufacturer's instructions.
- B. Provide a minimum separation of 3-inches between multiple exothermic welds.

- C. Remove a minimum amount of the existing coating or mortar required for placement of the weld mold on the steel structure. The steel surface must be completely clean and dry (near white metal surface preparation).
- D. Test the weld integrity by striking it from the side with a two pound hammer. If the weld comes off, move away a minimum of 3-inches and repeat steps A through D.
- E. After testing, apply weld coating.

3.3 INSTALLATION OF BURIED CABLES

- A. Direct buried wires and cables are to be avoided. Install all wires and cables in appropriate sized conduit.
- B. Underground conduit and wires shall be laid in a clean trench, free of debris, rocks or other material that may damage the insulation or conduit. All cables shall be placed in the trench with sufficient slack to eliminate the possibility of strain. Trenches shall be carefully backfilled with squeegee and red electrical caution tape placed six inches above conduit. Avoid damage to the cable. Splices in underground cables shall be made only where specified or shown and in the manner specified herein.

3.4 CATHODIC TEST STATION TESTING

- A. Wire Identification: Provide the Engineer 48 hours advance prior notice to verify that buried pipe lead wires and anode lead wires are properly identified with die stamped brass or stainless steel tags prior to backfilling the wires and the welded wire-to-pipe connections.
- B. Wire Integrity: Test each set of pipe lead wires for electrical continuity to the pipe. Test voltage drop, resistance, and that they provide similar potentials. Excavate the pipe and replace the pipe lead wires if more than twice the theoretical resistance of the pipe lead wire lengths is measured.

3.5 CATHODIC PROTECTION SYSTEM ACTIVATION

- A. The City and its Corrosion Engineer shall perform the inspection testing.
- B. Before beginning each day of testing, calibrate portable copper sulfate reference electrodes with respect to a master reference copper sulfate reference electrode in accordance with NACE TM0113.
- C. Measure CP Native Potentials (i.e. baseline pipe-to-soil potentials) at all Cathodic Test Stations prior to activating the cathodic protection system. Measure CP Native Potentials on both sides of all insulating flanges, monolithic insulators, dielectric unions, and at all CTS wires.
- D. At CTS constructed with buried copper/copper sulfate reference electrodes (i.e. stationary reference electrode") measure Native Potentials of the pipeline using both the stationary reference electrode and a portable copper sulfate reference electrode before the CP system is activated.
- E. Owner's Corrosion Engineer will activate the cathodic protection system by energizing the rectifier(s) and setting their output(s) to the estimated output required.
- F. Measure CP "On Potentials" at the same locations where CP "Native Potentials" were previously measured.

- G. Measure all anode currents at anode junction boxes by measuring the voltage drop across the calibrated shunts provided. Calculate the corresponding amount of direct current flow using the shunt rating. Explicitly state the shunt rating on each data sheet.
- H. Remeasure CP "On Potentials" at all CTS at least two weeks after the initial energization of the cathodic protection system to allow for the development of the cathodic polarization process. Install electronic current interrupters at the rectifier to continuously cycle the system on for 12 seconds and off for 3 seconds. If multiple rectifiers exist for a single electrically continuous section of pipeline, temporarily install current interrupters in all rectifiers for each pipe section and adjust them for isochronal cycles. Measure CP On Potentials and CP Off Potentials at all rectifiers and CTS.
- I. Furnish all test results including all CP Potential readings, anode current readings, insulating flange test data, dates, and times. Reference all data to pipeline station numbers. Submit all data along with a letter report to the Engineer. The letter report shall include a description of the test methods, analysis of the data, and conclusions about the CP system's effectiveness. Submit all data in spreadsheet format compatible with Microsoft Excel. Submit data in both hard copy and computer disk format.

3.6 ACCEPTANCE CRITERION FOR COATED STEEL PIPE

- A. Per NACE SP0169, a polarized potential of -0.850V

3.7 INSTALLATION OF MAGNESIUM ANODES

- A. Install magnesium anodes as indicated on the plans on foreign pipelines. Installation shall be coordinated with pipeline owner.
- B. Anodes shall be connected to pipeline with exothermic welding, and connected in test stations as shown in the plans and details
- C. Protect anodes before installation from damage, anodes shall be protected from the weather and installed dry.
- D. Anodes may be placed horizontally or vertically. Place anodes in native soils free of rocks and sand and backfill just to cover anode, add 5 gallons of potable water and allow to soak in. Back fill in layers, compacting each layer, and protect wires for damage.

END OF SECTION

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SECTION 26 43 13

SURGE PROTECTION DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type PC2 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), externally mounted.

B. Related Sections include but are not necessarily limited to:

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
 - b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
 - c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
 - d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
2. Military Standard:
 - a. MIL-STD-220B, Method of Insertion Loss Measurement.
3. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
4. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
 - a. 1283, Standard for Electromagnetic Interference Filters.
 - b. 1449, Standard for Surge Protective Devices.

B. Qualifications:

1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
 - a. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage:

1. The applied surge shall be induced at the 90 degrees phase angle of the applied system frequency voltage.
2. The voltage measured at the end of the 6 inches output leads of the SPD and from the zero voltage reference to the peak of the surge.

B. Let-Through Voltage:

1. The applied surge shall be induced at the 90 degrees phase angle of the applied system frequency voltage.

2. The voltage measured at the end of the 6 inches output leads of the SPD and from the system peak voltage to the peak of the surge.
- C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.
- D. Maximum Surge Current:
 1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current.
 2. Listed by mode, since number and type of components in any SPD may vary by mode.
- E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).
- F. Surge Current per Phase:
 1. The per phase rating is the total surge current capacity connected to a given phase conductor.
 - a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
 - b. The N-G mode is not included in the per phase calculation.
- G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

- A. Shop Drawings:
 1. Product technical data including:
 - a. Manufacturer's qualifications.
 - b. Standard catalog cut sheet.
 - c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
 - d. Testing procedures and testing equipment data.
 - e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
 - 1) Data in the Product Data Sheet heading:
 - a) SPD Type Number per PART 2 of the Specification.
 - b) Manufacturer's Name.
 - c) Product model number.
 - 2) Data in the Product Data Sheet body:
 - a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
 - b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
 - c) Name of the nationally recognized testing laboratory that preformed the tests.
 - d) Warranty information.
 - 3) Data in the Product Data Sheet closing:
 - a) Signature of the manufacturer's official (printed and signed).
 - b) Title of the official.
 - 4) Date of signature.
- B. Operation and Maintenance Manuals:

1. See Section 01 78 23 for requirements for:
 - a. The mechanics and administration of submittal process.
 - b. The content of the Operation and Maintenance Manuals.
2. Warranty.

1.5 WARRANTY

- A. Minimum of a five year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, MIL-STD 220B, UL 1283, UL 1449.

2.2 TYPE PC2 SPD

- A. Product:
 1. SPD tag number or electrical equipment tag number SPD is connected to [_____].
 2. Externally mounted next to panelboard inside electrical equipment enclosure.
 3. Hybrid solid-state high performance suppression system.
 - a. Do not use suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
 4. Do not connect multiple SPD modules in series to achieve the specified performance.
 5. Designed for parallel connection.
 6. Enclosure:
 - a. Metallic NEMA 4 or 4X for exterior locations.
 7. Field connection:
 - a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors. OR
 - b. Preinstalled lead conductors: Size per manufacturer, length as required with a maximum of 3 feet.
 8. Device monitor:
 - a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phase.
 - b. A fuse status only monitor system is not acceptable.
 9. Accessories (when specifically specified): Unit mounted disconnect switch.
- B. Operating Voltage: Nominal unit operating voltage and configuration as indicated on the Drawings.
- C. Modes of Protection: All modes.
 1. Single phase (2 pole): L-L, L-N, L-G and N-G.
- D. Maximum Continuous Operating Voltage: Less than 130% of system peak voltage.
- E. Operating Frequency: 45 to 65 Hz.
- F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.
- G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.
- H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation of more than 10% deviation of the clamping voltage.

- I. SPD Protection:
 1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
 2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.
- J. Maximum Clamping Voltages: Dynamic test at the 90 degrees phase angle including 6 inches lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		C High V & I Wave	B Combination Wave	
L-L < 250 V L-N < 150 V	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V

- K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.3 SOURCE QUALITY CONTROL

- A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.
- B. The SPD are to be tested as a complete SPD system including:
 1. Integral unit level and/or component level fusing.
 2. Neutral and ground shall not be bonded during testing.
 3. 6 inches lead lengths.
 4. Integral disconnect switch when provided.
- C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.
- D. Tests to be performed in accordance with IEEE C62.45:
 1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
 2. Single pulse surge current capacity test.
 3. Repetitive surge current capacity testing.
 4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Type PC2 SPD:
 1. Mounting options:
 - a. On wall or support structure adjacent to the equipment to be protected with leads routed through conduit. OR
 - b. Nipple connection directly to the equipment to be protected.
 2. Install leads as short and straight as possible.
 3. Maximum lead length: 3 feet.

4. Minimum lead size:
 - a. Type PC2 SPD: #2 stranded AWG.
5. When conduit connection is used, provide a minimum of four twists per foot in the lead conductors and install in NFPA 70 sized conduit.
6. Connect leads to the equipment to be protected by the following means:
 - a. Through a circuit breaker or molded case switch mounted in the equipment.
 - 1) Use manufacturer recommended circuit breaker size.

END OF SECTION

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DIVISION 31

EARTHWORK



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SECTION 31 09 13

TUNNEL INSTRUMENTATION AND MONITORING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Requirements for installation, monitoring, and removal of instrumentation for monitoring of ground movements before, during, and after tunnel construction.
- B. Requirements in this Section apply to all tunnels on the project. Required submittal information must be provided for each tunnel separately.

1.2 RELATED WORK

- A. Related documents and 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), GEI Consultants, July 2026
 - 6. Geotechnical Data Report (GDR), GEI Consultants, July 2026

1.3 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 shall 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. **STRUCTURE MONITORING POINT:** Location at which a building or other structure will be monitored for horizontal and vertical movement during tunnel and shaft construction.
- J. **UTILITY MONITORING POINT:** Location at which utilities will be monitored for vertical movement during tunnel and shaft construction.
 - 1. See Related Specification Section 31 71 00 – Tunnel Excavation and Initial Support for additional definitions.

1.4 GENERAL

- A. Monitor, at a minimum, all instrumentation and monitoring 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.
- C. Monitoring, data acquisition, and data recording may be automated at the Contractor's discretion. Should automation not be feasible for any reason, the Instrumentation Specialist must coordinate with the Owners surveyors to perform manual survey in accordance with this specification.

1.5 REQUIREMENTS

- A. Minimum instrumentation and monitoring requirements are presented herein.
- B. 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.
- C. Positively identify all utilities within the project location.
- D. Obtain applicable permits from Governing Agencies and utility owners to perform instrumentation and monitoring work.
- E. Remove or abandon in place all instrumentation in accordance with applicable laws, regulations, and guidelines following completion of construction.
- F. As a minimum install all instrumentation as shown in the Contract Drawings and in accordance with this specification.

1.6 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.

1.7 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. Tunnel 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.
 - c. For all instruments installed in boreholes and potholes:
 - 1) Detailed step by step procedures for installation.

- 2) Post installation acceptance test.
- 3) Sample installation record sheet.
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

2.1 GENERAL

- A. Surface Survey and Utility Monitoring Points shall 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.

2.2 PRODUCTS

- A. Automated Motorized Total Station (AMTS)
 1. If used, the AMTS system shall be capable of the required survey accuracy as specified herein. The monitoring system shall be able to monitor and correct for temperature variations as measurements are collected in real time. The procedure and method of collection and corrections shall be submitted to the Engineer for acceptance.
 2. The monitoring system shall be able to recognize and adjust for movement of the AMTS in real time and adjust the data to accurately report readings. A minimum of three backsight control targets are to be installed outside the zone of construction and read by the ATMS for each round of monitoring to correct for the movement of the unit immediately after each set of measurements.
- B. Surface Survey Points: If the Contractor elects to use an AMTS, surface survey points indicated on the drawings installed in pavement are to consist of one Road Prism. If the Contractor elects to use manual survey methods, surface survey points indicated on the drawings installed in pavement are to consist of one PK nail. Each Surface Survey Point is to be tagged or marked to indicate the identification number, tunnel station and offset from centerline.
 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 if an AMTS is utilized. Prisms are to be mounted in accordance with Manufacturer's recommendations.
 2. PK nails installed in pavement are to be nails that are driven or drilled and grouted into the pavement at locations shown on the Drawings or as approved by the Engineer if manual survey methods are utilized.

- C. Utility Monitoring Points: Each utility monitoring point shall consist of a pipe casing that exposes the utility and retains the ground to allow for multiple readings throughout the work.
 - 1. Utility Monitoring Points may be a Geo Instruments Utility Monitoring Point or approved equivalent and installed as shown on the Contract Drawings and per Manufacturer's recommendations.
 - 2. Utility Monitoring Points may be monitored using an AMTS or a displacement sensor that automatically transmits measurements to a gateway via wireless logger.
 - 3. If the Contractor elects to use manual survey methods, Utility Monitoring Points can consist of a survey rod placed on the utility for each reading or approved equivalent and installed as shown on the contract drawings and per Manufacturer's recommendations.
- D. Survey Equipment: The selected survey equipment shall have an accuracy of 0.01 feet.
- E. Wireless Loggers: Wireless Loggers shall be Geo Instruments GeoCloud Wireless Logger equipped with LoRaWAN or approved equivalent, if used.
- F. Wireless Gateways: Wireless Gateways shall be Geo Instruments GeoCloud Wireless Gateway or approved equivalent, if used.

PART 3 - EXECUTION

3.1 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 a minimum of two weeks prior to the start of tunnel construction, as described in Section 3.05.
- B. 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.

3.2 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.

3.3 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.

3.4 INSTALLATION

- A. If an Automated Motorized Total Station (AMTS) is utilized:
 - 1. Install AMTS and establish initial baseline readings of the AMTS position prior to monitoring. Complete at least three readings to verify accuracy of the equipment. If readings are within tolerances, proceed to take base line readings of monitoring points.
 - 2. Furnish protective enclosures to protect equipment from damage based on manufacturer's recommendation.
 - 3. Recalibrate AMTS based on manufacturer's recommended intervals.
- B. 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.
- C. Surface Survey Points:
 - 1. Install surface Survey Points at locations as shown on the Contract Drawings or as approved or directed by the Engineer.
 - 2. Each Surface Survey Point shall consist of a Road Prism if monitored through and AMTS or one PK nail if monitored through manual means.
 - 3. Collect an x, y, z baseline value for the Surface Survey Points. Road Prisms shall be monitored by an Automated Motorized Total Station (AMTS) for movement in the x, y, and z directions for each reading. PK nails shall be monitored by manual survey means.
- D. Utility Monitoring Points:
 - 1. Install Utility Monitoring Points per manufacture recommendation or as shown on the Contract Drawings.
 - 2. Be responsible for any damage to the utility during installation of the Utility Monitoring Points and replace or repair as necessary to facilitate monitoring.
 - 3. Use one of three options to measure the elevation of each utility:
 - a. Lower a rod into the hole until it rests on the utility. Place centralizers around the rod to prevent it from moving in the hole. Take survey readings from the top of the rod.
 - b. Temporarily lower a survey rod down the pipe casing until it rests on the utility. Take survey readings from the rod.
 - c. Using automated equipment configured as described in 2.2C.
 - 4. Monitor utility monitoring points for movement in the z direction only for each reading.

3.5 MONITORING

- A. Data Collection: Collect data by AMTS or manual survey for all instrumentation points as installed and detailed in 3.04.
- B. Control Points: Establish, at minimum, three survey control points per survey location to be used as backsight control targets. Control points shall be placed by the Instrument Surveyor outside the zone of influence of construction as approved by the Engineer.
- C. Initial Readings: Take initial readings of all monitoring points to establish a baseline. Provide the Engineer with Monitoring Point baseline data a minimum of one week prior to the start of construction.
- D. 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	Once Daily	Weekly
Utility Monitoring Points	Twice Weekly	Once Daily	Weekly

Notes:

- a. Daily readings must be taken around the same time each day and no more than four hours apart, i.e. between 8 am and 12 am for each reading.
 - b. Weekly measurements shall occur until movement between successive measurements is negligible as determined by the Engineer and monthly thereafter until the Tunnel Contractor demobilizes from the site. A minimum of two weekly readings shall be recorded after tunneling completion.
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.
- E. Reporting: Provide final data from readings of all monitoring locations to the Engineer within 1 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.
- F. 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.

3.6 RESPONSE VALUES

- A. Abide by the following response values:

Instrument Type	Response Values	
	Threshold Value	Shutdown Value
Surface Monitoring Points	0.04 feet in Z 0.04 feet in any of X or Y	0.08 feet in Z 0.08 feet in any of X or Y
Utility Monitoring Points	0.04 feet in Z	0.08 feet in Z

- 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. Written restart authorization is required before tunnel work resumes after a Shutdown Value.

3.7 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.
- B. Maintenance: Maintain survey monitoring locations by ensuring survey point identification tags or nomenclature is legible. Maintain batteries and/or solar panels for AMTS, digital sensors, wireless loggers, and wireless gateways as necessary if used so there is zero interruption in the monitoring reading schedule listed in Section 3.5.

3.8 FINAL DISPOSITION

- A. Surface Survey Points. Remove all Surface Survey Points in accordance with applicable laws, regulations, and guidelines.
- B. Utility Monitoring Points. Remove all Utility Monitoring Point materials. Utility Monitoring Point locations shall match the previous conditions prior to Utility Monitoring Point installation.

END OF SECTION

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SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Site clearing Work, including:
 - a. General provisions for site clearing Work.
 - b. Preparation for site clearing Work.
 - c. Clearing and grubbing.
 - d. Tree protection, selective removals, and selective trimming.
 - e. Disposal and cleaning.
 - f. Stripping and stockpiling of topsoil.
- B. Related Requirements: Include but are not necessarily limited to:
 - 1. Section 31 23 33 - Utilities - Trenching and Backfilling.

1.2 REFERENCES

- A. Terminology:
 - 1. Terms indicated below are not defined terms indicated with initial capital letters but, when used in this Section, have the meanings indicated below:
 - a. "Arborist" means Subcontractor retained to perform Work requiring a specialist in trees, shrubs, brush, other vegetation of the types existing at the Site, and possessing not less than the required qualifications indicated in this Section.
 - b. "Clearing and grubbing" means removing and disposing of all: (1) trees, brush, and other vegetation, logs, and similar items ("clearing"); and (2) stumps, roots, logs, rubbish, and debris on or in the soil ("grubbing") after Clearing. Clearing and grubbing includes grinding and removing of stumps. When clearing and grubbing, topsoil stripping and stockpiling, and required demolition Work is complete, the Site will be ready for grading and other new construction.
 - c. "Demolition" means removal, whether in whole or in part, of existing human-made construction, such as removal of buildings, structures, and building systems; site work (such as pavement, curbs, sidewalks, gutters) and the like; Underground Facilities; and other existing construction.
 - d. "Selective removal" means removal of specific trees, shrubs, brush, and other vegetation, whether as shown or indicated in the Contract Documents or as directed at the Site by Construction Manager.
 - e. "Selective trimming" means removal of selected parts of trees, shrubs, brush, and other vegetation, performed by arborist, for the purpose of either: (1) allowing installation of new construction adjacent to or through the tree, shrub, brush, or vegetation, or (2) removing damaged or unhealthy growth, to allow balance of the subject tree, shrub, brush, or vegetation to continue normal, healthy growth.
 - f. "Site clearing" means all the Work required by this Section and related Drawings.
 - g. "Topsoil" means existing material at the Site, visible after clearing and grubbing, to be stripped, when such material is friable, clay loam, surface soil present in depth of not less than four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material. Topsoil required for planting and landscaping Work in the Specifications of Division 32 may differ from the meaning indicated in this Section.
- B. Reference Standards:

1. ASTM International (ASTM):
 - a. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
 - b. D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
2. American National Standards Institute (ANSI):
 - a. A300, Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices.
3. International Society of Arboriculture (ISA):
 - a. Container Rootball Shaving.
 - b. Crown Correction.
 - c. Balled and Burlapped Root Correction.
 - d. Container Root Correction.
 - e. High Branched Crown Observation.
 - f. Low Branched Crown Observation.
 - g. Multiple Low Branches Crown Observation.
 - h. Balled and Burlapped Root Observation.
 - i. Container Root Observation - Tree.
 - j. Protection Maintenance.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Pre-Clearing Conference:

1. Prior to commencing site clearing Work, actively participate in conference regarding site clearing Work. Date, time, and location of conference will be mutually established by Contractor, Owner, and Construction Manager.
2. Participants:
 - a. Required Participants: Contractor's project manager, Contractor's site superintendent, arborist, Construction Manager.
 - b. Potential Participants: Owner, and representative of properties (other than Owner) affected by site clearing Work,
3. Owner will chair the conference, prepare and distribute an agenda, and prepare and distribute a record of the conference.
4. Participants shall be prepared to discuss:
 - a. Project requirements and the Contract requirements for site clearing Work.
 - b. Submittals required for site clearing Work.
 - c. Schedule for site clearing Work and availability of resources.
 - d. Locations and types of site clearing Work, with specific attention to areas of selective removals, selective trimming, and notable species. Limits of clearing and grubbing. Proposed locations for stockpiles and temporary storage of cuttings and debris.
 - e. Environmental and other conditions at the Site.
 - f. Growth, vegetation, and existing construction requiring protection.
 - g. Required observations and field quality control for site clearing Work.
5. If additional information affecting site clearing Work subsequently comes to light, reconvene the conference at earliest opportunity.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Arborist:

- a. Where selective removal, selective trimming, or both are required or necessary, retain the services of, and employ in the Work, accredited arborist, possessing qualifications acceptable to Construction Manager.
- b. Arborist shall be skilled, trained, and possess documented experience in successfully protecting, trimming, and restorative care of trees and shrubs of the types necessary for the Work.
- c. Certification: Arborist shall be certified by either International Society of Arboriculture (ISA) or American Society of Consulting Arborists (ASCA).
- d. Arborist shall use in selective removal and selective trimming Work only workers with specific skill and successful experience in this type of Work required. Such workers shall work under the direct, personal supervision of arborist.
- e. Submit to Construction Manager names, employer(s), certifications, other relevant qualifications and record of relevant experience, as indicated below, for not less than three successful projects involving same species of trees, shrubs, and vegetation as involved in the site clearing Work:
 - 1) Names and telephone numbers of site owners, architects or engineers responsible for projects.
 - 2) Approximate contract price of the selective removal and selective trimming of trees, shrubs, and vegetation.
 - 3) Approximate time of year work was performed on each referenced project.
 - 4) Approximate quantity and types of selective removal and selective trimming of performed.
 - 5) General indication of species of trees, shrubs, and vegetation involved.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:

- a. Limits of Site Clearing Work: When limits of site clearing Work are not expressly shown on the Drawings, or where Contractor proposes alternative limits of site clearing Work, submit drawings, developed from the Drawings, clearly indicating proposed limits of site clearing Work, with dimensions indicated where appropriate.
- b. Where proposed limits of clearing and grubbing, selective removals, and topsoil stripping are not identical with each other, clearly and expressly indicate limits of each on the Shop Drawings. .

B. Informational Submittals: Submit the following:

1. Permits and Approvals:

- a. Submit copy of each permit required and obtained for site clearing Work, issued by authority having jurisdiction.
- b. Where Owner's permission or approval is required for selected site clearing activities, submit copy of Owner's written permission or approval for such activity.
- c. When approval of owner of property (other than Owner) is required for selected site clearing activity, submit to Construction Manager written copy of such approval.

2. Certificates:

- a. Arborist's certification that trees and shrubs shown or indicated to remain were protected during the site clearing Work in accordance with the Contract Documents.
- b. Where trees or shrubs (shown or indicated to remain) were damaged during site clearing Work, submit arborist's certification that such trees and shrubs were promptly and properly treated or, where successful treatment was not feasible, were replaced.

3. Qualifications Statements:

- a. Arborist qualifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Tree Wound Dressing:
 - 1. Provide tree wound dressing, waterproof, adhesive and elastic with an antiseptic, free from kerosene, coal tar, creosote, and other material injurious to life of tree or other plant.
- B. Drain Tile:
 - 1. Provide four-inch diameter, standard strength, perforated wall, bell-and- spigot clay pipe, in accordance with ASTM C700.
- C. Filter Fabric:
 - 1. In accordance with requirements for temporary erosion and sediment controls indicated in Section 01 57 05 - Temporary Controls.
- D. Drainage Fill:
 - 1. Selected crushed stone, or crushed or uncrushed gravel, washed.
 - 2. Size 24 (in accordance with ASTM D448), with 90 to 100 percent passing 2.5-inch sieve and not more than 10 percent passing 3/4-inch sieve.
- E. Burlap:
 - 1. Jute, not less than 7.2 ounces per square yard.
- F. For other materials needed for site clearing Work, such as stone, topsoil, or other, comply with requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 SITE CLEARING – GENERAL

- A. Limits of Site Clearing Work:
 - 1. Limits of site clearing Work are shown and indicated on the Drawings.
- B. General Provisions for Site Clearing:
 - 1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to perform site clearing Work in accordance with the Contract Documents.
 - 2. Perform site clearing Work to avoid creating nuisances, pollution, and preventable adverse effects on the environment.
 - 3. Comply with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".
 - 4. Excavation required for site clearing shall comply with [Section 31 23 33 - Trenching and Backfilling].
 - 5. Requirements of Authorities Having Jurisdiction:
 - a. Perform site clearing Work in accordance with Laws and Regulations.
 - b. Obtain, pay for, and comply with permits required for site clearing Work. Obtain from authorities having jurisdiction and furnish copy of each permit as a Submittal.
 - 6. Traffic Control:
 - a. Where site clearing Work is along or adjacent to travelled ways subject to public traffic, comply with Section 01 55 26 - Traffic Control.
 - b. Establish such controls prior to and maintain in place throughout site clearing Work that has potential to affect traffic.
 - 7. Site clearing Work shall comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article, unless the Contract Documents indicate more-stringent requirements.

3.2 PREPARATION

A. Permits and Approvals:

1. Do not commence site clearing Work until necessary permits and approvals are obtained and copies furnished to Construction Manager as Submittals.
2. If construction occurs between February and August, a preconstruction nesting bird survey shall be conducted by a qualified wildlife biologist prior to any clearing or tree removal.

B. Delineation of Limits of Site Clearing Work Areas:

1. Locate and clearly flag at the Site:
 - a. Limits of site clearing Work.
 - b. Trees, shrubs, vegetation, and other materials to remain within limits of site clearing Work.
 - c. Trees, shrubs, and other vegetation to be selectively trimmed.
 - d. Trees, shrubs, and vegetation to be selectively removed.
 - e. Salvageable trees, shrubs, and vegetation (to be relocated) within limits of site clearing Work.
2. Flagging:
 - a. Flagging shall be high-visibility type. Where necessary, provide lath or stakes driven into the ground, with flagging, to clearly delineate limits.
 - b. Provide different-colored flagging for each type of delineation required by this Article.
 - c. Promptly replace lost, moved, or destroyed flagging until Construction Manager concurs that flagging is no longer needed.
3. Review with Construction Manager:
 - a. Before starting site clearing Work, other than flagging, review at the Site with Construction Manager.
 - b. Make corrections as necessary.
 - c. Review all trees to be removed or selectively trimmed.
 - d. Review with Construction Manager at the Site trees and shrubs to be selectively trimmed, to reach mutual agreement on extent of selective trimming required.

C. Protection: Establish protection of trees, shrubs, and vegetation to remain, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming", and other applicable provisions of the Contract Documents.

D. Temporary Erosion and Sediment Controls:

1. Provide applicable temporary erosion and sediment controls before commencing clearing and grubbing and topsoil stripping Work.
2. Comply with temporary erosion and sediment control requirements of Section 01 57 05 - Temporary Controls.
3. Continue providing temporary erosion and sediment controls as clearing and grubbing and topsoil stripping and stockpiling Work progresses into previously uncleared, ungrubbed areas of the Site...

3.3 CLEARING AND GRUBBING

A. Clearing and Grubbing – General:

1. Remove and dispose of all materials constituting clearing and grubbing Work within limits shown and indicated in the Contract Documents.
2. After grubbing Work is complete, properly fill holes resulting from grubbing before commencing site grading Work.

B. Trees and Shrubs Improperly Destroyed or Damaged:

1. Refer to this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".
- C. Trees and Shrubs to Remain:
1. Trees and shrubs to remain shall be protected, and trimmed where necessary or required, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".

3.4 TREE PROTECTION, SELECTIVE REMOVALS, AND SELECTIVE TRIMMING

- A. General Provisions for Tree Protection, Selective Removals, and Selective Trimming:
1. Contractor shall be responsible for removing and disposing of trees identified for removal on the Drawings. Unless indicated otherwise, the Contractor shall not be responsible for replacing any removed trees. Tree replacement requirements associated with Larimer County approval conditions that are not included in these Contract Documents will be performed under a separate contract, procured and administered by the Owner through a third-party landscape contractor.
 2. Provide temporary fencing, barricades, or guarding measures, as recommended by arborist, outside drip line of trees and shrubs to remain.
 3. Protect root systems from damage caused by noxious materials, storm water runoff, site clearing, planting and landscaping, other Work, and storage of materials and equipment. Protect root systems from flooding, erosion, and excessive wetting resulting from dewatering of excavations, drainage of tanks, and other construction activities.
 4. Fires are not allowed under or adjacent to trees, shrubs, and other vegetation to remain.
 5. Do not store matter resulting from site clearing or demolition, topsoil, or other excavated material within drip line of trees and shrubs to remain. Vehicles are not allowed within drip line. Restrict foot, vehicle and equipment traffic to prevent compaction of soil over root systems. Where such activities are unavoidable, and only as acceptable to Construction Manager, provide temporary, continuous, heavy-duty wood planking effectively fastened together and capable of distributing loads from such activities. Temporary planking shall be underlaid by layer of filter fabric covered with two-inch layer of gravel.
 6. Cut branches and roots, when necessary, with sharp pruning instruments; do not break or chop. Fully paint cuts 1/2-inch and larger in size with tree wound dressing.
- B. Excavation and Protection of Trees and Shrubs:
1. Excavate within drip line of trees only where shown.
 2. Where trenching for utilities is required within drip line, dig by hand under supervision of arborist. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of the Work.
 3. Where excavation for the Work is required within drip line of trees or shrubs, hand excavate to minimize damage to root systems. Perform excavation under supervision of arborist. Provide temporary shoring or other protective support systems at excavations, to minimize sloping and benching of excavations. Use narrow tine spading forks and comb excavated material to expose roots.
 4. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of construction and relocation is not practical, cut roots approximately three inches back from construction.
 5. Do not allow exposed roots to dry out before permanent backfill is provided; provide temporary earth cover. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.
- C. Grade Adjustments and Tree Protection:
1. Maintain existing grade within drip line of trees, unless otherwise shown or indicated.
 2. Lowering of Preconstruction Grade:

- a. Where required finish grade is below preconstruction grade around trees and shrubs, grade beyond drip line. Maintain preconstruction grade within drip line of trees and shrubs.
 - b. Prune tree and shrub roots exposed during grade lowering, or provide permanent protections as recommended by arborist. Do not cut main or lateral roots or tap-roots; cut only smaller roots.
 - c. Compensate for loss of roots and prune branches to stimulate root growth.
3. Minor Fills:
- a. Where preconstruction grade is six inches or less below elevation of finish grade shown, fill with topsoil complying with quality requirements of Specifications for finish grading and landscaping.
 - b. Place in single layer and do not compact.
 - c. Hand-grade to required finish elevations.
4. Moderate Fills:
- a. Where preconstruction grade is more than six inches, but less than 16 inches, below finish grade elevation, provide layer of drainage fill and filter fabric on preconstruction grade prior to placing topsoil that complies with quality requirements of Specifications on finish grading and landscaping.
 - b. Carefully place drainage fill against trunk of tree or shrub approximately two inches above elevation of finish grade and extend not less than 1.5 feet from tree or shrub trunk on all sides.
 - c. Provide filter fabric with edges overlapping by 6 inches, minimum.
 - d. Place fill layer of topsoil to finish grade elevation.
 - e. Do not compact stone, gravel or topsoil layers. Hand-grade to required finish elevations.
5. Deep Fills:
- a. Provide an open dry circular well of durable, unmortared stone, located not less than two feet s from trunk of associated tree or shrub.
 - b. To facilitate proper drainage, provide eight to 10 continuous runs of four-inch drain tiles horizontally on the preconstruction ground surface under the complete spread of branches in radial pattern around the tree or shrub.
 - c. Slope drain tiles away from tree or shrub.
 - d. Provide drainage fill on preconstruction ground surface in depth of two inches under and six inches over drain tiles.
 - e. Provide filter fabric over entire top surface of drainage fill.
 - f. Provide eight to 10 drainage tiles, each four-inch diameter, vertically in radial pattern around tree or shrub, located five feet from trunk of tree or shrub. Extend vertical drainage tiles from the filter fabric layer above the horizontal drainage tiles to postconstruction finished grade
 - g. Hold drainage tiles in place with drainage fill.
 - h. Hand-grade to required finish grade elevation.
- D. Tree and Shrub Pruning (Selective Trimming):
- 1. Perform pruning and selective trimming under the supervision of arborist.
 - 2. Remove branches from trees and shrubs to remain only after Construction Manager's concurrence, only to extent necessary to clear location of permanent construction, using branch removal methods in accordance with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 - 3. Extend pruning operation to restore natural shape of entire tree or shrub where pruning is approved by Construction Manager and as recommended by arborist.
 - 4. Prune branches to balance loss to root system caused by damage or cutting of root system.

5. Chip branches removed from trees and shrubs. Stockpile and spread chips as directed by Construction Manager, with arborist's recommendation.
- E. Selective Trimming:
1. In addition to pruning (as required above), perform other selective trimming under direction of arborist.
 2. Comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 3. Where shown or indicated, and as directed by Construction Manager with arborist's recommendation, carefully remove larger branches, when necessary, using appropriate methods.
 4. Repair cut branches in accordance with this Section.
 5. During selective trimming, avoid damaging healthy (to remain) elements of trees and shrubs.
 6. Dispose of trimmings as indicated in this Section's "Disposal and Cleaning" Article.
- F. Selective Removals:
1. Perform selective removals under direction of arborist.
 2. Comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 3. Fully remove trees and shrubs shown or indicated for selective removal.
 4. Remove stumps to not less than one foot below preconstruction ground surface.
 5. During selective removals, avoid damaging adjacent trees and shrubs to remain, and other property.
 6. Remove larger branches before cutting the trunk of tree or shrub being selectively removed.
 7. Dispose of trees and shrubs selectively removed as indicated in this Section's "Disposal and Cleaning" Article.
- G. Repair and Replacement of Trees and Shrubs:
1. Perform tree and shrub repair under direction of arborist.
 2. Cavity Repair:
 - a. Remove decayed areas to depth that exposes healthy tissue.
 - b. Shape cavities to provide drainage.
 - c. Paint inside of cavity with antiseptic tree wound dressing material.
 - d. Do not fill cavities.
 - e. When cavity's cross-section exceeds 60 percent of cross-section of tree or shrub branch, selectively trim subject branch. When cavity's cross-section exceeds 60 percent of cross-section of trunk of tree or shrub, remove tree or shrub upon Construction Manager's authorization. Construction Manager will consider arborist's recommendation. Comply with this Section's requirements for selective trimming and selective removals.
 3. Repair trees and shrubs damaged by construction operations, or selectively trimmed, within 24 hours of occurrence of such damage or selective trimming. Treat damaged trunks, branches, and roots according to written instructions of arborist, in accordance with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article.
 4. Remove trees and shrubs that are (1) dead or destroyed due to construction operations, or (2) damaged beyond reasonable hope of recovery (as determined by arborist) following repairs, or (3) damaged and determined by arborist to be incapable of resuming normal growth pattern after repairs.,
 5. Obtain opinion from arborist regarding whether damaged trees, shrubs, and other vegetation is repairable with reasonable chance of success. Submit arborist's certification required in this Section's "Submittals" Article.

6. Tree replacements shall be addressed separately by Others.

3.5 DISPOSAL AND CLEANING

A. Disposal – General:

1. Dispose of matter resulting from clearing and grubbing, selective removals, and selective trimming, at appropriate offsite location, unless otherwise expressly allowed by the Contract Documents or mutual agreement of Owner and Contractor.
2. Do not use cleared, grubbed, or trimmed material as fill, backfill, or in embankments.
3. Dispose of cleared, grubbed, and trimmed material, and other materials, rubbish, and debris, in accordance with Laws and Regulations.
4. Pay all costs associated with transporting and disposing of materials and debris resulting from site clearing Work.
5. Cleared lumber and trimmings from trees are Contractor's property and, at Contractor's option, may be sold or salvaged offsite.

B. Cleaning:

1. Perform progress cleaning and other cleaning Work, and disposal of resulting materials and debris, in accordance with Section –01 57 05 Temporary Controls.

C. Burning:

1. Burning of trees, shrubs, brush, other vegetation, and other materials at, or adjacent to, the Site, whether in-place or cut, is prohibited unless: (a) burning is not prohibited by Laws or Regulations, and (b) required permits, if any, are obtained by Contractor from authorities having jurisdiction and are furnished to Construction Manager as Submittals; and (c) written approval of Owner is obtained and furnished to Construction Manager as a Submittal; and (d) when burning will be performed on lands at the Site not owned by Owner, obtain and submit to Construction Manager as Submittals written approval of owners of such properties.
2. Before burning, alert local fire department (both orally and in writing) not less than 72 hours before burning, and provide at location of burning appropriate emergency materials, tools, and equipment to contain and extinguish fires. Use such items and furnish necessary labor to prevent fire from burning other than intended trees, shrubs, brush, and vegetation.
3. If burning is allowed, exercise appropriate care and judgement. Do not perform burning in high wind conditions. Do not perform burning when areas adjacent to burning are of dryness that will foster wildfires.
4. Promptly and fully extinguish fires before they burn unintended areas or materials, and when burning is completed.
5. Dispose of ashes and burned materials off-site at appropriate location.

3.6 TOPSOIL STRIPPING AND STOCKPILING

A. Stripping:

1. Before commencing topsoil stripping:
 - a. Perform clearing and grubbing and selective removals.
 - b. Remove grass and other vegetation that may remain following clearing and grubbing.
 - c. Provide necessary and required temporary erosion and sediment controls.
2. Strip topsoil to depths encountered, in manner that prevents intermingling of topsoil with underlying subsoil and other objectionable material. Remove heavy growths of grass and vegetation and material below topsoil.
3. Before stockpiling, separate objectionable material from topsoil.
4. Do not strip topsoil from within drip line of trees and shrubs to remain as part of the completed Project.

B. Stockpiling:

1. Construct and maintain topsoil stockpiles in accordance with Section 01 35 13 – Special Project Procedures.
- C. Reuse of Stripped Topsoil:
1. Reuse in the finish grading and landscaping Work topsoil that complies with the Contract Documents for such Work.
 2. Where topsoil stripped from the Site does not comply with the Contract Documents relative to quality required for use in finish grading and landscaping Work, provide appropriate soil amendment material, properly and fully mixed into topsoil stripped from the Site, so that amended material complies with quality requirements for topsoil required for finish grading and landscaping Work.
- D. Disposal of Excess Topsoil:
1. Topsoil in excess of quantity required for finished Project becomes Contractor's property when Construction Manager indicates finish grading and landscaping Work is complete. Properly dispose of excess topsoil offsite. Contractor may sell excess topsoil at offsite location.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for temporary (during construction) dewatering of excavations including:
 - a. Qualifications of Contractor's design professional retained for designing temporary dewatering systems.
 - b. Contractor's additional investigations and evaluations necessary for designing temporary dewatering systems.
 - c. Performance criteria and general provisions for temporary dewatering systems.
 - d. Disposal of water discharged from temporary dewatering systems.
 - e. Operation, maintenance, and removal of temporary dewatering systems.

B. Related Requirements: Include, but are not necessarily limited to:

1. Section 31 23 33 – Utilities - Trenching and Backfilling.

1.2 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
 - a. "Dewatering" means: Lowering of groundwater surface elevation and intercepting horizontal water seepage to prevent groundwater from entering excavations; removal of water accumulated within excavations; and conveyance of groundwater and water removed from excavations to proper discharge location.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with Section 01 41 24 - Permit Requirements.
2. Comply with Section 01 57 05 - Temporary Controls, regarding permits and approvals of authorities having jurisdiction necessary for disposal of groundwater and water removed from excavations, and temporary erosion and sediment controls.
3. When Contractor intends to use temporary pumps equipped with gasoline- or diesel-fueled engines, obtain and comply with necessary permits and Laws and Regulations, and comply with Section 01 57 05 - Temporary Controls, regarding exhaust emissions, air pollution controls, and noise controls.

B. Qualifications:

1. Professional Engineer or Other Appropriate Design Professional:
 - a. Retain the services of professional engineer, licensed and registered in Colorado, to evaluate groundwater conditions and design temporary systems and equipment for temporary dewatering of excavations.
 - b. Professional engineer shall be appropriately experienced in evaluating groundwater conditions and conductivity in subsurface conditions similar to those at the Site, and in designing and evaluating temporary dewatering systems of the type necessary for the Work.
 - c. Responsibilities shall include:
 - 1) Evaluating existing subsurface data and information for the Site and adjacent areas, available to the Contractor.

- 2) Advising Contractor regarding additional subsurface investigations necessary to provide temporary dewatering systems that will result in dewatering of excavations as required by this Section.
- 3) Evaluating the potential effect of temporary dewatering system operation on existing facilities at and adjacent to the Site.
- 4) Personally designing or supervising the design of temporary dewatering systems necessary for the Work, including preparing drawings, performance requirements, and specifications for temporary dewatering systems such as wells, pumps, and related systems.
- 5) Sealing and signing instruments of service developed for the Work, including calculations, evaluation reports, recommendations of a technical nature, drawings, specifications, and similar documents.
- 6) Assisting Contractor with obtaining permits and approvals necessary for temporary dewatering systems.
- 7) Consulting with Contractor, including visiting the Site during construction as required by Contractor, during installation, operation, and removal of temporary dewatering systems.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:

1. Advisory on Dewatering Approach:

- a. Furnish document regarding Contractor's proposed approach for temporary dewatering of excavations, indicating the following:
 - 1) General indication of Contractor's overall, intended approach for temporary dewatering of excavations; for example, indicate whether a system of temporary wells and pumps will be provided by Contractor, whether Contractor intends or proposes using existing wells and pumps for temporary dewatering of excavations, whether temporary dewatering will be accomplished only via temporary pumps placed in or adjacent to excavations, other approaches, or a combination thereof.
 - 2) Indication of whether Contractor or Subcontractor intends to retain services of a professional engineer or other appropriate design professional relative to temporary dewatering systems. When such individual or entity will be so retained, indicate name of entity and specific, individual design professional-in-responsible-charge, together with indication of type of license and registration and associated license and registration number and jurisdiction. If not previously furnished with Contractor's insurance documentation, furnish evidence that such professional engineer or other appropriate design professional (as applicable) possesses professional liability insurance in accordance with the Contract Documents, including indication of whether required coverage limits have been eroded during the current policy by prior claims.
 - 3) Contractor-proposed modifications to the permanent Work requested to accommodate temporary dewatering systems. In the event such changes are proposed, approval, if any, of such changes will be only via an appropriate Contract modification. If no such changes or modifications are requested prior to start of the Work of this Section, Engineer will proceed on the premise that Contractor-proposed modifications are not intended.
 - 4) Propose locations for discharges from temporary dewatering systems, together with indication of typical anticipated rate of discharge. Also indicate intended approximate locations of aboveground conveyance piping and how Contractor will mitigate effect on Owner, facility manager, and other property owners and occupants where such piping would restrict use or access to existing facilities or property.
 - 5) Anticipated start and end dates for temporary dewatering operations.

- 6) Description of how temporary dewatering systems and operations will, or may, affect Owner, facility manager (if other than Owner), and other property owners and occupants. Include description of how Contractor will mitigate the potential for negative impacts.
 - 7) Indication of Contractor's proposed actions regarding temporary dewatering systems after temporary dewatering operations cease; for example, when temporary wells and pumps are provided by Contractor, indicate whether such items will remain in place and, if so, how they will be prepared for abandonment by Contractor.
- b. Engineer's (or Owner's) review, comments upon, acceptance, or other appropriate action on such Submittal does not, in any way, reduce or mitigate Contractor's sole responsibility for construction means, methods, techniques, procedures, sequences, and associated safety and protection measures.
 - c. Submittal Information for Record Purposes Only: calculations, evaluation reports, recommendations, drawings, or specifications developed, sealed, and signed by Contractor or Subcontractor or by professional engineer or other appropriate design professional retained by Contractor or Subcontractor. Furnishing such documents to Engineer and Owner will not, in any way, reduce or mitigate Contractor's sole responsibility for construction means, methods, techniques, procedures, sequences, or associated safety and protection measures.

1.5 FIELD CONDITIONS

A. Existing Conditions:

1. Refer to Section 31 23 33 – Utilities Trenching and Backfilling.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT FOR TEMPORARY DEWATERING SYSTEMS

A. Description:

1. Provide temporary dewatering systems comprised of materials and equipment suitable for the intended purpose, service environment (including subsurface and groundwater conditions), and duration of use.
2. Contractor shall determine required capacities for elements of temporary dewatering systems necessary for compliance with requirements of this Section and other relevant provisions of the Contract Documents.
3. Provide temporary dewatering system materials and equipment in accordance with Laws and Regulations and generally accepted practices in the industry for temporary systems for dewatering of excavations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification, Evaluation, and Assessment of Existing Conditions:

1. Evaluate information and data available to Contractor regarding subsurface and physical conditions at the Site and adjacent areas relative to groundwater and temporary dewatering systems. Perform additional investigations as necessary to enable Contractor to provide appropriate temporary dewatering systems required to comply with this Section.
2. Such investigations and evaluations by Contractor may include excavating (and subsequently backfilling), test pits to visually observe subsurface conditions and groundwater, test borings, sampling and laboratory analyses, providing monitoring wells and obtaining measurements of groundwater surface elevations, performing drawdown tests using existing wells and pumping equipment, and determining capacities and operating characteristics of existing wells, pumping equipment, and related systems. Obtain

and record data and perform evaluations necessary for Contractor to provide temporary dewatering systems as required.

3. As the Work progresses, evaluate performance of temporary dewatering systems as necessary and modify temporary dewatering systems as appropriate to comply with this Section and other provisions of the Contract Documents.
- B. Installing the Work constitutes Contractor's approval of field conditions prevailing at the time of the Work and condition and operability of existing materials, equipment, and systems (if any) used by Contractor for temporary dewatering.

3.2 TEMPORARY DEWATERING DURING CONSTRUCTION

A. Performance Criteria:

1. Provide and maintain adequate drainage and dewatering equipment to remove and dispose of all surface water and ground water entering excavations, or other parts of the Work and work areas. Keep each excavation dry during excavation, subgrade preparation, and continually thereafter until temporary dewatering system is no longer required, in accordance with Article 3.3 of this Section.
2. Temporary dewatering systems shall depress and maintain groundwater surface level two feet below bottom elevation of each excavation during the Work.
3. Operation Relative to Existing Buildings, Structures, and Facilities:
 - a. Provide, operate, and maintain temporary dewatering systems to avoid settlement and damage to buildings, structures, Underground Facilities, and other facilities.
 - b. Prevent softening and disturbance of subgrade below new construction and fill material, to allow the Work to be constructed in dry conditions, and to maintain stable excavation side slopes and stable temporary supports of excavations.
4. If, in Engineer's opinion, groundwater surface elevations are not as required by the Contract Documents, provide additional or alternative temporary dewatering system components or elements as necessary, at no additional cost to Owner.
5. Groundwater surface elevation shall be lowered in advance of excavating for a sufficient period to allow dewatering of fine-grain soils.
6. Remove water from excavations as fast as water collects.

B. Related Work:

1. Provide temporary erosion and sediment controls in accordance with Section 01 57 05 - Temporary Controls.
2. Comply with Section 01 57 05 - Temporary Controls, regarding control of surface water, storm water runoff, water pollution, air pollution, noise, and others as applicable.

C. Temporary Dewatering Systems - General:

1. Design, provide, operate, and maintain temporary systems for dewatering of excavations in accordance with the Contract Documents, Laws and Regulations, and prevailing practice typical in the industry.
 - a. In the event of conflict between such requirements, obtain interpretation or clarification from Engineer before proceeding.
 - b. Design dewatering systems to avoid adverse impacts on adjacent wells and ditches as well as prevent settlement of surrounding ground.
2. Temporary dewatering systems, may include the following temporary elements: swales, sumps, pumps, hoses, piping, wells (whether dewatering wells, monitoring wells, or other wells), and similar facilities.
3. Furnish, either at the Site or within reasonably close proximity thereto, available standby items, such as pumps, piping, hoses, instrumentation, controls, and others, should elements of operating temporary dewatering system fail.

4. Locate elements of temporary dewatering systems to allow continuous dewatering operation without interfering with the Work, and the work of other contractors (if any), to the extent practicable.

D. Disposal of Water Removed by Dewatering System:

1. Water conveyed by temporary dewatering systems that includes oils, sediments, or Constituents of Concern that will reduce the quality of surface water or groundwater downstream of the point of discharge, shall not be directly discharged. Divert such waters through temporary settling basin, or filters before discharging to surface water, groundwater, or drainage routes.
2. Temporary dewatering systems shall not discharge across roadways, driveways, parking areas, other travelled ways, sidewalks, or overland across other property adjacent to the Site. Where hoses that are part of temporary dewatering system discharge to existing gutters or swales, such discharge shall not exceed capacity of such swales and gutters especially during precipitation and runoff events.
3. Contractor's temporary dewatering systems shall discharge to a location at or adjacent to the Site acceptable to Owner and Engineer, and in accordance with Laws and Regulations.
4. Convey water from excavations in closed conduits or appropriate drainage swales. Do not use trench excavations as temporary drainage ditches.
5. Dispose of water removed from excavations in a manner that does not endanger health and safety, property, the Work, and other portions of the Project.
6. Dispose of water in manner that causes no inconvenience to Owner, others involved in the Project, and adjacent and downstream property owners and occupants.

3.3 OPERATION, MAINTENANCE, AND REMOVAL OF TEMPORARY DEWATERING SYSTEMS

A. Operation and Maintenance of Temporary Dewatering Systems:

1. Contractor shall operate temporary dewatering systems continuously, 24 hours per day, seven days per week, until such system is no longer necessary or required.
2. Not less than once per day, including Saturdays, Sundays, and holidays visit and visually inspect temporary dewatering system, operating components, including pumps, instrumentation, and controls, and verify proper operation. At the same time, visually observe discharge location of temporary dewatering systems to verify operations. Establish and maintain written records of each location checked, observations made, readings and data taken or recorded (if any), and furnish copies of such records to Engineer upon request.
3. Contractor shall be responsible for condition of piping, conduits, and channels used for drainage and such piping, conduits, and channels shall be clean and free of oils, sediments, and Constituents of Concern.
4. Provide temporary electricity, temporary fuel, and other temporary facilities as necessary.
5. Perform pumping of water from excavations in a manner that prevents carrying away of unsolidified concrete materials, and that avoids damaging the subgrade.
6. During construction, Contractor shall maintain all materials, equipment, and systems used for temporary dewatering regardless of whether such items were provided by Contractor or existed prior to commencement of temporary dewatering, in accordance with operating instructions and recommendations of manufacturer of the associated equipment and systems, Laws and Regulations, the Contract Documents, and practice typical in the industry. Perform routine, preventative, and troubleshooting maintenance. Where temporary dewatering system fails or becomes inoperable, immediately remedy the situation, whether by appropriate repairs or operation of standby equipment.

B. Criteria for Discontinuation of Temporary Dewatering Operations:

1. Operate and maintain temporary dewatering systems until building, structure, or other facility to be constructed in the excavation is completed to a sufficient extent and has achieved structural strength and integrity sufficient for discontinuation of operation of temporary dewatering systems, and backfilling Work is reasonably complete. Facilities

constructed in excavations shall be able to withstand horizontal and vertical soil and water pressures from natural groundwater prior to discontinuation of temporary dewatering.

2. Control of ground water shall continue until the permanent construction provides sufficient dead load to withstand hydrostatic uplift of the normal groundwater, until concrete has attained sufficient strength to withstand earth and hydrostatic loads, and until waterproofing Work is completed.
3. Before discontinuing dewatering operations or permanently allowing rise in groundwater surface elevation, prepare computations to demonstrate that buildings, structures, Underground Facilities, and other facilities affected by the rise in groundwater surface elevation are protected by fill or other means to sustain uplift. Use a safety factor of not less than 1.25 when preparing such calculations. Submit such calculations to Engineer upon request. Maintain temporary dewatering systems in operation until Contractor's evaluations and calculations establish appropriate resistance of facilities against uplift and other damage caused by rising groundwater surface elevations.
4. Do not discontinue dewatering operations without first obtaining Engineer's concurrence for such discontinuation.
5. Shut off dewatering system at such a rate to prevent quick upsurge of water that might weaken the subgrade.

C. Removal of Temporary Dewatering Systems:

1. When temporary dewatering system is permanently deactivated, remove from the Site all elements of temporary dewatering system unless Owner (through Engineer) approves temporary dewatering system's, or part thereof, continuing existence at the Site after final payment.
2. Where wells provided by Contractor (whether for dewatering, monitoring, or other purpose) or piping are allowed to remain following permanent discontinuation of dewatering operations, accurately record their locations on the record drawings, in accordance with Section 01 77 19 – Closeout Requirements.
3. When a well includes power supply for electric pump, remove and disconnect electrical power supply from well casing back to source. Where wells provided by Contractor will be abandoned in place, remove the well casing to not less than two feet below finished grade and provide secure, removeable cap on well casing. Provide stake, visible at finished grade but not protruding above finished grade, indicating location of well casing.
4. Restore disturbed areas in accordance with the Contract Documents. Where the Contract Documents do not indicate requirements for restoration, restore such areas in accordance with Section 01 50 10 - Protection of Existing Facilities.

END OF SECTION

SECTION 31 23 33
UTILITIES - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Requirements for excavating, filling, and other earth Work for linear, buried utility projects, including:
 - a. Field conditions.
 - b. Soil and aggregate materials.
 - c. Excavation.
 - d. Preparation of subgrades.
 - e. Backfilling, filling and compacting.
 - f. Rough grading.
 - g. Disposal of excavated spoil materials.

B. Related Requirements Include, but are not necessarily limited to, the following:

1. Section 01 35 13 – Special Project Procedures
2. Section 03 31 30 - Concrete Materials and Proportioning.
3. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
4. Section 31 10 00 - Site Clearing.
5. Section 31 71 00 – Tunnel Excavation and Initial Support
6. Section 31 23 19 - Dewatering.
7. Section 31 32 19.16 - Geotextile Soil Stabilization.

1.2 SEQUENCING

A. Conduct excavations after site clearing, utility locating, and erosion and sediment controls are in place.

B. Comply with permit requirements and conditions.

1.3 PRICE AND PAYMENT PROCEDURES

A. Measurement:

1. Contractor shall provide all labor, materials, construction equipment and machinery, tools, and incidentals required or necessary for performing all trenching, backfilling, and related earth Work for the Contract, including all Work related to excavating, preparing subgrades, providing and stockpiling materials, filling with required materials, compacting, grading, proper disposal of excess spoil materials, and all other Work required by this Section.
 - a. This Section includes trenching, backfilling, and related earth Work required for constructing: buried utilities, including piping and, where applicable, other Underground Facilities; site improvements (including pavement, sidewalks, curbs, and the like); subgrade preparation for other Work; and all other trenching, backfilling, and related earth Work required by the Contract Documents and not addressed under other Specifications sections.
2. Unless expressly indicated otherwise in the Contract Documents, such as Section 01 20 00 - Measurement and Payment, the Work of this Section is included in the various lump sum and unit price bid/pay items for the Contract.
3. All Work under this Section is unclassified and covered by this Section and the associated bid/payment item(s).

- a. No separate payment will be made for removing, handling, or disposing of rock (unless the Contract includes a separate bid/pay item specifically for rock excavation or rock removal), stones, concrete (whether or not reinforced), debris, stumps, and other material, regardless of moisture content, unless such material constitutes an unforeseen Hazardous Environmental Condition and Work associated with such Hazardous Environmental Condition is not included in the Contract.

1.4 REFERENCES

A. Terminology:

1. The following terms are not defined and are not indicated with initial capital letters but, when used in this Section, have the following meaning:
 - a. "Backfill" as shown on the drawings, means suitable job excavated material or imported suitable material placed in trench above Pipe Zone.
 - b. "Bedding" as shown on the drawings, means granular material placed in trench bottom of stable trench upon which the pipe is laid.
 - c. "Borrow" means material required for trenching, backfilling, and related earth Work in excess of quantity of suitable material available from required grading, cuts, and excavations at the Site.
 - d. Borrow may be necessary even though not otherwise expressly required by the Contract Documents. "Cohesive soil" means clay (fine grained soil), or soil with a clay content, which has cohesive strength.
 - 1) Cohesive soil does not crumble, can be excavated with vertical or near-vertical side slopes, and is plastic when moist.
 - 2) Cohesive soil is difficult to break up when dry and exhibits significant cohesion when submerged.
 - 3) Cohesive soils include, but are not limited to, clayey silt, sandy clay, silty clay, clay and organic clay.
 - e. "Cohesionless soil" means fill material that does not clump together; its grains remain separate and apart from each other.
 - 1) Cohesionless soils typically have a low proportion of fine (no. 200 mesh size and less) particles and may be soil material or granular material.
 - 2) The terms "cohesionless soils", "cohesionless materials", "non-cohesive soils", and the like have the same meaning.
 - 3) Cohesionless soils include clean sands and clean gravels per ASTM D2487
 - f. "Embedment" as shown on the drawings, means granular material placed on top of bedding and under pipe haunches to a height detailed on the trench details.
 - g. "Fill" means soil material, granular material, or other material indicated in this Section required for backfilling excavations or as material for achieving required rough grading.
 - 1) Unless indicated otherwise in the context of a specific provision, the terms "fill" and "backfill" have the same meaning, as do derivative terms such as, "filling" and "backfilling".
 - 2) When used by itself, the term "backfill" means material required for refilling an excavation.
 - h. "Foundations" means bottoms of manholes, chambers, vaults, and similar structures; base slabs (slabs-on-grade); bearing directly on soil, granular material, or rock.
 - i. "Granular material" means gravel, sand, or silt, (coarse grained soil) with little or no clay content.
 - 1) Granular soil has no cohesive strength.
 - 2) Some moist granular soils exhibit apparent cohesion.
 - 3) Granular soil cannot be molded when moist and crumbles easily when dry.
 - 4) The terms "granular material", "aggregate material", and "granular soil" have the same meaning.

- 5) Detailed requirements for specific types of granular material are indicated in Article 2.1 of this Section.
 - j. "Pipe Zone" as shown on the drawings means the portion of the trench from bottom of Subgrade to 6-inches above the pipe crown.
 - k. "Rock" means: igneous, metamorphic, or sedimentary rock or stone; boulders over one cubic yard in volume in trenches; and mass concrete; that cannot be removed using rippers and therefore requires drilling and blasting or use of large excavator-mounted pneumatic breakers.
 - 1) If rock is encountered during the Work, promptly furnish notice of differing subsurface condition in accordance with the General Conditions (as may be modified by the Supplementary Conditions); when necessary, Engineer will furnish requirements for rock removal via appropriate Contract modification.
 - 2) The following do not qualify as rock:
 - a) Soft, weathered or disintegrated rock that can be removed by normal excavating equipment, including bulldozers with rippers and large tracked excavators with rock teeth or rock buckets.
 - b) Loose or previously blasted rock.
 - c) Broken stone in rock fills.
 - d) Rock or stone that falls into the excavation from outside limits of excavation shown or indicated in the Contract Documents.
 - e) Boulders that can be removed without drilling, blasting, or pneumatic breakers.
 - f) Pavements, sidewalks, and gutters of concrete, asphalt, or masonry.
 - l. "Subgrade" means the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.
 - m. "Trench Zone" as shown on the drawings means the portion of the trench from 6-inches above the pipe crown to finished grade in unimproved areas or bottom of base course or subgrade in improved areas.
 - n. "Trenching" means excavating for buried utilities, other Underground Facilities, and related excavation Work.
 - 1) In this Section, the words, "trenching" and "excavating" have the same meaning.
 - 2) In this Section, the word "excavation", whether singular or plural, is general and includes trenching.
 - o. "Unauthorized excavation" means removing materials beyond limits shown or indicated in the Contract Documents or otherwise directed by Engineer.
 - p. "Unclassified", when used in referring to trenching, excavating, or excavations, means excavation and disposal of all materials, of any description whatsoever, encountered in performing the Work, unless otherwise shown or indicated in the Contract Documents.
 - q. "Unsuitable soil materials" means soil or other materials encountered in the excavation at or below subgrade elevation of insufficient strength, stiffness, or characteristics to achieve adequate compaction or support the Work in accordance with the Contract Documents or as determined by Engineer.
 - 1) See paragraph 2.1B in this Section
 - 2) The terms "unsuitable soil material", "unsuitable soil", and "unsuitable material" have the same meaning.
- B. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. AMRL R18 - AASHTO Accreditation Procedure Manual.
 2. ASTM International (ASTM):
 - a. C33/C33M - Standard Specification for Concrete Aggregates.
 - b. D653 - Standard Terminology Relating to Soil, Rock, and Contained Fluids

- c. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- d. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
- e. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
- f. D2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.
- g. D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- h. D2434 - Standard Test Methods for Measurement of Hydraulic Conductivity of Coarse-Grained Soils.
- i. D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- j. D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.
- k. D3740 - Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- l. D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- m. D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- n. D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- o. D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
- p. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- q. D7928 - Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.
- r. E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:

- 1. Comply with Section 01 14 16 – Coordination with Owner's Operations.

B. Qualifications:

1. Contractor's Testing Laboratory:

- a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of materials specified in this Section.
- b. When Contractor is expressly required, by this Section's "Field Quality Control" Article or elsewhere in the Contract Documents, to retain testing laboratory for tests required under this Section's "Field Quality Control" Article, retain one testing laboratory for quality assurance testing and field quality control testing.
- c. Testing laboratory shall possess current, valid accreditation from the AASHTO Materials Reference Laboratory (AMRL), in accordance with AASHTO AMRL R18, for ASTM D3740, for tests required for quality assurance testing indicated in this Article and field quality control testing indicated to be Contractor's responsibility.
- d. Testing laboratory shall comply with ASTM E329 and Section 01 45 16.13 - Contractor's Quality Control.
- e. Testing laboratory shall be experienced in the types of testing required.
- f. Selection of testing laboratory is subject to Engineer's acceptance.

- 1) Upon Engineer's request, submit qualifications statement for testing laboratory, including name of entity, location, copies of applicable certifications, summary of entity's experience, and names and qualifications of personnel who will perform the subject sampling and testing.

C. Quality Assurance Testing:

1. Quality assurance testing, which may also be regarded as source quality control testing, is in addition to field quality control testing required by this Section's "Field Quality Control" Article.
2. Materials used in the Work may require testing and retesting, as directed by Engineer, during the Project.
 - a. Allow free access to onsite material stockpiles, borrow sources, and other sources of aggregate and soil materials at all times.
 - b. Tests not specifically indicated to be performed at Owner's expense (if any), including retesting of defective materials and defective Work, shall be at Contractor's cost.
3. Contractor's Testing Laboratory Scope for Quality Assurance Sampling and Testing:
 - a. Obtain samples and perform testing of proposed fill materials in the laboratory, at the Site, and at borrow locations (if any) to provide assurance that the Work will comply with the Contract Documents.
 - b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
 - c. Submit to Engineer, via Contractor, written results of each test.
4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:
 - a. Perform the following quality assurance tests on materials to be incorporated into the Work.
 - 1) Submit results of such tests to Engineer and obtain Engineer's acceptance thereof prior to incorporating the subject materials into the Work.
 - b. Gradation in accordance with ASTM D6913 and ASTM D7928.
 - 1) Perform one test for every 1,500 cubic yards of each material to be incorporated into the Work: under-slab fill, granular structural fill, trench subgrade stabilization material, base course material, bedding, and embedment.
 - c. Atterberg limits in accordance with ASTM D4318.
 - 1) Perform one test for every 1,000 cubic yards of the following types of materials to be incorporated into the Work: suitable soil material, and soil structural fill.
 - d. Moisture/density relations for fill and trench backfill in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable.
 - 1) Perform one test for every 1,500 cubic yards of each material to be incorporated into the Work.
 - e. Moisture content of stockpiled or borrow material in accordance with ASTM D2216.
 - 1) Perform one test for every 1,000 cubic yards of each material to be incorporated into the Work.

1.6 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Schedule (table or written narrative) indicating, for each specific area of the Work, type of fill materials proposed, together with indication of whether source of materials is onsite or borrow source.
 - 1) Identification of each type of material shall employ material names/designations identical to those in the Contract Documents.
2. Product Data:

- a. Borrow Soil Materials: Name and address of Supplier of borrow soil materials, gradation, and Supplier's certification that materials are sufficiently free of Constituents of Concern so that a Hazardous Environmental Condition will not be created or exacerbated.
 - 1) If no soil materials will be obtained from any borrow location, expressly so indicate to Engineer in writing.
 - b. Bedding/Embedment Materials: Name and address of Supplier of bedding/embedment materials, gradation, and Supplier's certification that materials are sufficiently free of cinders, clay lumps, debris, waste, frozen materials, organic material and other deleterious matter.
 - c. Under-slab fill, granular structural fill, trench subgrade stabilization material, base course material, and soil structural fill: Supplier's published description of aggregate materials, including name and address of Supplier, certification of material's compliance with AASHTO and state department of transportation standards, and gradation.
3. Samples:
- a. Submit Sample of bedding/embedment material.
 - 1) Furnish Samples in durable, tightly-sealed containers; plastic bags are unacceptable.
 - 2) Samples shall be of sufficient quantity and material size to demonstrate the array of gradation and material types expected in the Work.
- B. Informational Submittals: Submit the following:
- 1. Procedure Submittals:
 - a. Excavation plan indicating:
 - 1) Excavation Method(s): Indicate high-level methods to be used for excavating, such as use of excavator or other earth moving construction equipment, use of explosives in excavating (when allowed), trenchless excavating methods,
 - a) Describe approach for spoil management, topsoil stockpile, and bedding/embedment staging and placement.
 - b) Where different methods will be used, indicate locations of each in the Work.
 - c) Purpose of indicating high-level excavating methods is for Owner's information regarding effect of excavating method on Owner's or facility manager's (if other than Owner) property and operations.
 - 2) Copies of permits and approvals required for trenching, backfilling, and related earth Work, obtained from authorities having jurisdiction, including owners of affected utilities and transportation facilities, for excavation methods proposed.
 - 3) Trench shield (trench box) certification if employed:
 - a) Specific to Project conditions.
 - b) Re-certified if members become distressed.
 - c) Certification by registered professional engineer, registered in the state where the Project is located.
 - d) Engineer is not responsible to, and will not, review and approve.
 - 4) Trench Safety Plan and/or trench shoring drawing:
 - a) Trench Safety Plan and/or trench shoring drawings submittal is required only as evidence that plans and drawings have been prepared if required by Authorities Having Jurisdiction.
 - b) Engineer is not responsible to, and will not, review and approve.
 - 5) Compaction procedure and compaction equipment proposed for use.
 - a) Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.

- 6) Engineer's acceptance of excavation plan does not, in any way, modify Contractor's sole responsibility for complying with the Contract Documents, construction means, methods, procedures, techniques, or sequences, and safety and protection measures incident thereto.
2. Quality Assurance Test Results Submittals:
 - a. Submit results of quality assurance testing performed in accordance with this Section's "Quality Assurance" Article, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
 - 1) Tests on materials from onsite and borrow sources.
 - 2) Optimum moisture – maximum dry density curve for each type of fill material.
3. Field Quality Control Submittals:
 - a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
 - 1) Indication of soil classification in accordance with ASTM D2487.
 - 2) Field density testing.
 - 3) Proctor Compaction Test to determine optimum moisture for soil and maximum dry density.
4. Qualifications Statements:
 - a. Quality assurance testing laboratory, when requested by Engineer.

1.7 FIELD CONDITIONS

- A. Special Project Procedures
 1. See Section 01 35 13 – Special Project Procedures
- B. Existing Conditions:
 1. See Geotechnical Data Report and Geotechnical Baseline Report.
 2. Subsurface Conditions:
 - a. Subsurface Information: The Supplementary Conditions indicate information (if any) that is Technical Data on subsurface conditions at the Site.
 - 1) Such information and data are not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by Contractor.
 - 2) Owner and Engineer are not responsible for interpretations or conclusions drawn therefrom by Contractor.
 - b. Contractor's Explorations: Soil borings and other exploratory operations may be made by Contractor, at no additional cost to Owner.
 - 1) Coordinate Contractor-performed test borings and other exploratory operations with Owner, utility owners, and owners of transportation facilities as appropriate.
 - 2) Perform such explorations without disrupting or otherwise adversely affecting operations of Owner and others.
 3. Where subsurface conditions or locations of Underground Facilities and structures are unforeseen or differ substantively from that shown or indicated in the Contract Documents, comply with Contract requirements for giving notice and other actions.
 4. Existing Structures and Underground Facilities:
 - a. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work.
 - 1) Such information was obtained from existing records and is not guaranteed to be correct or complete.
 - 2) Contractor shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities.

- 3) Existing structures and Underground Facilities shall be supported and protected from damage by Contractor.
- 4) Immediately repair and restore existing structures and Underground Facilities damaged by Contractor without additional cost to Owner.
- b. Movement or operation of construction equipment and machinery over Underground Facilities shall be at Contractor's sole risk.
 - 1) When required by owner of the Underground Facility, prepare and submit to owner of such Underground Facility, and obtain their acceptance, of Contractor's plan presenting Contractor's analysis of the loads to be imparted during construction (including transient loading by construction equipment, machinery, and vehicles) and Contractor's proposed measures to protect structures and Underground Facilities during the Work.
- c. Acceptance of or approval by utility owner or Engineer of Contractor's proposed evaluation and method(s) for protecting Underground Facilities in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, means, methods, procedures, techniques, and sequences of construction, and the safety and protection measures incident thereto.
- d. Coordinate with utility owners for shut off of services in active piping and conduits.
 - 1) When required by utility owner, Owner will assist Contractor with utility owner notifications.
 - 2) Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.
- e. In general, service lines and laterals to individual residences, businesses, buildings, and structures, are not shown; however, Contractor shall assume that a service exists for each utility owner to each residence, business, building, structure, and property.
- f. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by Engineer after acceptable temporary utility services are provided by Contractor for the affected structure or property.
5. Wetlands and Waters of the US
 - a. Open-cut trenches shall be as narrow as safely practicable when crossing waters of the U.S. and non-jurisdictional waters and wetlands.
 - b. Surface impacts shall be minimized to the extent safely practicable when crossing waters of the U.S. and in non-jurisdictional waters and wetlands.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Suitable Fill and Backfill Material Requirements

1. Select or processed fill, backfill, and embankment materials.
 - a. Do not use wet, soft, or frozen material, asphalt and concrete chunks, cinders, ashes, refuse, vegetable or organic material, boulders, rocks, or other deleterious material as backfill.
2. Soils not classified as unsuitable as defined in Paragraph 2.1,B "Unsuitable Material" herein, are defined as suitable materials and may be used in fills, backfilling, and embankment construction subject to the limitations specified herein.
 - a. In addition, when acceptable to the Engineer, some of the material listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.
3. Suitable materials may be obtained from on-site excavations, may be processed on-site materials, or may be imported.

B. Unsuitable Material

1. Under Roadways: Unsuitable material for trench backfill materials under roadways includes the following:
 - a. Soils classified under ASTM D 2487 as PT, OH, CH, MH, ML or OL.
 - b. Soils that cannot be compacted sufficiently to achieve the percentage of maximum density specified for the intended use.
2. All Locations. Unsuitable material for fill, trench backfill includes the following:
 - a. Wet, soft, or frozen materials.
 - 1) Wet job excavated material may be suitable if scarified and/or wind rowed to dry to specified moisture before used as backfill.
 - b. Materials containing asphalt, concrete chunks, cinders, ashes, refuse, vegetable or organic material, boulders, rocks or other deleterious material.

C. Under-slab Fill

1. Provide granular under-slab fill under structure foundations, manholes, chambers, vaults, handholes, and similar Work unless other under-slab material is required by the Contract Documents.
 - a. ASTM C33/C33M gradation size no. 67, 67/57 blend, or other material acceptable to Engineer. Liquid Limit shall not exceed 30.
 - a. Well-graded, crushed aggregate, free of organic and deleterious material, complying with CDOT for Class 6 aggregate base course. Liquid Limit shall not exceed 30.

D. Granular Structural Fill:

1. Granular structural fill, sometimes called “select granular fill”, is required for improving subgrade (after removal of unsuitable material), as backfill for excavations in areas that, after restoration, will be subject to vehicular traffic, and at other locations shown or indicated for such material in the Contract Documents.
 - a. Material shall be well-graded, crushed aggregate, free of organic and deleterious material, complying with CDOT for Class 1 structural backfill material.
 - 1) Liquid Limit shall not exceed 30.
 - 2) Plasticity not over 6

E. Trench Subgrade Stabilization Materials:

1. When directed by the Engineer, or indicated on the drawings, provide subgrade stabilization material consisting of:
 - a. Washed narrowly graded mixture of crushed stone or crushed gravel **fully encapsulated in geotextile fabric.**
 - b. Meet the following gradation requirements:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve.
4-inch	100
3-inch	100
1 1/2-inch	40 to 100
3/4-inch	10 to 40
1/2-inch	0 to 5

F. Suitable Soil Material as Non-Structural Fill:

1. Provide suitable soil material as fill for the Work, unless other material is required.
2. Material shall be:
 - a. Free of rock larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious material.

- b. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, SP-SM, CL-ML or CL.
 - c. Liquid limit: Not greater than 45.
 - d. Plasticity index: not greater than 20.
3. Previously-excavated materials complying with the Contract Documents requirements for suitable soil material may be used for suitable soil material.
 4. When onsite materials are unsuitable for use as suitable soil material, provide or approved borrow material as suitable soil material.
 - a. Prior to using borrow material as suitable soil material, furnish product data Submittal and quality assurance Submittal for proposed material and obtain Engineer's approval and acceptance (as applicable) of the proposed material.

G. Base Course Material:

1. Base Course material is granular material underlying pavement, sidewalks, and other surfaces expressly indicated in the Contract Documents.
2. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Slag is unacceptable.
3. Material shall be CDOT for Class 6 aggregate base course.

H. Pipe Bedding Material:

1. Materials: Unless otherwise expressly required in the Contract Documents, pipe bedding material shall be crushed stone and gravel, free of: rock or gravel larger than one-inch in any dimension, cinders, clay lumps, debris, waste, frozen materials, organic material and other deleterious matter which may inhibit or result in nonuniform compaction or damage to the pipe, coatings or gaskets.
 - a. ASTM C33, gradation 67 (3/4 IN to No. 4 sieve) defined below:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve.
1-inch	100
3/4-inch	90 to 100
3/8-inch	20 to 55
No 4	0 to 10
No 20	0

- 1) Washed narrowly graded mixture of crushed stone or crushed gravel
- 2) **Fully encapsulated in geotextile fabric.**
- 3) Reclaimed concrete material is not acceptable.

- b. Graded Gravel (1/2 to No. 16 sieve) defined below:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve.
3/4-inch	100
1/2-inch	90 to 100
3/8-inch	40 to 100
No 4	0 to 30
No 8	0 to 10
No 16	0 to 5

- 1) Washed narrowly graded mixture of crushed stone or crushed gravel
- 2) **Fully encapsulated in geotextile fabric**
- 3) Reclaimed concrete material is not acceptable.

c. Uniformly graded pea gravel (squeegee) with the following gradation:

Sieve Sizes (Square Openings)	Percentage by Weight Passing Sieve.
3/8-inch	100
No 4	70 to 100
No 8	25 to 90
No 16	5 to 80
No 100	1 to 15
No 200	0 to 5

d. Flowable Fill, also known as Controlled Low Strength Material (CLSM).

I. Pipe Embedment Material:

1. Same as Pipe Bedding Material

J. Trench Backfill Material:

1. Material not classified as unsuitable
2. Selected material approved by Engineer from site excavation or from offsite borrow.
3. Job excavated material may be used for compacted backfill when the job excavated material is finely divided and free from debris, organic material, cinders, any corrosive materials and stones larger than 3 inches in greatest dimension.
4. Masses of moist, stiff clay shall not be used.

K. Groundwater Barriers (Trench Plugs) in accordance with Larimer County 1041 Permit Condition of Approval #6:

1. Stiff clay, or Flowable Fill.
2. Stiff Clay groundwater barriers shall be compacted soil meeting ASTM D2487 soil classification GC, SC, CL, or ML-CL.
 - a. Material may be finely divided, suitable job excavated material, free from stones, organic matter, and debris.

L. Concrete for encasement, reaction blocks, and pipe collars.

1. See Section 03 31 30.

M. Water

1. Water for filling, backfilling and compaction:
2. Free from oil and deleterious amounts of acids, alkalies, and organic materials.
3. Provided from a source approved by Engineer.

N. Marking Tape:

1. See Specification 10 14 00.
2. Pipe Marking Tape Schedule:
 - a. Location: As shown in Trench Details on Drawings.
 - b. Letter height: 1-1/4 IN minimum.
 - c. Natural gas:
 - 1) Color: Yellow with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED GAS LINE BELOW"
 - d. Potable water:
 - 1) Color: Blue with black letters.

- 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED WATER LINE BELOW"
- e. Storm and sanitary sewer lines:
 - 1) Color: Green with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED SEWER LINE BELOW"
- f. (Nonpotable) water piping, except 3 IN and smaller irrigation pipe:
 - 1) Color: Green with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED NONPOTABLE WATER LINE BELOW"
- g. Fiber Optic Conduit:
 - 1) Color: Orange with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED FIBER OPTIC CABLE BELOW"
- h. Other piping:
 - 1) Color: Yellow with black letters.
 - 2) Legend:
 - a) First line: "CAUTION CAUTION CAUTION"
 - b) Second line: "BURIED PIPE LINE BELOW"
- 3. Electrical Marking Schedule:
 - a. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
 - 1) Tag type: Type F - Underground Warning Tape.
 - 2) Letter height: 1-1/4 IN minimum.
 - 3) Location:
 - a) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.
 - b) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.
 - 4) Electrical power (e.g., low and medium voltage):
 - a) Color: Red with black letters.
 - b) Legend:
 - (1) First line: "CAUTION CAUTION CAUTION".
 - (2) Second line: "BURIED ELECTRIC LINE BELOW".
- O. Geosynthetics:
 - 1. Comply with Section 31 32 19.16 - Geotextile Soil Stabilization.
- P. Flowable Fill, also known as Controlled Low Strength Material (CLSM):
 - 1. Flowable fill shall be used to backfill any open cut roadway crossing, vertically from bedding to 2-feet below the road surface, horizontally from tight-of-way line to right-of-way line.
 - 2. Unless expressly required otherwise by the Contract Documents, flowable fill may be used, at Contractor's option (following Engineer's approval), for backfilling in lieu of the following materials: granular structural fill, pipe embedment material, soil structural fill, suitable soil material used as non-structural fill, and base course material.

3. Comply with Section 03 31 30 Concrete Materials and Proportioning.
4. Material provided shall be excavatable by ordinary mechanical excavation equipment, such as backhoes.

Q. Erosion Control Stone Fill:

1. Erosion control stone fill is stone material of required gradation provided at locations shown or indicated on the Drawings to dissipate energy of blowoff discharge piping, and to reduce the potential for erosion and scouring.
2. Erosion control stone fill material shall be blasted or broken un-weathered rock acceptable to Engineer and entity responsible for the third-party reference specifications indicated in this provision. Slag is unacceptable.
3. Bedding stone material shall consist of crushed stone or gravel (free of soft, non-durable particles, organic material, and thin or elongated particles). Bedding stone material shall be blasted or broken un-weathered rock or recycled material acceptable to Engineer and entity responsible for the third-party reference specifications indicated in this provision. Slag is unacceptable.

2.2 SOURCE QUALITY CONTROL

A. Tests and Inspections at Source of Supply:

1. Perform quality assurance testing, and submit results to Engineer, in accordance with the "Quality Assurance" Article in Part 1 of this Section.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Provide Engineer and Owner's Construction Manager with sufficient notice and with means to examine areas and conditions under which trenching, backfilling, other related earth Work, and grading will be performed.
 - a. Engineer or Owner's Construction Manager will advise Contractor in writing when they are aware of conditions that may be detrimental to proper and timely completion of the Work.
 - b. Do not proceed with the Work until unsatisfactory conditions are corrected.
2. This Article, however, in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, for construction means, methods, procedures, techniques, and sequences, and for the safety and protection measures incident thereto.
 - a. Nothing in this Article, including action by Engineer or Owner's Construction Manager, is for benefit of Contractor.

- B. Installing the Work constitutes Contractor's approval of underlying work, subgrades, and field conditions prevailing at the time of the Work.

3.2 SITE REQUIREMENTS

- A. See Section 01 35 13 for additional requirements.
- B. Avoid overloading or surcharging a sufficient distance back from edge of excavation to prevent slides or caving.
1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.
- C. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
- D. Protect and maintain benchmarks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.

- E. Verify location of existing underground utilities
- F. Take necessary precautions to protect existing utilities from damage due to any construction activity.
 - 1. Repair damages to utility items at own Contractor's expense.
 - 2. Assess no cost to Owner, Engineer, or auxiliary party for any damages.
 - 3. Obtain Global Positioning System (GPS) x/y/z coordinates where exposed and where crossed by Work of this Project.
 - a. Record on Record Documents

3.3 PREPARATION

- A. Site Preparation:
 - 1. Comply with Section 31 10 00 - Site Clearing.
 - 2. Comply with Section 01 57 05 - Temporary Controls.
- B. Maintenance and Protection of Traffic:
 - 1. Comply with Section 01 55 26 - Traffic Control.

3.4 EROSION AND SEDIMENT CONTROLS DURING CONSTRUCTION

- A. Temporary Erosion and Sediment Controls – General:
 - 1. Provide temporary erosion and sediment controls in accordance with Section 01 57 05 - Temporary Controls, and other requirements of the Contract Documents.
 - 2. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction and the Project's storm water pollution prevention plan and permit.

3.5 EXCAVATION

- A. Excavation – General:
 - 1. Perform all excavation Work, including trenching and backfilling, required to complete the Work as shown, specified, and required.
 - a. Excavating Work includes removing, handling, and proper disposal of earth, sand, clay, expansive-type soils, other unsuitable soil materials, gravel, hardpan, soft, weathered or decomposed rock, concrete and masonry (reinforced or unreinforced), pavements, rubbish, debris, stumps, and other materials, regardless of moisture content, within the excavation limits.
 - 2. Trenching and backfilling Work shall comply with the Contract Documents, including required grades, elevations, general dimensions, and alignment shown or indicated on the Drawings including cuts and fills, as applicable.
 - 3. Protect existing buildings and structures against undermining and destabilization.
 - a. If adjacent trenching affects foundations of one or more buildings or structures, promptly advise Engineer in writing.
 - 4. Surplus Excavation: Remove surplus excavated material from the job site at no additional cost to Owner.
 - 5. If unsuitable material and obstructions are encountered during excavation, remove material and replace as directed by Engineer.
 - a. Remove and dispose of unsuitable materials as directed by Engineer to site provided by Contractor
 - 6. Cut trench walls vertically from bottom of trench to 1 FT above top of pipe, conduit, or utility service.
 - 7. Keep trenches free of surface water runoff.
 - a. Include cost in Bid.
 - b. No separate payment for surface water runoff pumping will be made.

B. Excavation Methods:

1. Traditional Excavation Methods: Excavation via traditional methods, such as tracked excavator, loader, other earth moving construction equipment or machinery, or excavation using hand tools, is acceptable for all excavating Work.
2. Use of Explosives:
 - a. Use of explosives is not allowed.
3. Trenchless: See Section 31 71 00 – Tunnel Excavation and Initial Support..

C. Excavation Protection:

1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
2. Provide safe access to excavations, including emergency exit, and safe access for construction equipment and machinery, where applicable, in accordance with laws and Regulations.
3. Comply with Section 31 75 00 – Construction Shafts, regarding temporary support of excavations for trenchless construction.
4. Comply with Section 31 23 19 - Dewatering, regarding dewatering of excavations and related matters.

D. Excavations for Manholes, Chambers, and Vaults:

1. Refer to this Section, Section 01 20 00 - Measurement and Payment, and applicable details (if any) on the Drawings for requirements on excavation pay limits for pipelines, manholes, chambers, vaults, and similar items.
2. Elevation of bottom of manholes, chambers, and vaults may be changed only via duly issued Contract modification.
 - a. Such modifications may be directed by Engineer to ensure a stable bearing surface.
 - b. Elevations of piping, conduit, and similar other Underground Facilities shall be as shown or indicated on the Contract Documents.
3. Extend excavations sufficiently on each side of manholes, chambers, vaults, or similar construction only as necessary for installing precast concrete structures and appurtenances, including temporary supports of excavations, observation and inspection of the Work, and safe sloping of sides of excavations, as necessary.

E. Subgrades – General:

1. Provide firm, dense, thoroughly compacted, consolidated subgrades, free of mud, muck, and other soft and unsuitable materials.
 - a. Subgrades shall remain firm and intact under all construction operations.
 - b. Reinforce slab subgrade by providing granular structural fill on subgrades that are otherwise solid but become soft or muddy on top due to construction operations.
2. Finished elevation of stable subgrades shall not be above subgrade elevations shown on the Drawings.
3. If, in Engineer's opinion, subgrade becomes soft, muddy, or both, because of construction delays, failure to dewater properly, or other cause within Contractor's control, excavate subgrade to firm material, trim the subgrade, and backfill with granular structural fill material at Contractor's cost.
4. Subgrade Stabilization:
 - a. Stabilize the subgrade when directed by the Engineer or Owner.
 - b. Observe the following requirements when unstable trench bottom materials are encountered.
 - 1) Notify Owner when unstable materials are encountered.
 - 2) Define by drawing station locations and limits.

- 3) If Owner or Engineer determines that subgrade cannot be made stable, Contractor will be directed to over excavate and stabilize with Trench Stabilization Material and geotextile fabric per the detail on the Drawings.
 - 4) Over excavate to depth of 18 inches or as directed by Engineer
 - 5) Place Trench Stabilization Material directly on Geotextile
 - 6) Trench Stabilization Material shall be fully encapsulated in geotextile and edges shall lap at least 12 inches
 - 7) Trench Stabilization Material shall be placed up to the design subgrade elevation
 - 8) Any subgrade stabilization performed without written direction of the Engineer or Owner will not be paid for by the Owner
5. Unsuitable Subgrade:
- a. Remove unsuitable subgrade materials below foundations.
 - b. Limits of required removal of unsuitable material, when not otherwise expressly shown or indicated in the Contract Documents, shall be outside exterior limits of foundations around perimeter of manhole, chamber, vault, or similar item, by not less than the greater of the following horizontal distances:
 - 1) Distance equal to depth of required removal of unsuitable material, below bottom of foundations.
 - 2) Three feet.
 - 3) As directed by Engineer, in consultation with geotechnical engineering.
6. Preparation of Subgrades for Subsequent Work:
- a. Level off subgrades to receive foundations, bedding or compacted fill.
 - b. Where subgrades are to receive subsequent fill or manholes, chambers, vaults, or similar items, remove loose materials and bring subgrades into compliance with the Contract Documents.
 - c. Where compacted fill material is required to bring subgrade up to underside of construction, scarify existing subgrade upon which fill material will be placed to depth of six inches and then compact to density required in this Section before fill material is placed thereon.
 - d. Do not excavate lower than required for buried piping or foundations, unless directed otherwise by Engineer.
 - e. Where excavation extends below required elevation without authorization, promptly advise Engineer and remedy unauthorized excavation in accordance with the Contract Documents. Corrections may include:
 - 1) Under soil-supported foundations or soil-supported retaining walls:
 - a) Filling entire vertical distance between excavated subgrade and material required under foundation or other structure with compacted granular structural fill or CLSM.
 - b) Concrete fill is acceptable for bringing elevations to proper position.
 - 2) For locations other than those indicated above including slabs-on-grade:
 - a) Backfill and compact unauthorized excavations as indicated for authorized excavations of same classification, unless otherwise directed by Engineer.
 - 3) Contractor is not eligible for change in Contract Price or Contract Times for remedying unauthorized excavations.
7. Evaluation and Protection of Subgrade:
- a. Advise Engineer as soon as excavation is completed for Engineer's observation of subgrades and, where necessary or required, inspection and testing of subgrades.
 - b. If Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide subgrade stabilization as indicated in this Article.

- c. Do not commence further construction until subgrade under compacted fill material, under foundations and retaining walls is acceptable (in accordance with the Contract Documents) to Engineer, who may consider results of required testing, and who may elect to consult with geotechnical consultant (if any).
 - d. Engineer shall have sufficient opportunity to observe subgrade, after successful completion of tests and inspections required by the Contract Documents.
 - e. Place fill material and perform subsequent construction after subgrade is acceptable in accordance with the Contract Documents.
 - f. Protect subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
 - g. If subgrade under foundations or fill material, is found to be frozen, loose, wet, or soft before construction is placed thereon, when approved by engineer, remove frozen, loose, wet, or soft material and replace material as specified for Subgrade Stabilization.
 - h. Loose, wet, or soft materials, when approved by Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
 - i. Stabilization shall be in accordance with the Contract Documents.
 - 1) Where the Contract Documents do not address subgrade stabilization, promptly submit to Engineer written request for clarification or interpretation, or other written instrument in accordance with the Contract Documents.
 - 2) In such event, do not proceed until response is obtained from engineer.
- F. Demonstration of Contractor's proposed embedment compaction methods.
- 1. Prior to laying main pipe, excavate an example trench similar in depth to project piping.
 - a. Depth of cover shall be at least 10 feet
 - 2. Install example pipe with same bedding and embedment materials proposed for project.
 - 3. Demonstrate to Engineer proposed methods for embedment placement and compaction for Pipe Zone.
 - 4. Backfill trench and take deflection measurements as described in Section 33 05 24.
 - a. If deflection measurements exceed allowable, revise means and repeat demonstration until allowable deflection criteria can be met.
- G. Pipe Trench Preparation:
- 1. Not more than 250 feet of trench may be opened in advance of installing pipe in trench, unless otherwise more restrictive length is dictated by Larimer County during review of the Proposed Construction Sequencing Plan as detailed in Section 01 14 34 – Construction and Schedule Constraints.
 - 2. Trench width shall be in accordance with the details on the drawings:
 - a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping.
 - b. The Drawings show additional requirements for trenches .
 - c. Enlargement of trench width at pipe joints may be made when required and approved by Engineer.
 - d. For excavating and backfilling for manholes, chambers, and vaults associated with buried piping, excavation for manhole, chamber, or vault shall be not wider than two feet greater than widest outside dimension (including bottom footings or flanges, if any, of precast concrete structures) of the associated manhole, chamber, or vault at the base of the excavation.
 - e. Trench width shall be sufficient for Contractor's means of temporarily supporting the excavation and dewatering.
 - f. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.

- g. Do not use construction equipment or machinery that necessitates trench to be excavated to excessive width.
 - 3. Depth of trench shall be as shown or indicated in the Contract Documents.
 - a. If required and approved by Engineer in writing (such as a duly issued Contract modification), depths may be revised.
 - 4. Where Engineer considers existing subgrade (beneath intended bedding material) unsuitable, remove and replace such unsuitable material with trench stabilization material for full width of trench, down to suitable material.
- H. Preparation for Slabs-on-Grade:
- 1. Do not place slabs-on-grade until all the following conditions are met:
 - a. Subgrade is acceptable in accordance with the Contract Documents.
 - b. Required fill material (where applicable) has been provided on subgrade in accordance with the Contract Documents.
 - c. Underground Facilities are installed and have successfully completed required field testing and inspections.
- I. Trenching for Electrical Installations:
- 1. Modify for electrical installations as follows:
 - a. Open no more than 600 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
 - b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
 - c. Do not over excavate trench.
 - d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
 - e. See Division 26 for additional requirements.
- J. Freeze Protection:
- 1. Do not place foundations, pipe bedding or fill material on frozen subgrade.
 - 2. When freezing temperatures are expected, based on widely recognized, reputable source for weather forecasts at or near the Site, do not excavate to full depth indicated, unless foundations or fill material can be placed immediately after excavation has been completed and is acceptable in accordance with the Contract Documents.
 - 3. Protect from freezing excavation, subgrade, and fill materials when subsequent Work thereon is delayed.
- K. Construction Traffic on Soils:
- 1. Furnish and use appropriate tracked excavators or other low-contact pressure equipment to remove existing materials.
 - 2. Minimize construction traffic on existing materials and saturated soils and avoid soil disturbance.
 - 3. Repair disturbed subgrade materials prior to performing subsequent Work.
 - a. Remedial work shall be in accordance with the Contract Documents. When not addressed in the Contract Documents, remedial Work shall be as directed by Engineer via appropriate Contract modification.
 - 4. Allow only minimal foot traffic on bearing soils prepared for subsequent installation of fill or foundations.

3.6 FILLING AND COMPACTING

- A. Filling and Compacting – General:
- 1. Provide and compact all fill, including trench backfill, required for the finished grades as shown and as indicated in this Section.

2. Do not drop backfill directly upon any structure or pipe.
 3. Do not place backfill around or upon any concrete structure until the concrete has attained sufficient strength to withstand the loads imposed.
 4. Prior to backfilling, obtain Global Positioning System (GPS) x/y/z coordinates at each change of direction and change of elevation for pipelines, conduits and duct banks constructed for this Project.
 - a. Record on Record Documents.
- B. Place fill, including trench backfill, as promptly as progress of the Work allows, but not until completing the following:
1. Obtaining Engineer's concurrence, after observation by Engineer or Owner's Construction Manager of construction below finish grade, including removal of trash and debris from excavations, waterproofing (where required), and related Work.
 2. Successful completion of required field quality control activities for Work that will be covered or concealed by filling, including field quality control testing of buried piping, conduits that will convey fluid or gas, and exfiltration testing (where performed or required) of manholes, chambers, vaults, and similar items.
 - a. For manholes, chambers, and vaults, where infiltration testing or vacuum testing is performed or required, such testing may be performed following backfilling.
 3. Completion of proper documentation of as-constructed conditions and existing conditions (such as locations of Underground Facilities) in accordance with Section 01 77 19 – Closeout Requirements.
 4. Removal of temporary supports of excavations.
 5. Remove fill that includes organic materials or other unacceptable material and replace with fill material complying with the Contract Documents.
- C. Placement – General:
1. Place fill, including trench backfill, to the grades shown or indicated. Bring up evenly on all sides fill around manholes, chambers, vaults, and similar items, and Underground Facilities.
 2. Management of Moisture Content:
 - a. Place fill materials, including trench backfill, at moisture content and density as indicated in this Article's requirements on compaction density.
 - 1) Prior to placing fill material, optimum moisture and maximum density properties for proposed material shall be obtained.
 - 2) Furnish and use construction equipment and machinery capable of adding measured amounts of water to fill materials to bring fill materials to a condition within required moisture content range.
 - 3) Control moisture for each lift necessary for required compaction.
 - b. When subgrade or fill materials require moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted.
 - 1) Furnish and use construction equipment and machinery capable of discing, aerating, and mixing fill materials to ensure reasonable uniformity of moisture content throughout fill materials, and to reduce moisture content of borrow materials by air drying, when necessary.
 - c. Materials at moisture content in excess of specified limit shall be dried by appropriate means, such as aeration or stockpiling for gravity drainage and air drying.
 3. Compaction:
 - a. General:
 - 1) Limit equipment loads during backfilling and compacting to prevent damage to pipe, pipe lining, and pipe coating from over-deflection.
 - 2) For pipe cover depths less than 2 feet, mechanically compact using hand operated, vibratory compactors and rollers.

- b. Compaction Equipment
 - 1) Perform compaction with construction equipment and machinery suitable for the type of fill material placed.
 - a) Unless otherwise required, compact cohesive soils using sheepsfoot compactor, and compact granular materials using pneumatic rollers, vibrators, or other construction equipment or machinery to obtain required density.
 - 2) Select and use equipment capable of providing the minimum density required in the Contract Documents.
 - 3) Use light compaction equipment and machinery, with equipment or machinery gross weight not exceeding 7,000 pounds within horizontal distance of 10 feet from the wall of completed, below-grade manholes, chambers, vaults, and similar items, and walls of adjacent buildings or structures.
 - 4) Furnish and use construction equipment and machinery capable of compacting in restricted areas next to structures and around piping and Underground Facilities.
- c. Compaction Test Area:
 - 1) Effectiveness of construction equipment and machinery selected by Contractor for compacting, shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed.
 - 2) If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following:
 - a) Increase the quantity of coverages,
 - b) Decrease the lift thicknesses, or
 - c) Use different compactor equipment or machinery.
- 4. Placement of Lifts and Compaction:
 - a. Place fill materials in horizontal, loose lifts, not exceeding specified thickness prior to compacting.
 - b. Place fill in manner ensuring uniform lift thickness after placing.
 - c. Preparation of surfaces for placement of fill:
 - 1) Before commencing placing of fill, scarify underlying material to depth of six inches.
 - 2) Where ground surface is steeper than one vertical to four horizontal ("1V:4H"), plow surface to bench and break up surface so that fill material will bind with existing surface.
 - 3) For slopes steeper than 1V:4H and less than 1V:1.5H, bench shall be six feet wide.
 - 4) For slopes steeper than or equal to 1V:1.5H and less than 1V:0.5H, bench shall be four feet wide.
 - d. Mechanically compact each lift, by not less than two complete coverages of compactor.
 - 1) One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface.
 - e. Compaction of fill materials by inundation with water is unacceptable.
- 5. Restrictions:
 - a. Do not place fill materials when standing water is present on surface of area where fill will be placed.
 - b. Do not compact fill when standing water is present on the fill to be compacted.
 - c. Do not place or compact fill in frozen condition or on top of frozen material.
 - d. Fill containing organic or deleterious materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
- 6. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment or machinery, perform all work necessary to provide required densities.

- a. Such work shall include, at no additional cost to Owner, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
- 7. Repair, at Contractor's cost, observed or measured settlement.
 - a. Make repairs and replacements as necessary and required within 30 days after being so advised by Engineer, unless more-timely action is necessary to avoid or reduce the potential for safety hazards or damage to property.
- D. Fill Placed in Pipe Trenches:
 - 1. Piping trenches may be backfilled prior to testing of piping, unless nature of test requires observation of pipe or manholes, chambers, vaults, or similar items during testing.
 - a. Do not construct building or structure over piping until piping has been successfully tested and passed.
 - 2. Pipe Zone Backfill:
 - a. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints.
 - 1) Make excavations for steel pipe welding as necessary.
 - b. Install initial layer of pipe bedding material on prepared subgrade and densify/compact as required.
 - 1) Provide appropriate divot in the bedding material to accommodate each pipe bell or joint.
 - 2) Install piping so that pipe barrel carries the weight of each pipe segment, rather than pipe bells or joints bearing the pipe's weight.
 - c. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
 - d. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and densify/compact sufficient pipe embedment material under and around each side of pipe and back of bell or end thereof to hold piping in proper position and maintain alignment during subsequent pipe jointing and embedment operations.
 - e. Subsequent to forming pipe joint, place additional pipe embedment material, in required lifts, to required top elevation of pipe embedment material shown on the Drawings.
 - 1) Ensure bedding material is properly and fully placed under pipe "haunches" for proper support of piping.
 - 2) Thoroughly tamp each lift, including area under haunches, with methods demonstrated to effectively densify material under haunches to the degree required to limit deflection to the specified values and to ensure that voids are completely filled before placing each succeeding lift.
 - 3) Densify/compact lifts of pipe bedding material in accordance with this Article prior to placing subsequent backfill material.
 - 4) Deposit and densify/compact Pipe Zone Backfill material uniformly and simultaneously on each side of piping.
 - f. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
 - 3. Trench Zone Backfill: Unless otherwise shown, placing and compacting of Trench Zone fill materials shall comply with the following:
 - a. Place backfill in lift thicknesses capable of being compacted to specified densities.
 - b. Each layer of Trench Zone backfill material shall be compacted by not less than two complete coverages of all portions of surface of each lift using appropriate compaction equipment or machinery.

- c. Job excavated materials shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness.
 - d. Each layer of material shall have the specified moisture content and the specified degree of compaction.
 - e. Increased layer thickness may be permitted if Contractor can demonstrate, to the satisfaction of Engineer, that the specified compaction/density will be obtained.
 - f. The method of compaction/densification and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe.
- E. Installation of Flowable Fill, also known as Controlled Low Strength Material (CLSM):
- 1. Discharge flowable fill from ready-mix delivery vehicle into excavation, or other space to be backfilled with such material, via chutes, pumping, or hand-carried in buckets, in accordance with the Contract Documents (including the Specifications of Division 03 - Concrete) and requirements of flowable fill ready-mix Supplier.
 - 2. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
 - 3. Flowable fill shall not be placed until groundwater level has been lowered in conformance with the requirements of Section 31 23 19.
 - 4. Place flowable fill in lifts not greater than four feet depth.
 - a. Provide pipe anchors or use smaller lifts to prevent pipe flotation.
 - 5. Placing of each lift of flowable fill shall be a continuous operation, to the extent practicable.
 - 6. Place flowable fill in manner that prevents flotation of piping or other damage to the Work, other Underground Facilities, and adjacent property.
 - 7. Cold Weather Placing:
 - a. Do not place flowable fill on frozen subgrade.
 - b. Flowable fill batching, mixing, and placing may be performed when weather conditions are favorable, and ambient air temperature is 34 degrees F and rising.
 - c. At the time of placing, flowable fill must have a temperature of not less than 40 degrees F.
 - d. Discontinue placing flowable fill when ambient air temperature is 38 degrees F or less and falling.
 - 8. After placing flowable fill, allow not less than 12 hours before placing subsequent lift or approved otherwise by Engineer.
 - 9. Prevent contact with flowable fill by construction vehicles and equipment, or other traffic, for not less than 24 hours after placing, or until flowable fill is sufficiently hard to prevent rutting or other damage by vehicles and construction equipment.
- F. Fill or Trench Backfill Required Under base course for Pavement and Other Traveled Ways:
- 1. Where bottom of pavement or surfacing of other traveled way will be at elevation equal to or less than preconstruction ground surface, after required excavation and preparation of subgrade, provide required base course material to required depth.
 - a. At underside of pavement or other surfacing of traveled way, base course material shall extend horizontally 2 feet beyond edges of pavement or other surfacing.
 - b. Exterior edges of base course material shall be placed and compacted at uniform slope of one foot vertical-to-one foot horizontal away from top edge of base course down to subgrade.
 - 2. Where bottom of pavement or surfacing of other traveled way will be at elevation greater than preconstruction ground surface, after required preparation of subgrade, provide required fill material and base course material to required depth.
 - 3. At underside of pavement or other surfacing of traveled way, base course material shall extend horizontally 2 feet beyond edges of pavement or other surfacing.

- a. Exterior edges of base course material and fill material shall be placed and compacted at uniform slope of one foot vertical-to-one foot horizontal away from top edge of base course down to subgrade.

G. Temporary Pavement:

1. Provide not less than 1.5 inches of temporary bituminous pavement immediately after filling excavations in paved roads and other pavement subject to vehicular traffic, where such pavement will remain permanently.
2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
3. Permanent replacement pavement shall be equal to that of the existing roadways, unless otherwise shown or specified.

H. Compaction/Density Requirements:

1. Requirements for Trench Zone Backfill and Sitework (including civil, grading, and Underground Facilities).
 - a. Under pavement, other traveled ways, curbs, gutters, sidewalks, and buried utilities (including manholes, chambers, vaults, and similar items):

COMPACTION REQUIREMENT	MOISTURE CONTENT
95% compaction per ASTM D698	-2 to +3% of optimum

- b. Sitework not covered by the above category or classification:

COMPACTION REQUIREMENT	MOISTURE CONTENT
85% compaction per ASTM D698	-2 to +3% of optimum

- c. Outside buildings and structures, under slabs-on-grade:

COMPACTION REQUIREMENT	MOISTURE CONTENT
95% compaction per ASTM D698	-2 to +3% of optimum

- 1) For underside of structures and slabs on grade, scarify existing subgrade upon which fill material will be placed to depth of six inches and then compact to density shown above.
- 2) Make an allowance for 6 inches of topsoil surfacing and slope for protection where required.
2. Requirements for materials supporting foundations and adjacent to buildings and structures.

COMPACTION REQUIREMENT	MOISTURE CONTENT
95% compaction per ASTM D698	-2 to +3% of optimum

- a. For underside of foundations, scarify existing subgrade upon which fill material will be placed to depth of six inches and then compact to density shown above.
3. Requirements for pipe bedding and embedment:
 - a. See Articles 3.5.F and 3.6.D.2. Pipe deflection measurements will be used to verify bedding and embedment materials have been placed to required densities.
 - b. See Article 3.11.C.3.e for frequency of measurements.
 - c. The contractor's means of achieving required densification shall be performance based on pipe deflection that is closely monitored.

4. Trench subgrade stabilization areas:

COMPACTION REQUIREMENT	MOISTURE CONTENT
95% compaction per ASTM D698	-2 to +3% of optimum

5. Requirements for Groundwater Barriers:

COMPACTION REQUIREMENT	MOISTURE CONTENT
95% compaction per ASTM D698	-2 to +3% of optimum

6. Pipe Zone above embedment material and Trench Zone under pavement, other traveled ways, curbs, gutters, sidewalks, and buried utilities:

COMPACTION REQUIREMENT	MOISTURE CONTENT
95% compaction per ASTM D698	-2 to +3% of optimum

7. Trench Zone under turf runways: See Section 01 35 13 – Appendix A.
8. Trench Zone under unimproved areas

COMPACTION REQUIREMENT	MOISTURE CONTENT
85% compaction per ASTM D698	-2 to +3% of optimum

- a. Make an allowance for 6 inches of topsoil surfacing and slope for protection where required.
9. Fill or Trench Backfill Lift Thickness:
 - a. Unless expressly shown or indicated otherwise, place fill in trenches, below piping, below foundations, or under paved areas in horizontal uncompacted layers not exceeding 8 inches deep and thoroughly compact each before next layer is placed.
 - b. In pipe trenches, above elevation of bottom of pipe, horizontal uncompacted layers shall be six inches deep.
10. Fill Moisture Content: Fill or Trench Backfill shall be wetted and thoroughly mixed to achieve moisture content to within the required range indicated in the applicable tables above.
11. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated.
12. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction Work.
 - a. Responsibility for field quality control testing is indicated in this Section's "Field Quality Control" Article.
13. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the required compaction.
 - a. Perform additional compaction Work at no additional cost to Owner until required compaction is achieved.
 - b. Such work includes complete removal of unacceptable (as determined by Engineer) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.
- I. Replacement of Unacceptable Excavated Materials:
 1. In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with material specified in Part 2 of this section and thoroughly compact in accordance with applicable table in this provision.
 2. Slope the sides of excavation in accordance with the maximum allowable inclinations specified for each element of the Work.

3.7 UNAUTHORIZED EXCAVATION

A. Unauthorized Excavation – General:

1. Excavations outside lines and grades shown or indicated and that are not approved by Engineer (including excavations below required subgrade elevation, unless Engineer directs removal of unsuitable subgrade material), together with removing and disposing of the associated material, shall be at Contractor's cost and risk.
2. Fill unauthorized excavations with properly compacted granular structural fill material at Contractor's cost.

3.8 PAVEMENT BASE COURSE

A. Pavement base course – General:

1. Place base course material, in layers of specified thickness, over subgrade to support pavement.
2. Prepare subgrade underlying base course in accordance with this Section's general requirements for subgrades.

B. Grade Control:

1. During construction, maintain lines and grades including crown and cross-slope of base course.

C. Placing of Pavement Base Course:

1. Provide base course material where required to the limits shown or indicated.
2. Place base course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness.
 - a. If the Contract Documents do not show or indicate required section of replacement paving, replacement base course shall be of thickness equal to existing base course.
3. Maintain optimum moisture content for compacting base material during placing operations.
4. Identify any unstable base course by proof rolling.
 - a. Make at least two passes with a 20 ton tandem rear axle dump truck traveling 2 to 6 miles per hour. If an unstable area is found, recompact and retest.
5. After completing compaction, other than that necessary for bringing material for the next course and proof rolling, do not haul or drive over compacted base course.
6. To prevent softening of subgrade, do not install pavement in excess of 500 feet in length without compacting.
7. If subgrade material becomes churned up into or mixed with base course material, remove the mixed material and replace with clean, compacted base course material.

3.9 GRADING

A. Grading – General:

1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines:

1. Grade areas adjacent to building lines to drain away from buildings and structures.
2. Grade to prevent ponding of water.
 - a. Provide grades and slopes as shown on the Drawings and to allow effective drainage to proper drainage routes, such as catch basins, ditches or swales intended to convey storm water, and other storm water drainage routes.
 - b. Where intended grade for effective drainage is unclear, promptly submit to Engineer request for interpretation and obtain Engineer's interpretation or clarification before proceeding,
3. Provide final surfaces free of irregular surface changes, in accordance with the following:
 - a. Grassed Areas and Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover:
 - 1) Finish areas to receive topsoil or special cover to within not more than one inch above or below required subgrade elevations.
 - b. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below required subgrade elevation.

- c. Pavement (including hard-surfaced pavement and areas with stone surfacing): Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 0.5-inch above or below required subgrade elevation.
- C. Grading Surface of Fill Under Concrete Slabs-on-Grade:
 - 1. Grade smooth and even, free of voids, compacted as specified, and to required elevation.
 - 2. Provide final grades within tolerance of 0.5-inch when tested with a ten-foot straight edge.

3.10 DISPOSAL OF EXCAVATED SPOIL MATERIALS

- A. Spoil Disposal - General:
 - 1. Contractor shall haul away excavated material that does not comply with requirements for fill, or is in excess of quantity required for fill.
 - 2. Disposal of materials shall comply with Laws and Regulations, at no additional cost to Owner.

3.11 FIELD QUALITY CONTROL

- A. Laboratory Test Methods
 - 1. Cohesionless soils as defined in Part 1 of this specification and ASTM D653
 - a. ASTM D4253 and ASTM D4254 for Maximum and Minimum Index Density
 - 2. Cohesive soils as defined in Part 1 of this specification and ASTM D653
 - a. ASTM D698 for Compaction Characteristics of soil
 - 3. ASTM 2216 for Moisture content of soils
- B. Field Test Methods
 - 1. In-Place Density and Moisture Content ASTM D4253
 - a. Test at depth at least 8-inches below surface.
 - 2. Pipe Deflection: See Section 33 05 23
- C. Testing Laboratory:
 - 1. Employ a testing laboratory to perform field quality control testing.
 - 2. Testing Laboratory Scope:
 - a. Perform laboratory tests to determine: Index Density, Compaction Characteristics and Moisture Characteristics of materials proposed for use.
 - b. Perform field moisture content tests (in accordance with ASTM D6938) and density tests (in accordance with ASTM D6938) to verify that required compaction and moisture content of fill materials was provided.
 - 1) Furnish to Engineer and Contractor written results of each test.
 - c. Authority and Duties of Testing Laboratory:
 - 1) Testing laboratory representatives ("technician") shall inspect the materials in the field, perform testing, and report findings to Engineer and Contractor.
 - a) When the Work is defective, technician will direct attention of Engineer and Contractor to such defective Work.
 - 2) Technician shall not supervise performance of any of Contractor's Work.
 - a) Technician shall not perform other duties for Contractor.
 - 3) Work will be tested and inspected by testing laboratory as the Work progresses, but failure to detect defective Work (including defective materials) shall not, in any way, prevent later rejection when defect is discovered, nor shall it obligate Engineer for Substantial Completion or final acceptance.
 - a) Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.

3. Responsibilities and Duties of Contractor:
 - a. Use of testing laboratory in no way relieves Contractor of responsibility to provide Work in compliance with the Contract Documents.
 - b. When Owner furnishes services of testing laboratory, geotechnical consultant, or any combination thereof, for trenching, backfilling, and related earth Work, Owner and Engineer do not represent that the sampling and testing performed by Owner-hired testing laboratory or observations by Owner-hired geotechnical consultants, is sufficient for Contractor's purposes, or to monitor all aspects of the trenching, backfilling, and related earth Work.
 - 1) If additional quality control is needed to verify that the Work performed and materials delivered to the Site are in accordance with the Contract Documents, Contractor may retain its own, independent testing laboratory to perform additional sampling and testing for Contractor's purposes.
 - c. To facilitate testing laboratory and geotechnical consultant, Contractor shall advise testing laboratory and geotechnical consultant not less than two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
 - d. Contractor shall be responsible for providing required compaction for fill and other earthwork.
 - 1) Contractor shall control construction operations by performing confirming tests to verify that Contractor has complied with the Contract Documents relative to compaction and moisture content.
 - e. Contractor shall demonstrate adequacy of compaction/densification equipment and procedures before exceeding one or more of the following quantities. Each test location shall include tests for each layer, type, or class of fill to finish grade.
 - 1) 200 linear feet of Pipe Zone fill or twice weekly, whichever is more frequent.
 - a) Measure pipe deflection.
 - 2) 200 linear feet of Trench Zone fill.
 - a) Measure in-place density
 - (1) Perform tests at multiple points along 200 foot segment
 - (a) One test per each 200 cubic yards placed
 - (b) Or two times each day
 - b) Measure pipe deflection
 - 3) Special provisions for Turf Runway Trench Zone compaction: See notes on Drawings
 - 4) 10 cubic yards of granular structural fill.
 - 5) 100 cubic yards of suitable soil material.
 - 6) 50 cubic yards of base course material.
 - 7) Base Course for traveled roadways or sidewalks shall be proof rolled to confirm compaction prior to placing final pavement, concrete or gravel surfacing.
 - a) Make at least two passes with a 20 ton tandem rear axle dump truck traveling 2 to 6 miles per hour. If an unstable area is found, recompact and retest.
4. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon.
 - a. Testing of subgrades and fill layers shall be as follows:
 - 1) Trenches for Underground Facilities (including buried ductbanks):
 - a) In Open Fields: Two locations every 1,000 linear feet.
 - b) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
 - c) Crossing Paved Roads: Two locations along each crossing.

- d) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
 - b. For granular structural fill: Once per lift for each 1,000 square feet placed and compacted.
 - c. For Suitable Soil Material: One per 1,000 square feet on every compacted lift.
 - d. Base Course Material: One per 1,000 square feet on every compacted lift.
 - 5. Periodic compliance tests will be made by Engineer to verify that compaction is in accordance with the Contract Documents, at no cost to Contractor.
 - a. Contractor shall remove overburden above the level at which Engineer wishes to test and shall fill and re-compact the material after testing is complete.
- D. Defective Work:
- 1. If testing laboratory reports or inspections indicate subgrade, fill, or bedding compaction less than specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's cost until subgrades, bedding, and fill are acceptable.
 - 2. Costs for retesting of subgrade, fill, or bedding materials that did not originally comply with the Contract Documents, including required density, shall be paid by Contractor.

3.12 RESTORATION

A. Restoration – General:

- 1. See Section 01 35 13 for additional requirements.
- 2. Perform finish grading, including providing topsoil, in accordance with Section 31 10 00 – Site Clearing.
- 3. Provide replacement paving, sidewalks, curbs, gutters, and similar items in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.
- 4. Restore landscaping including lawn and meadow areas, in accordance with the Contract Documents.

END OF SECTION

SECTION 31 32 19.16
GEOTEXTILE SOIL STABILIZATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nonwoven geotextile material.
- B. Related Requirements:
 - 1. Section 31 23 33 – Utilities - Trenching and Backfilling.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway Transportation Officials (AASHTO):
 - a. M288, Standard Specification for Geotextile Specification for Highway Applications.
 - 2. ASTM International (ASTM):
 - a. D3786, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
 - b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
 - c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - f. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - g. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
 - h. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
 - i. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
 - j. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
- B. Qualifications:
 - 1. Each manufacturing, fabricating firm shall demonstrate five years continuous experience, including a minimum of 10,000,000 square feet of geotextile installation in the past three years.
 - 2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 square feet of geotextile.
 - 3. Installer shall attend pre-installation conference.

1.3 DEFINITIONS

- A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.
- B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
 - 2. Manufacturer and Installer quality control manuals.

3. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
 - a. Results shall include or bracket the rolls delivered for use in the Work.
 4. Geotextile layout plan with proposed size, number, position and sequencing of geotextile rolls and direction of all field seams.
 5. Proposed details of anchoring and overlapping if different than included in Contract Documents.
- B. Informational Submittals:
1. Provide in accordance with Specification Section 01 33 00.
 2. For needle punched geotextiles, the manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
 3. Qualification documentation specified in the QUALITY ASSURANCE Article in PART 1 of this Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.
- B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
 1. Do not remove the plastic wrapping until deployment.
- C. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).
- D. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.
- E. Do not expose geotextile to temperatures in excess of 71 degrees C (160 degrees F) or less than 0 DEGC (32 degrees F) unless recommended by the manufacturer.
- F. Do not use hooks, tongs or other sharp instruments for handling geotextile.
 1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
 2. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. GSE Lining Technology.
 2. Propex Geosynthetics.
 3. SKAPS Industries.
 4. TenCate Mirafi.
 5. Tenax.

2.2 MATERIALS AND MANUFACTURE

- A. Geotextile:
 1. Nonwoven pervious sheet of polymeric material.
 2. Geotextile fibers:
 - a. Long-chain synthetic polymer composed of at least 85% by weight polyolefins, polyesters, or polyamides.
 - b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
 - c. Do not as reclaimed or recycled fibers or polymer to the formulation.

3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.
4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
 - a. Values shown are for the weaker principal direction.
 - b. Acceptance of geotextile shall be in accordance with ASTM D4759.
 - c. Type I Geotextile: AASHTO M288 Class 2, for use in demolition fill.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Mass per Unit Area, OZ/SY	ASTM D5261	=10
AOS, U.S. Standard Sieve	ASTM D4751	70-100
Permittivity, SEC-1	ASTM D4491	=0.5
Puncture, LBS	ASTM D4833	=90
Grab Tensile, LBS	ASTM D4632	=250
Trapezoidal Tear, LBS	ASTM D4533	=90
Burst Strength, PSI	ASTM D3786	=190
Ultraviolet Degradation % retained @ 500 hours	ASTM D4355	=50
Sewn Seam Strength, LBS	ASTM D4632	=220

- d. Type 2 Geotextile: AASHTO M288 Class 2, for use in drainage composite and other areas shown on the Drawings.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Mass per Unit Area, OZ/SY	ASTM D5261	=8
AOS, U.S. Standard Sieve	ASTM D4751	70-100
Permittivity, SEC-1	ASTM D4491	=0.5
Puncture, LBS	ASTM D4833	=90
Grab Tensile, LBS	ASTM D4632	=250
Trapezoidal Tear, LBS	ASTM D4533	=90
Burst Strength, PSI	ASTM D3786	=190
Ultraviolet Degradation % retained @ 500 hours	ASTM D4355	=50
Sewn Seam Strength, LBS	ASTM D4632	=220

B. Thread:

1. High-strength polyester, nylon, or other approved thread type.
2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
3. Contrasting color with the geotextile.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

- A. Install geotextiles in accordance with manufacturer's written recommendations.
- B. Hand place geotextile.
 - 1. No equipment will be permitted to traffic in direct contact with the geotextile.
- C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.
- D. Seam Construction:
 - 1. Sew all Type I geotextile seams.
 - 2. Broom clean existing geotextile and cut off to provide a clean area for seaming with the new geotextile.
 - 3. Sew seams continuously using an SSA flat seam with one row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
 - 4. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 inches unless otherwise recommended by the manufacturer.
 - 5. Test seams at the frequency specified in the FIELD QUALITY CONTROL Article in PART 3 of this Section.
 - 6. Tie off thread at the end of each seam to prevent unraveling.
 - 7. Construct seams on the top side of the geotextile to allow inspection.
 - 8. Sew skipped stitches or discontinuities with an extra line of stitching with 18 inches of overlap.
 - 9. Type 2 geotextile seams may be sewn or overlapped.
 - a. Construct overlapped seams in accordance with manufacturer's recommendations or as shown on Drawings.
- E. Heat tack the geotextile overlaps as shown on the Drawings.
- F. Backfill anchor trenches in accordance with Specification Section 31 23 33 – Utilities - Trenching and Backfilling.
- G. Place cover soil in accordance with Specification Section 31 23 33 – Utilities - Trenching and Backfilling.
- H. Protect geotextiles from clogging, tears, and other damage during installation.
- I. Geotextile Repair:
 - 1. Place a patch of the same type of geotextile which extends a minimum of 12 inches beyond the edge of the damage or defect.
 - 2. Fasten patches continuously using a sewn seam or other approved method.
 - 3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
 - 4. Replace geotextile which cannot be repaired.
- J. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.
- K. Do not use staples or pins to hold the geotextile in place.
- L. Do not leave geotextile uncovered for more than 14 days.

3.3 FIELD QUALITY CONTROL

- A. Conduct destructive seam testing at locations identified by Owner.

1. Minimum testing will be at a frequency of one test per 2,000 linear feet of seam.
- B. Provide as-constructed drawing showing roll number; layout; joint locations; and destructive sample repair, and patch locations.

END OF SECTION

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SECTION 31 71 00

TUNNEL EXCAVATION AND INITIAL SUPPORT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Requirements for guided 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. Requirements in this Section apply to all tunnels on the project. Required submittal information must be provided for each tunnel separately.
- C. Section 1.6 and Appendix A herein specifies allowable tunnel construction methods for each tunnel.

1.2 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 09 13 – Tunnel 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), GEI Consultants, July, 2026
 - 6. Geotechnical Data Report (GDR), GEI Consultants, July, 2026

1.3 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. **GOVERNING AGENCY:** Agency which owns and/or operates the property in which the tunnel work will be conducted.
- E. **GUIDANCE SYSTEM:** A system that is utilized to guide the tunnel excavation along the design line and grade within specified tolerances.
- F. **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 unless used in conjunction with a Pilot Tube.
- G. **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 established through the initial launch of the machine and casing pipe and is not steerable throughout tunneling.
- H. **INITIAL SUPPORT:** Temporary ground support installed concurrent with tunnel excavation to maintain tunnel stability prior to installation of the Carrier Pipe. Includes Erected Support and Casing Pipe.
- I. **INTERMEDIATE CASING(s):** One or more intermediate sized casing(s) that has a smaller diameter than the proposed Casing Pipe and facilitates line and grade control. The intermediate casing is installed between a Pilot Tube and Casing Pipe.
- J. **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.

- K. **LAUNCH SEAL:** A seal that is fitted on the shaft wall and through which the boring machine and casing pipe passes in order to avoid inflow of groundwater and/or ground into the tunnel shaft.
- L. **LUBRICANT:** Bentonite fluid used to fill and pressurize the annular space between the ground and Casing Pipe and reduce frictional resistance during Jacking.
- M. **MICROTUNNEL BORING MACHINE (MTBM):** A closed-face, remotely operated, steerable, laser-guided, articulated shield advanced by pipe jacking that can exert a continuous and controllable pressure at the tunnel heading by Slurry pressure to counterbalance ground and water pressures. Spoils are mixed with the Slurry and removed by transport through Slurry lines at a controlled rate to maintain the required face pressure.
- N. **MICROTUNNELING:** Excavation by MTBM.
- O. **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. Consists of steel, concrete, brick, timber, rubble, or other artificial material.
- P. **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.
- Q. **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.
- R. **PILOT TUBE:** A Guidance System consisting of a small diameter, double-wall pipe jacked into the ground ahead of the Casing Pipe or Intermediate Casing with directional control. The Pilot Tube creates the physical alignment along which the Casing Pipe is installed.
- S. **SLURRY:** Water mixture that may contain additives, which is used to transport the spoils and counterbalance ground and water pressures at the MTBM face.
- T. **STEERABLE HEAD:** A head attached to the front of the first Casing Pipe with hydraulic paddles that can apply force to the soil surrounding the tunnel which allows steering in both left-right and up-down; such as a McLaughlin On Target System or similar.
- U. **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.
- V. **TWO-PASS TUNNELING SYSTEM:** A method of tunneling in which Initial Support is installed prior to installation of the Carrier Pipe.

1.4 REFERENCE STANDARDS

- A. ANSI/AWS D1.1 Structural Welding Code.
- B. ASTM A36 / A36M-19 – Standard Specification for Carbon Structural Steel
- C. ASTM A1097 – Standard Specification for Steel Casing Pipe, Electric-Fusion (Arc)-Welded (Outside Diameter of 10 in. and Larger)
- D. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

1.5 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, ground improvement, 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; 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, installation, 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.

1.6 ALLOWABLE TUNNELING METHODS

- A. Allowable tunnel excavation and Initial Support methods are provided on a per tunnel basis in Appendix A of this Specification Section.
- B. 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.

1.7 GROUND CONDITIONS

- A. Information regarding the ground conditions to be anticipated can be found in the GBR and GDR. In the case of a conflict, the GBR takes precedence.

1.8 GASSY CONDITIONS

- A. Adhere to OSHA 29 CFR 1926 Subpart S (1926.800) and all other applicable regulations regarding working where naturally occurring gases may be present.
- B. Tunnels are classified as Potentially Gassy.

1.9 QUALIFICATIONS

- A. Tunnel contractors will substantially perform all tunnel construction work. Subcontracting of major aspects of the tunnel work such as excavation or installation of Initial Support 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. If Initial Support design differs from as specified herein, design of engineered structures as defined herein shall be signed and sealed by a Registered Professional Engineer in the State of Colorado 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. All submittal requirements stated below shall be submitted as one complete submittal package.
 - 1. Submit qualifications as stated in 1.9.
 - 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. Guidance System selection and line and grade control methods;
 - d. Line and grade surveying methods during installation;
 - e. Excavating the tunnel including description of activities involved in a single cycle of excavation and Initial Support Installation;
 - f. Addressing and handling excavating the tunnel in mixed face conditions where shown in the GBR;
 - g. Procedures for measuring excavated muck quantities versus the installed length or progress during tunneling operations;
 - 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;
 - l. Loss of line and grade during tunnel construction.
 - m. For the tunnel installation method selected,
 - 1) 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.
 - 2) Submit descriptions of the boring machine including cutterhead configuration, muck transport, and if applicable details of the slurry separation system. Confirm that the selected system is capable of excavating the ground conditions presented in the GBR.
 - 3. If proposed Initial Support varies in diameter, wall thickness, material type or strength from that specified herein, submit Initial Support design calculations including loads, methods, assumptions, and results with a minimum factor of safety of 2.0 as follows.
 - a. Anticipated jacking loads experienced by the casing pipe per 50-foot increment, including graphical representation, and maximum acceptable jacking load for the Initial Support.

- b. If proposed initial support thickness is less than as specified herein, include 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.
 - c. Calculations shall be signed and stamped by a Professional Engineer Registered in the State of Colorado with minimum qualifications as stated in Section 1.09.
- 4. 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 groundwater.
- 5. 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.
- 6. Submit Manufacturer's written certifications that Initial Support materials meet or exceed the specified requirements as stated herein.
- 7. 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.
- 8. Certifications of qualified welders where welding is required.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
 - 1. Instrumentation monitoring results as required herein and in Section 31 09 13 – Tunnel Instrumentation and Monitoring.
 - 2. Provide copies of reports and written daily logs as detailed in this specification to the Engineer and public authorities as required within the specified timeframe following preparation and submittal to third party authority. These reports are for record purposes only.
- C. Postconstruction Submittals:
 - 1. Record Drawings as detailed in Section 3.14.

PART 2 - EQUIPMENT, PRODUCTS AND MATERIALS

2.1 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. Utilize a Guidance System capable of accurately measuring and controlling the excavation equipment and Initial Support position during installation such that the Carrier Pipe can be installed to the line and grade tolerances specified in this Section.
5. The excavation and installation equipment will be capable of handling and removing all anticipated material documented in the GBR.
6. Have the minimum thrust capacity required to install the Casing Pipe.

2.2 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.
- 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 54-inch minimum Casing Pipe diameter stated is 0.625 inches or as required by the Governing Agency granting the utility permit; whichever results in a greater thickness. Casing Pipe thickness and diameter may be increased by the Contractor at its discretion.
 3. At a minimum the Casing Pipe will conform to ASTM A1097 SS Grade 36 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. Completely welded with a full penetration butt weld in accordance with ANSI/AWS D1.1 within the launch shaft prior to installation.
 - b. T-5 as manufactured by Permalok, Tri-Loc as manufactured by Trinity Products, or equivalent subject to Engineer approval.
 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

3.1 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 – Tunnel Instrumentation and Monitoring.
 - 5. For each tunnel, a pre-job activity and safety meeting has been conducted with the Contractor, Construction Manager, 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 include but are not limited to electrical, lighting, water, and ventilation.

3.2 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.

3.3 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. Guided Auger Boring shall utilize a Guidance System to install the Casing Pipe. The Guidance System will consist of:
 - 1. Pilot Tube installation is acceptable for Guided Auger Boring and requires:
 - a. Use a system to guide the Pilot Tube by controlling the orientation and inclination of the steering head. Use a system and the steering head such that if deviations are detected, the operator can modify the direction of advance of the steering head and Pilot Tube. Use a steering head that will allow for the installation of the Pilot Tube through non-displaceable soil along line and grade through ground conditions baselined in the GBR, within the tolerances stated by the manufacturer, and presented herein.
 - b. Use a monitoring system that consists of an optical theodolite or laser-based instrument set on design line and grade, target, and camera or monitoring screen which gives the operator continuous information on the location of the steering head.
 - c. The entry angle of the pilot hole and the boring process must be straight and have a vertical and horizontal tolerance of plus or minus 1 inch from the specified line and grade.
 - d. Limit the advancing force to stay at or below the safe working limit of the Pilot Tube.
 - e. Carry out steering corrections made to the pilot alignment in such a manner that the joint angle of any two adjacent pipes or segments does not exceed allowable limits.
 - 2. A Steerable Auger System is acceptable for auger boring and requires:
 - a. The ability to modify the horizontal and vertical direction of advance of the steering head. The steering head generally has hydraulic panels that can react against the surrounding ground in the required direction to return the steering head and Casing Pipe to the design line and grade.
 - b. A monitoring system capable of providing the operator information regarding the location of the steering head including manometer with information of the current grade of the alignment. Monitoring equipment shall be capable of monitoring the following:
 - 1) The Jacking pressure and advancement of the steering head.
 - 2) Position and deviation of the steering head in both line and grade.
- C. Intermediate Casings
 - 1. If the Contractor elects to use a Pilot Tube Guidance System, install Intermediate Casings as follows:
 - a. Minimum two Intermediate Casings. The first Intermediate Casing shall be 12 to 18-inch diameter, and the second Intermediate Casing being 36 to 42-inch diameter installed the full length of the crossing prior to advancing the final Casing Pipe.
- D. Control the advance and volume of material excavated to result in stable ground at the leading edge of the pipe and to prevent the loss of ground and heave.
- E. 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.

3.4 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.

3.5 MICROTUNNELING

- A. Requirements presented in Sections 3.01 and Section 3.02 of this Specification apply to this Section unless modified herein.
- B. The microtunneling equipment shall employ a spoil removal system with a pressure balance system that is capable of equalizing pressures between the tunnel face and the microtunneling machine head in order to prevent loss of material beyond the outside diameter of the pipe.
- C. Maintain excavation face pressure equilibrium at all times between the measured active earth pressure and computed passive earth pressure. Continuously monitor and maintain fluid pressure used at the face to remove excavated material and to control normal hydrostatic pressure.
- D. The MTBM shall be steerable and capable of controlling the advance of the heading to maintain line and grade within specified tolerances.
- E. Equip the MTBM with stabilizers or extendable fins, or a bidirectional cutterhead that allow the equipment to maintain a level orientation and correct a condition in which the shield begins to roll.
- F. Record, at a minimum, the following data which is to 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. Slurry flow rates for both the inflow and outflow lines;
 - 5. Cutter head RPM; and
 - 6. Line and grade.

3.6 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.

3.7 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 and Engineer in writing within 24 hours of 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 and Engineer, 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 or Engineer 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 3.7B apply thereafter.

3.8 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.

3.9 TUNNEL LINE AND GRADE TOLERANCES

- A. At a minimum, the tunnel is to be within six inches of the design line and three 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 one inch between the outside of the Carrier Pipe and the closest point of the Initial Support in all directions.
- C. Initial Support resulting in a negative grade of the Carrier Pipe at any point along the constructed alignment will not be accepted unless approved by the pipeline design Engineer.
- D. 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.
- E. 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.
- F. 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.
- G. 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.

3.10 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.

3.11 TUNNEL ACCESS

- A. Provide safe access for the Owner and Engineer at all times 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.

3.12 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.

3.13 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.

3.14 CONSTRUCTION RECORDS

- A. Maintain Written Daily Logs for all components and phases of tunnel construction. Submit Daily Logs 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;
 - 7. List of visitors to construction site;
 - 8. Description of encountered ground type and conditions, and ground behavior;
 - 9. Inconsistencies such as unusual spacings, deformations, and unusual performance;
 - 10. Tunnel excavation records including but not limited to the following:
 - a. The station of the face of the excavation and advance distance;
 - b. The position of the tunneling face or machine in relation to the design line and grade;

- c. Description and position of complete and partially complete Initial Support installed;
 - d. The maximum jacking load encountered during each Initial Support segment advancement;
 - e. The date, starting time, and finish time;
 - f. Any unusual conditions, breakdowns, and delays;
 - g. Excavated muck quantity;
 - h. Summary of daily tunneling activities.
- B. Maintain records of all surveys.
- C. 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.
- D. As-built drawings shall be submitted and accepted by the Engineer prior to recommending final payment.

3.15 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.

APPENDIX A – ALLOWABLE TUNNELING AND INITIAL SUPPORT METHODS

Tunnel	Excavation Method			Initial Support Method
	TBM	MTBM	Guided Auger Boring	Casing Pipe
I-25 Crossing		X		X
CR52 Crossing	X	X	X	X

"X" = Allowable method

END OF SECTION

SECTION 31 73 00

CONTACT GROUT

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Requirements for conducting Contact Grouting of overcut and voids outside the Initial Support.
- B. Requirements in this Section apply to all tunnels on the project. Submittals must be provided for each tunnel separately.

1.2 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 03 31 30 – Concrete Materials and Proportioning
 - 2. 31 09 13 – Tunnel Instrumentation and Monitoring
 - 3. 31 71 00 – Tunnel Excavation and Initial Support
 - 4. 31 74 23 – Carrier Pipe Installation and Backfill
 - 5. 31 75 00 – Construction Shafts
 - 6. Geotechnical Baseline Report (GBR), GEI Consultants, July 2026
 - 7. Geotechnical Data Report (GDR), GEI Consultants, July 2026

1.3 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.

1.4 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.
- D. ASTM D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material

1.5 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 weeks before beginning grouting, and update weekly. Notify the Engineer at least one working day in advance of schedule changes.
- E. Contact Grouting is required for all Initial Support systems.

1.6 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.

1.7 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two weeks before the scheduled start of the applicable activity.
 - 1. 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 Contact 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 data collected during contact grouting as specified in Section 31 09 13 – Tunnel 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

2.1 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 means to quantify volume of 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.

2.2 COMMUNICATIONS EQUIPMENT

- A. Provide equipment to communicate between workers in the tunnel at the grout injection points with workers outside the tunnel.

2.3 MATERIALS

- 1. Cement: per Division 03 31 30 – Concrete Materials and Proportioning.03 31 30 – Concrete Materials and Proportioning
- B. 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 500 psi.
 - c. No shrinkage when tested per ASTM C827.
 - 2. Sand may be added only with approval of the Engineer.
 - 3. Tested for compressive strength per ASTM C942.
 - 4. 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.
- C. Ports and Port Patches in Initial Support.
 - 1. Ports and Port Patches in the Initial Support as shown on the Contract Drawings.
 - 2. The holes or ports are to be compatible with a minimum 1-inch diameter pipe nipple.
 - 3. Ports are to be pre-fabricated in Casing Pipe.

PART 3 - EXECUTION

3.1 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 10 psi.

- E. Maximum Contact Grout injection port spacing as shown on the Contract Drawings. Contact Grout through any injection port will be considered complete when the proposed grout pressure is maintained for a minimum of 5 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.

3.2 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.

3.3 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 tunnel. Make at least one set of test samples from each 5 cubic yards of Contact Grout placed in any one day. Test grout compressive strength at seven days and 28 days.
- C. Test the flow consistency per ASTM D6103 with each sample collected for compression and shrinkage testing.
- D. Provide testing results to the Engineer as they become available from the Contractor-employed testing agency.

3.4 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. Requirements for installation of the Carrier Pipe in the tunnels and backfilling the annulus between the Carrier Pipe and Initial Support with Backfill Grout.
- B. Requirements in this Section apply to all tunnels on the project. Required submittal information must be provided for each tunnel separately.

1.2 RELATED WORK

- A. Related Documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 71 00 – Tunnel Excavation and Initial Support
 - 2. 31 73 00 – Contact Grout
 - 3. 31 75 00 – Construction Shafts
 - 4. 31 09 13 – Tunnel Instrumentation and Monitoring

1.3 DEFINITIONS

- A. **BULKHEAD:** Material placed between the Carrier Pipe and the Initial Support used to contain the Backfill Grout during placement. 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.
- B. **BACKFILL:** Filling of the annular space between the Carrier Pipe and Initial Support.
- C. **BACKFILL GROUT:** Flowable material to be used in the Backfill operations; can be Cellular Grout or Flyash Grout.
- D. **CELLULAR GROUT:** A low density, lightweight, cementitious material that contains stable air or gas cells as preformed foam uniformly distributed throughout the mixture.
- E. **CONTACT GROUTING:** As defined in Section 31 73 00 – Contact Grout.
- F. **FLYASH GROUT:** A self-leveling and self-compacting, cementitious material using pozzolanic flyash as the primary cementitious material.
- G. See Section 31 71 00 – Tunnel Excavation and Initial Support for additional definitions.

1.4 REFERENCE STANDARDS

- A. ASTM C495 – Standard Test Method for compressive strength of lightweight insulating concrete.
- B. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- C. ASTM C796 – Standard Test Method for foaming agents for use in producing Cellular Grout using preformed foam.
- D. ASTM C869 – Standard Specification for foaming agents used in making preformed foam for Cellular Grout.
- E. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders
- F. ASTM D5971 – Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material
- G. ASTM D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material.
- H. ASTM D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material

1.5 GENERAL REQUIREMENTS

- A. Be responsible for design, construction, and execution of the pipe installation and Backfill Grout placement.
- 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. Restrain Carrier Pipe from movement due to buoyant and other forces during Backfill Grouting.
 - 3. Backfill annulus outside Carrier Pipe fully with Backfill Grout.
 - 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 or portals. Grout ports through the Carrier Pipe are not allowed.
 - 5. Provide testing of materials and verification of material properties as required herein.
- D. Pipe Installation Methods
 - 1. Install Carrier Pipe in the tunnel either incrementally or by jacking or pulling a pre-assembled pipe string.
 - 2. Utilize casing spacers as shown on the Contract Drawings 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. 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 have a minimum of the following experience:
 - 1. Be thoroughly knowledgeable about the transportation, placement, and securement of prefabricated pipe in tunnels.
 - 2. Successfully have completed at least two 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 similar projects in which the pipe annulus in a tunnel was backfilled with Flyash Grout or Cellular Grout as applicable.
 - 4. Be thoroughly knowledgeable about mixing, pumping and placement of Backfill Grout, including Flyash Grout or Cellular Grout as applicable, in tunnels.
 - 5. Be thoroughly knowledgeable about heat of hydration of various Backfill Grout mixes and installation practices to prevent damage to the Carrier Pipe during cure.

1.7 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two 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 will address, as a minimum, pipe:
 - a. Transportation,
 - b. Section joining,
 - c. Casing spacer or blocking configuration,

- d. Line and grade surveying, and
- e. Line and grade control.
- 3. Methods, procedures, and equipment for monitoring, controlling, and adjusting the alignment of the Carrier Pipe in the tunnel 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 based on maximum lift heights.
 - c. Carrier Pipe ballasting plan to reduce damage during Backfill Grout curing and water source.
 - d. Bending stresses on the pipe between tiedowns or braces.
 - e. Maximum allowable backfill injection and head pressure (if a pump is used)
 - f. The calculations shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
- 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. Number of lifts and maximum lift heights
 - e. Flow rates
 - f. Pressures
 - g. Bulkhead details
 - h. Proposed orientation of all grout and ventilation pipes.
 - i. Methods and description of instrumentation to monitor and control placement of the backfill, and procedures to be used to verify backfill volumes.
 - j. Method of draining free water during Backfill Grouting to prevent grout separation and mixing.
 - k. Methods to prevent damage to the Carrier Pipe due to heat of hydration.
- 7. Pipe manufacturer certification letter stating that the proposed backfill materials and methods are acceptable for the Carrier Pipe type.
- 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
- 9. Schedule.

- a. Provide the Owner's Representative with a schedule of Carrier Pipe installation and Backfill Grouting activities at least three weeks before beginning pipe installation, and update weekly.
- b. Notify the Owner's Representative at least one working day in advance of schedule changes.

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 and in tunnel annulus.
 2. Have a heat of hydration that will not weaken or otherwise harm pipe materials using submitted and approved installation precautions.
 3. Viscosity is to be low enough to allow grout to completely fill all voids in the annulus between the Carrier Pipe and the ground.
 4. Minimum 28-day compressive strength of 300 psi. Test in accordance with ASTM C495.
 5. Minimum wet density of 45 pcf unless water is present in the tunnel at which point a minimum wet density of 70 pcf is required, or per the direction of the Engineer.
 6. Additives may be used only with review per approval of the Engineer.
 7. Non-shrink mix.
 8. Grout will be a mix of potable water and cement and/or flyash or foamed Cellular Grout. No aggregates are allowed.
 - a. Cellular Grout:
 - 1) Cement: Portland Type I/II or Type IL.
 - 2) Foaming agent for Cellular Grout: in accordance with ASTM C869.
 - b. Test in accordance with ASTM C796.
 - c. Flyash Grout:
 - 1) Flyash Grout is to 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 is not to 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.

3. Use brick and mortar, concrete, or Engineer approved equivalent for the Bulkhead.

PART 3 - EXECUTION

3.1 GENERAL

- A. The Carrier Pipe is to be internal braced, 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 is to be conducted under the direct supervision of the Installation and Backfill Grouting Expert(s).

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 and Contact Grouting has been completed outside the Initial Support as specified in Section 31 73 00 – Contact Grout.
 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. All water has been removed from between the Initial Support and Carrier Pipe within the bulkhead locations, and shaft water (groundwater, nuisance, construction, precipitation, etc.) is prevented from entering the Initial Support.
 4. The tunnel has been cleaned as specified herein.

3.3 SURVEYS

- A. Surveys are to be at intervals not exceeding 20 feet and will be for both line and grade to an accuracy of 0.01 feet 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 are to 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. Show the Mix Design meets requirements by one of two methods:
 - a. Perform testing on mix
 - 1) Two sets of compression test specimens will be made. Test one set of specimens at an age of 7 days and the other set at an age of 28 days.
 - 2) Test mix for unit weight at the time of cylinder casting.
 - b. Submit prior test results of same mix. Test results shall be dated no greater than 2 years prior to date of planned Backfill Grout placement.
- 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. Flow consistency per ASTM D6103.
- D. Compression Testing of Backfill Grout:
 - 1. Make a minimum of one set of 5 specimens each day when up to 25 cubic yards of Backfill Grout is placed.
 - 2. Make at least one additional set of specimens from each additional 50 cubic yards, or major fraction thereof, placed in any one day, but no more than three sets of specimens for each day.
 - 3. Test two specimens of each set 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 is to be installed to the line and grade specified in the Technical Specifications and Drawings.
- B. The Carrier Pipe will have a clearance of at least 1.0 inch 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 will be made gradually such that pipe joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- D. If the Carrier Pipe is off line and/or grade by more than the specified tolerances, the Contractor will make adjustments, repairs and changes as necessary to achieve the specified tolerances.
- E. 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 will 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.

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 will facilitate complete filling of 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 will be determined by the Contractor as represented in the required submittal calculations.

- D. Do not subject the Backfill grout to free fall greater than 10 feet.
- E. The pressure of the backfill against the Carrier Pipe must not exceed manufacturer limitations at any time and at any location.
- F. 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. Introduce Backfill Grout in tunnels at a spacing of not greater than every 250 feet, through the use of slicklines, or other approved method(s).
- G. Backfill grout is to be injected from the top of the shafts or pumped from the base of the shaft.
 - 1. Vertical drop holes along the tunnel length will not be allowed.
- H. 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.
- I. 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.
- J. To prevent contamination of the Backfill Grout, do not introduce water into the tunnel through injection lines. Provide a means for nuisance water to drain from within the Initial Support annulus through the bulkheads when displaced by grout.
- K. Reduce damage associated with Backfill Grout curing by completely filling the Carrier Pipe with water during Backfill Grouting.
- L. Use bulkhead fans, lifts, or other means as submitted and approved by the Engineer to prevent damage to the Carrier Pipe during Backfill Grouting.
- M. Maintain submitted controls for heat of hydration damages through the cure cycle of the Backfill Grout until temperatures can be demonstrated to not cause damage to the Carrier Pipe.

3.8 CONSTRUCTION RECORDS

- A. 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. Quantity of Backfill installed;
 - 6. Materials testing agency including index testing and specimens;
 - 7. Problems or unusual conditions encountered and actions taken to address these situations.

END OF SECTION

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SECTION 31 75 00

CONSTRUCTION SHAFTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Requirements for construction of shafts, pits, portals and all excavations to access tunnel work including requirements for excavation, ground support, and abandonment.
- B. Requirements in this Section apply to all tunnels on the project. Required submittal information must be provided for each tunnel separately.

1.2 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
 - 1. 31 09 13 – Tunnel 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. 31 23 19 – Dewatering
 - 6. 31 23 33 – Utilities – Trenching and Backfilling
 - 7. Geotechnical Baseline Report (GBR), GEI Consultants, July, 2026
 - 8. Geotechnical Data Report (GDR), GEI Consultants, July, 2026

1.3 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. **WATERTIGHT SHAFT:** A Shaft as described above, constructed in a method that prevents groundwater inflow without dewatering. Examples of Watertight shafts include slurry walls, overlapping secant piles and grouted or gasketed sheet piles. See Section 31 71 00 – Tunnel Excavation and Initial Support for additional definitions.

1.4 REFERENCE STANDARDS

- A. Occupational Safety and Health Administration (OSHA) Regulation 1926 Subpart P, Excavations.

1.5 GENERAL

- A. Be fully responsible for the construction pits, shafts, and shaft support systems.

1.6 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.
- D. Provide internal sumps, or at locations identified in the GBR, Watertight Shafts or external dewatering systems per 31 23 19 – Dewatering.

1.7 GROUND CONDITIONS

- A. Information regarding the ground conditions can be found in the GDR and GBR.

1.8 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 Colorado 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.

1.9 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 Colorado Professional Engineer with qualifications as listed under Section 1.8.
 - 4. 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.
 - 5. At locations identified in the GBR, if Watertight Shafts are implemented, include within the submittal the methods to be utilized in order to construct the shafts in a manner which eliminates groundwater inflow per Section 3.01D of this Specification Section. If Watertight Shafts are not implemented, provide a dewatering plan in accordance with Section 31 23 19 – Dewatering.

- 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

2.1 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

2.2 MATERIALS

- A. Determine the type and design the shaft temporary support.

PART 3 - EXECUTION

3.1 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.
- D. If Watertight Shafts are utilized in lieu of a dewatering system, maximum groundwater inflow rates shall not exceed 25 gallons per minute for launching shafts and 15 gallons per minute for receiving shafts.

3.2 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.

3.3 RESTORATION

- A. All structures and utilities modified or moved shall be restored to the original condition or as determined by the Engineer.

3.4 ABANDONMENT

- A. Backfill around pipes and manholes inside shafts to the spring line of the pipe with flowable fill and pipe bedding in accordance with the Construction Drawings. Backfill shafts above spring line in lifts with approved materials in accordance with 31 23 33 – Utilities – Trenching and Backfilling.
- B. Backfill shafts and excavations with specified and approved materials and methods in accordance with Project Specifications.
- C. 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



DIVISION 33

UTILITIES



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SECTION 33 05 16
PRECAST CONCRETE MANHOLE STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Precast circular concrete manhole structures, rectangular vaults and appurtenant items.
2. Related Specification Sections include but are not necessarily limited to:
3. Division 00 – Procurement and Contracting Requirements
4. Division 01 – General Requirements
5. Section 03 31 30 – Concrete, Materials and Proportioning
6. Section 07 11 14 – Bituminous Damp proofing
7. Section 31 23 33 – Utilities – Trenching and Backfilling
8. Section 33 05 81 – Metallic Castings for Utility Structures
9. Section 31 23 33 – Utilities – Trenching and Backfilling

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
 - a. A48/A48M, Standard Specification for Gray Iron Castings.
 - b. C150/C150M, Standard Specification for Portland Cement.
 - c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - d. C497, Test Methods for Concrete Pipe, Manhole Sections, or Tile
 - e. C857, Standard Practice for Minimum Structural Design Loading for Underground Utility Structures
 - f. C858, Standard Specification for Underground Precast Concrete Utility Structures.
 - g. C890, Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
 - h. C923, Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 - i. C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
3. Fabrication and/or layout drawings:
 - a. Include detailed diagrams of manholes showing typical components and dimensions, reinforcements and other details.
 - b. Itemize, on separate schedule, sectional breakdown of each manhole structure with all components and refer to drawing identification number or notation.
 - c. Indicate knockout elevations for all piping entering each manhole.
4. Buoyancy uplift and structural calculations.

- a. All calculations shall be signed and sealed by a professional engineer registered in the State of Colorado.
- b. Supplier shall submit buoyancy calculations for each site specific manhole using an assumed at-grade water condition.
- c. Supplier shall submit buoyancy calculations for each precast concrete manhole or vault using an assumed at-grade water elevation.
- d. Manufacturer shall submit complete structural calculations for each manhole/vault size and depth.
- 5. Drawings shall be signed and sealed by a Professional Engineer registered in the State of Colorado.
- B. Unless approved prior to submittal, submit all products from this Specification Section in one complete submittal package. Include all products and accessories together.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Manhole rings, covers and frames: See Section 33 05 81 Metallic Castings for Utility Structures
 - 2. Precast Manhole Bases and Vaults
 - a. Copeland Precast
 - b. Forterra
 - c. Lindsay Precast
 - d. Rinker
 - e. Oldcastle
 - 3. Recycled HDPE Adjuster Rings
 - a. Infra-Riser: IR-C Recycled HDPE rings
 - b. Or Equal
 - 4. Black mastic joint compound:
 - a. Kalktite 340.
 - b. Tufflex.
 - c. Plastico.
 - 5. Premolded joint compound:
 - a. Mar Marc – Mac Wrap.
 - b. Kent Seal., Butyl Rubber Sealant.
 - c. General Sealants GS #79, #44, or #4.
 - d. Conseal CS202.
 - e. Ram Nec.
 - 6. Pipe Penetration:
 - a. Link-Seal.
 - 7. Coatings
 - a. As indicated in Section 07 11 14.
 - 8. Manhole steps shall be polyethylene encapsulated steel provided from one of the following, alternates will not be accepted:
 - a. M.A. Industries No. PS2-PF.
 - b. M. Bowen Co. BOWCO No. 93813.
 - c. Rubber-Delta Pipe Products WEDG-LOK SL-11.

- d. American Step Company, Inc. ML-13.
- 9. Black mastic joint compound:
 - a. Kalktite 340.
 - b. Tufflex.
 - c. Plastico.or approved equalDeeter Foundry.
- 10. Premolded joint compound:
 - a. Mar Marc – Mac Wrap.
 - b. RAM-NEK.
 - c. Kent Seal., Butyl Rubber Sealant.
 - d. General Sealants GS #79, #44, or #4.
 - e. Conseal CS202.
 - f. Ram Nec.

B. Submit request for substitution in accordance with the General Conditions.

2.2 MANHOLE/VAULT STRUCTURE COMPONENTS

A. Manhole Components:

- 1. Reinforcement: ASTM C478.
- 2. Minimum wall thickness: 6 IN.
- 3. Minimum base thickness: 8 IN.
- 4. Provide the following components for each manhole structure:
 - a. Base (precast) with integral bottom section.
 - b. Precast barrel section(s).
 - c. Recycled HDPE adjuster ring(s).
 - d. Precast concrete transition section.
 - e. Precast flat top.
- 5. Refer to drawings for manhole and vault details, depths, inside dimensions, and penetrations.

B. Manhole Frames and Cover:

- 1. See drawing details.
- 2. See Section 33 05 81

C. Manhole Steps:

- 1. See Details on Drawings
- 2. General:
 - a. Provide maximum distance from surface to first rung is not greater than 12 IN and that maximum spacing on remaining steps is 12 IN OC, spacing consistent within +/-1" within a manhole.
 - b. Safety tread.
- 3. Polyethylene encapsulated ½ IN Grade 60 steel rod.
 - a. Minimum step width: 12 IN.
 - b. Distance from face of wall to back of tread: 5-3/4 IN.
 - c. Embedment: 3-3/8 IN.
 - d. Encapsulated material thickness per manufacturer.

D. Special Coatings and Joint Treatment:

- 1. Joints of precast sections:
 - a. Provide premolded joint compound and external seal tape.

- 1) Premolded joint sealant:
 - a) NPC Bidco, Inc., C-56.
 - b) Ram-Nek, Henry Co.
 - c) EZ-Stik, Press-Seal Gasket Corp.
 - d) CS-102, Conseal.
- 2) Elastomeric joint seals:
 - a) Kent Seal.
- 3) External joint wrap.
 - a) NPC, Bidco, Inc.
 - b) EZ-Wrap, Press-Seal Gasket Corp.
 - c) RUBR-Nek, Henry Co.
2. Vertical exterior wall surfaces: As indicated in Section 07 11 14
3. Interior surfaces:
 - a. Internal lining not required.
- E. Pipe to manhole connections shall utilize Link-Seal.
- F. Insulation for Installation on Exterior of Manholes
 1. Closed cell extruded polystyrene rigid foam board insulation
 2. Thickness: 2-inch
 3. Manufacturer: Owens Corning Foamular NGX 250 or approved equal

2.3 MANUFACTURER REQUIREMENTS

- A. General:
 1. Marking and Identification: Each manhole shall be marked on the inside and outside with the following information:
 - a. Manufacturer's name or trademark.
 - b. Manufacturer's factory location.
 - c. Manufacturer's serial number.
 - d. Manufacture date
 - e. Total manhole depth and diameter.
- B. Design Criteria:
 1. Manhole risers, transition slabs, flat tops, and manhole base sections shall be designed, by manufacturer, to meet the intent of ASTM C478.
 2. Design precast vaults and appurtenances in accordance with ASTM C858.
 - a. Notify Engineer and furnish cast-in-place structures if sizes of precast utility structures shown on Drawings can not be designed or fabricated.
 3. Structure shall be checked for buoyancy.
 - a. The minimum factor of safety for uplift with the design groundwater elevation shall be 1.25, unless a larger factor of safety is required by the local governing body or building code.
 - b. If the buoyant weight of soil above base slab extensions beyond the external dimensions of the structure is used to resist uplift, the volume of soil considered to resist uplift shall be limited to soil within the vertical projection of the edge of the base slab extensions.
- C. Design loads:
 1. Design precast units for all loads and load cases described in ASTM C857, with the following values and selections:
 - a. Wheel loads shall be considered.

- 1) Use wheel load designation as shown in ASTM C857, Table 1.
 - b. Unit weight of soil W shall be taken as no less than 125 lb/CUFT.
 - c. Minimum lateral soil pressure coefficient (K_0): 0.50.
 2. AASHTO LRFD HL-93 design live loading applied to manhole cover and transition and base slabs.
 3. Dead load of manhole sections fully supported by transition and base slabs.
- D. Rectangular Vault Specific Design Requirements:
1. Out-of-plane shear:
 - a. Out-of-plane shear shall be shown in the calculations.
 - b. Wall thickness shall be determined based on meeting design requirements for out-of-plane shear resulting from soil and groundwater loads.
 - c. Wall sections shall be designed as one-way spans between corners for calculation of out-of-plane shear. Transfer of shear or bending load shall not be considered to be transferred across joints between precast units or between walls and slabs, unless unit as integrally cast together.
 - d. Use of shear steel reinforcement to increase out-of-plane shear capacity shall be prohibited.
 2. The distribution of moments in adjacent walls of different lengths in rectangular structures shall be considered.
 3. Design precast units taking into account reduced cross section at openings and penetrations.
- E. Design:
1. Required wall thickness for all members shall be that stated by manufacturer based upon loading conditions and material properties. The wall thickness of risers and flat tops shall be not less than that prescribed by manufacturer's design by more than 5%. A wall greater than the prescribed design shall not be cause for rejection.
 2. Each manhole or vault component shall be free of all defects, including indentations, cracks, and foreign inclusions, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. The internal diameter of manhole components shall not vary more than 1%. Variations in height of two opposite sides of the risers and conical tops shall not be more than 5/8 inch. The under run in height of a riser or conical top shall not be more than 1/4 in per foot of height with a maximum of 1/2 in in any one section.
 3. Manhole joints shall be formed with a flush flat end, alignment guides and gasket so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surfaces irregularities that would affect joint integrity.
 4. Clear distance between two wall penetrations shall be a minimum of 6" on 48" to 72" diameter manholes and a minimum of 8" on larger diameter manholes. A minimum clearance of 3" is required between wall penetration and joint.

PART 3 - EXECUTION

3.1 MANHOLE AND VAULT CONSTRUCTION

- A. General:
1. Unless otherwise shown on the drawings, utilize precast concrete base with integral bottom section.
 2. Ensure accurate vertical placement and leveling prior to backfill.
- B. Build each manhole and vault to dimensions shown on plans and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.

- C. All horizontal joints: install a resilient O-ring type gasket or pre-molded joint compound and external seal tape.
- D. Pipe penetrations in manhole.
 - 1. Provide seal type as shown on the drawings at all pipe penetrations.
- E. Insulation for Installation on Exterior of Manholes
 - 1. Score or cut as required to fit tight to manhole shape.
 - 2. Secure to manhole with adhesive recommended by manufacturer
 - a. Adhesive must be compatible with bituminous dampproofing material
- F. Set and adjust frame and cover final 6 IN (minimum) to 18 IN (maximum) to match finished pavement or finished grade elevation using precast or rubber adjuster rings.

3.2 FIELD QUALITY CONTROL

- A. Any proposed repairs of precast components or structures shall be submitted to Engineer for approval.
- B. Structures shall be observed for signs of leakage during periods of high groundwater.
- C. No leakage that includes visible flow through joints between precast concrete sections or through pipe penetrations shall be permitted.
- D. Damp spots on interior wall surfaces shall be considered leakage and shall not be permitted.
 - 1. Damp spots shall be defined as spots where moisture from a source outside the structure can be picked up on a dry hand.
 - 2. Locate the source of water movement through the wall and permanently seal.
- E. Dampness on the top of the base slab will not be construed as leakage.

END OF SECTION

SECTION 33 05 19
DUCTILE-IRON UTILITY PIPE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ductile iron piping, fittings, specials, and appurtenances.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 09 90 04 - Painting.
 - 2. Section 26 42 17 – Impressed Current Cathodic Protection.
 - 3. Section 31 23 33 – Utilities Trenching and Backfilling.
 - 4. Section 40 05 01 – Common Work Results For Process Piping.

1.2 REFERENCES

- A. Definitions:
 - 1. CLSM: Controlled Low Strength Material.
 - 2. Mechanical Couplings: Fittings intended to join grooved and/or shouldered pipe.
 - 3. Pipe Diameter: Pipe diameter specified or shown on the Drawings is the nominal pipe diameter for ductile iron pipe.
- B. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B1.1 - Unified Inch Screw Threads (UN and UNR Thread Form).
 - b. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - c. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
 - 2. ASTM International (ASTM):
 - a. A47 - Standard Specification for Ferritic Malleable Iron Castings.
 - b. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
 - d. A536 - Standard Specification for Ductile Iron Castings.
 - e. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
 - 3. American Water Works Association (AWWA):
 - a. C203 - Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
 - b. C217 - Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe.
 - 4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
 - a. C104/A21.4 - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
 - b. C105/A21.5 - Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - c. C110/A21.10 - Standard for Ductile-Iron and Gray-Iron Fittings.
 - d. C111/A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - e. C115/A21.15 - Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

- f. C150/A21.50 - Standard for Thickness Design of Ductile-Iron Pipe.
- g. C151/A21.51 - Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
- h. C153/A21.53 - Standard for Ductile-Iron Compact Fittings for Water Service.
- i. C217 - Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
- j. C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe.
- k. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.3 SUBMITTALS

A. Action Submittals:

- 1. Submit shop drawings for ductile iron pipe, fittings and appurtenances as one package.
- 2. Submit the class and wall thickness for all pipe and pressure rating and wall thickness of all fittings.
- 3. Submit standard and restrained joints details indicating all pertinent dimensions and manufacturing tolerances.
- 4. Submit a materials list indicating the anticipated number of straight lengths of pipe to be used and all fittings and specials
- 5. Submit separate shop drawing for fittings only if manufactured by a separate supplier.
- 6. Material list.
- 7. Manufacturing Information.
 - a. Pipe and fitting details for temporary and permanent facilities indicating:
 - 1) Manufacturing tolerances.
 - 2) Maximum angular deflection limitations of field joints.
 - 3) Closure sections and cutoffs for field length adjustment.
 - 4) Bulkheads, including details for removal of test bulkheads and repair of linings.
 - 5) All other pertinent information required for the manufacture and installation of the product.
 - b. Joint Details:
 - 1) Push-on joints.
 - 2) Restrained joints.
 - 3) Flanged joints.
 - 4) Mechanical Joints.
- 8. Product data for the following:
 - a. Pipe and fittings:
 - 1) Material data.
 - 2) Chemical and physical test reports.
 - 3) Manufacturer's recommendation for maximum allowable joint deflection.
 - b. Coatings and Linings:
 - 1) Technical data sheets itemizing chemical composition, technical and performance information that indicates compliance with this Specification.
 - 2) Color chart, if applicable.
 - 3) Surface preparation requirements.
 - 4) Curing requirements.
 - 5) Manufacturer's name, product number or name.
 - 6) Coating or lining thickness.
 - c. Flanged Joints:

- 1) For each flanged connection: Reference standard, class, dimensional data, bolt hole number, pattern and diameter, bolt diameter and length, face condition (raised or flat).
 - d. Gaskets and Bolting: Technical data sheets itemizing chemical composition, technical and performance information that indicates compliance with this Specification.
 - e. Wall Sleeves: Dimensional data, including sleeve length, thickness, and diameter.
 - 9. Pipe handling equipment and methods for loading and unloading pipe.
 - a. Pipe support requirements for storage.
 - 1) Minimum allowable width, quantity, and location of contact points to prevent excess deflections.
 - b. Pipe moving support requirements: Minimum allowable sling width.
 - 10. If mechanical coupling system is used, submit piping, fittings, and appurtenant items which will be utilized to meet system requirements.
- B. Informational Submittals:
- 1. Certificates.
 - a. Manufacturer's Certificate of Compliance that products furnished meet requirements of this Specification.
 - b. Ductile Iron Pipe Installation: Certificate that training has been provided to Contractor's installation crews regarding proper pipe handling and storage procedures.
 - 2. Reports:
 - a. Factory Hydrostatic Test Reports.
 - b. Field Hydrostatic Test Reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Pipe and Fittings :
 - a. American Ductile Iron Pipe.
 - b. McWane Ductile.
 - c. US Pipe.
 - 2. Restrained joints:
 - a. American (Flex-Ring) - 4 inches to 54 inches.
 - b. U.S. Pipe (HDSS) - 4 inches to 36 inches
 - 1) U.S. Pipe HDSS Quicklok is not acceptable
 - c. Or approved equal.
 - 3. Dismantling joints:
 - a. Smith-Blair (Style 975).
 - b. Dresser (Style 131).
 - c. Or approved equal.
 - 4. Joint restraints (MJ Fittings):
 - a. EBAA Iron, Inc., Megalug®.
 - b. Star Pipe Products, Stargrip®.
 - c. Or approved equal.

2.2 MATERIALS

- A. Ductile Iron Pipe:

1. AWWA/ANSI C115/A21.15.
 2. AWWA/ANSI C150/A21.50.
 3. AWWA/ANSI C151/A21.51.
 4. Wall Thickness:
 - a. Pressure Class: 250 unless noted otherwise.
- B. Fittings and Flanges:
1. AWWA/ANSI C110/A21.10.
 2. AWWA/ANSI C153/A21.53.
 3. AWWA/ANSI C115/A21.15.
 4. Flanges drilled and faced per ASME B16.1 for both 125 and 250 psi applications.
- C. Nuts and Bolts:
1. Buried:
 - a. Tee-head bolts for mechanical joints: Per AWWA/ANSI C111/A21.11.
 - b. Other bolts and nuts: ASTM A307 .
 - c. Wax tape Coatings per AWWA C217.
 2. Exposed: Mechanical galvanized ASTM B695, Class 40.
 3. Heads and dimensions per ASME B1.1.
 4. Threaded per ASME B1.1.
 5. Project ends 1/4 to 1/2 inches beyond nuts.
- D. Gaskets:
1. Flanged Joints:
 - a. For pipe sizes between 4 and 64 inches and maximum working pressures not exceeding 250 psig: SBR in accordance with AWWA C111.
 - b. For pipe sizes between 4 and 24 inches and maximum working pressures greater than 250 psig: In accordance with ASME B16.21.
 2. Mechanical and push-on joints: in accordance with AWWA C-111.
 - a. Maximum pressure: 350 psi.
- E. Polyethylene Encasement: Per AWWA/ANSI C105/A21.5.
1. Provide with an integral anti-microbial compound and corrosion inhibitor (V-Bio®).
 2. Provide tube style PE encasement for pipes up to 12 inches diameter.
- F. See Section 40 05 01 - Common Work Results for Process Piping.

2.3 MANUFACTURED UNITS

- A. Joint restraints (MJ Fittings):
1. Gland body, wedges and wedge actuating components: ASTM A536 grade 65-45-12 ductile iron.
 2. Coating: Manufacturer's standard epoxy.

2.4 FABRICATION

- A. Furnish and install without outside coatings of bituminous material any exposed pipe scheduled to be painted.
- B. Furnish cast parts with lacquer finish compatible with finish coat.
- C. Minimum Pressure Class: See article 2.2 A.

2.5 LININGS AND COATINGS

- A. Cement mortar lining: Per AWWA/ANSI C104/A21.4.

1. Standard thickness.
- B. Coating: Manufacturer's standard bituminous coating.
 1. Minimum dry film thickness: 1 mil.
- C. Field coating at buried mechanical couplings, restrained joints or mechanical joints.
 1. Wax coating per AWWA C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.

2.6 ACCESSORIES

- A. Couplings:
 1. For pipe with flange by flange ends (Dismantling Joints).
 - a. Self-contained flanged restrained joint fitting, including both flange components and sufficient harness bars to withstand the imposed thrust.
 - b. Design pressure rating: equal to or greater than flange rating.
 2. Provide bolts, nuts, and washers (when required) of suitable quality, workmanship, and yield strength to ensure compatibility with the coupling design and rated pressure.
 - a. Select materials to minimize the possibility of galvanic corrosion.
 3. See Paragraph 2.2 of this Specification for gasket requirements.
- B. Pipeline Markers and Pipe Locating Tape: See Section 10 14 00 - Identification Devices.
- C. Cathodic Protection: See Section 26 42 17 – Impressed Current Cathodic Protection.

2.7 SOURCE QUALITY CONTROL

- A. Factory Test:
 1. Subject pipe to hydrostatic test of not less than 500 psi with the pipe under the full test pressure for at least 10 seconds.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install piping complete with jointing materials and accessories, anchors, and other appurtenances.
- B. Prepare trench as required in the Contract Documents, Section 31 23 33 - Utilities - Trenching and Backfilling.
- C. Unless otherwise permitted by Engineer, maximum length of open trench: 300 linear feet or the amount of pipe that can be installed in a single day, whichever is less.
- D. A. Handling and Storage:
 1. Stack pipe no higher than the maximum height given in AWWA C600.
 - a. Alternate bell ends with spigot ends.
- E. Protection of Appurtenances:
 1. Wrap buried ductile iron pipe appurtenances with polyethylene, following the procedures of AWWA C600.
- F. Installation of buried bolted joints:
 1. Coat buried bolted joints with wax tape then wrap in polyethylene.

3.2 LAYING PIPE

- A. Trenching, bedding material, and backfilling of buried piping: comply with Section 31 23 33 - Trenching and Backfilling, and other relevant requirements of the Contract Documents.
- B. Install piping in accordance with the following:

1. Section 40 05 01 – Common Work Results for Process Piping.
- C. Handle pipe with proper equipment in a manner to prevent distortion or damage.
 1. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining is not permitted.
 2. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.
- D. Lift pipe during unloading or lifting into trench using one or more slings as required to prevent uncontrolled swinging, damage to pipe, or harm to workers.
 1. Design slings to bear uniformly against pipe.
- E. Locate horizontal deflections on alignment as shown on the Drawings.
- F. Locate vertical deflections on alignment, and match pipe angle point locations indicated on the Drawings.
- G. For grades exceeding 10 percent lay pipe in an uphill direction except for short runs that may be allowed by Engineer.
 1. Block pipe laid on a downhill grade and hold in place until sufficient support is provided by subsequently installed pipe segment to prevent movement.

3.3 JOINTING

- A. Jointing – General:
 1. Join pipe segments and fittings together in accordance with relevant requirement of the Contract Documents, including the Specifications referenced in this Section’s “Laying Pipe” Article.
- B. Joining Method – Push-On Mechanical (Gland-Type) Joints:
 1. Install in accordance with AWWA/ANSI C111/A21.11.
 2. Assemble mechanical joints carefully according to manufacturer’s recommendations.
 3. If effective sealing is not obtained, disassemble, thoroughly clean, and reassemble the joint.
 4. Do not overstress bolts.
 5. Where piping utilizes mechanical joints with tie rods, align joint holes to permit installation of harness bolts.
 6. Apply wax tape per C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
- C. Joining Method – Flanged Joints:
 1. Install in accordance with AWWA/ANSI C115/A21.15.
 2. Extend pipe completely through screwed-on flanged and machine flange face and pipe in single operation.
 3. Make flange faces flat and perpendicular to pipe centerline.
 4. When bolting flange joints, exercise extreme care to ensure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress, bending or torsional strains to be applied to cast flanges or flanged fittings.
 5. Allow one flange free movement in any direction while bolts are being tightened.
 6. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.
 7. Gradually tighten flange bolts uniformly to permit even gasket compression.
- D. Joining Method – Mechanical Joints:
 1. Thoroughly clean the last 8 inches outside of the spigot and the inside of the bell to remove oil, grit, excess coating, and other foreign matter from the joint and then paint with a thin film of non-toxic, water soluble gasket lubricant.

2. After preparation of the spigot, slip gland onto the spigot end of the pipe with the lip extension of the gland toward the plain end.
 3. Paint the rubber gasket with the gasket lubricant and place on the spigot end with the thick edge toward the gland.
 4. Push the entire section of the pipe forward to seat the spigot end in the bell, then press the gasket into place within the bell.
 - a. Locate the gasket evenly around the entire joint.
 5. Move the gland toward the bell and center with the gland lip against the gasket.
 - a. Insert all of the bolts and finger tighten nuts.
 - b. Tighten all nuts with a torque limiting wrench following the range of torque given in AWWA C600.
 - 1) Tighten bolts spaced 180 degrees apart alternately in order to produce an equal pressure on all parts of the gland.
 6. Deflect joints scheduled for deflection after joint assembly but before tightening the bolts.
 - a. Maximum deflection for mechanical joints: 50-percent of the manufacturers maximum recommended deflection.
 7. Apply wax tape per AWWA C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
- E. Wax Tape Coating System:
1. After installation, coat all buried nuts and bolts with a wax tape coating system in accordance with:
 - a. AWWA C217.
 - b. Manufacturer's printed instructions.
 2. Cut strips of wax tape and apply them around all bolts and nuts so that there are no voids or spaces under the tape.
 3. Apply a sufficient amount of tape to completely encapsulate all bare metal.
- F. Cutting:
1. Do not damage interior lining material during cutting.
 2. Use abrasive wheel cutters or saws.
 3. Make square cuts.
 4. Bevel and free cut ends of sharp edges after cutting.
- G. Support exposed pipe in accordance with Section 40 05 01 – Common Work Results for Process Piping.
- H. Install polyethylene encasement on all buried piping in full compliance to AWWA/ANSI C105/A21.5.
1. Encase underground appurtenances required as part of installation.
 2. Clean all material to be wrapped prior to wrapping operations.
 3. Do not trap soil or embedment material shall not be trapped between the polyethylene material and the item to be protected during installation.
 4. Secure polyethylene encasement at ends, seams, overlaps and folds by adhesive tape or plastic tie straps approved for such purpose.
 5. Provide sufficient slack in contouring the encasement around buried items to prevent stretching the material where it bridges irregularities and to prevent damage by backfilling operations.
 - a. Make sections 2 feet longer than pipe section to be covered.
 6. Where tapping polyethylene encased pipe, first wrap location of tap with three layers of polyethylene adhesive tape.
 - a. Make tap through tape.

7. Slip tube over pipe while pipe is suspended immediately before placing in trench.
 8. After installing in trench, pull tube ends over joint and overlap.
 9. Fasten securely in-place on each side of each joint with joint tape or strapping.
 10. Pull loose tube along pipe barrel up snugly around pipe and fasten in-place with joint tape at 3 feet intervals.
 11. Completely cover fittings and connections with film held snugly in-place with joint tape or strapping.
 12. Repair cuts, tears, punctures and other damage to the polyethylene material with adhesive tape and a short length of additional polyethylene material, if needed.
 - a. Allow Engineer to inspect all repairs prior to all backfilling activities.
- I. Install restrained joint systems where shown on the drawings.

3.4 FIELD QUALITY CONTROL

- A. Test piping systems in accordance with Section 40 05 01 - Common Work Results for Process Piping, and requirements of the Specifications cross-referenced in this Section's "Laying Pipe" Article.

END OF SECTION

SECTION 33 05 23
PIPELINE UNDERCROSSINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Construction of new pipe under existing piped utilities.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

1.2 GENERAL REQUIREMENTS

- A. Protect and preserve all existing utilities exposed during trenching, pipe installation and backfilling operations.
- B. Provide temporary supports and bracing as required to prevent sagging or joint deflection in crossed utilities when exposed during trenching operations.
- C. Provide utility protection in accordance with details depicted on the drawings.
- D. Provide flow fill embedment to spring line of crossed utility where shown on the drawings

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. For all crossed utilities 18-inch and larger in diameter, provide a Utility Support Plan (USP).
 - 2. USP shall include, at a minimum, the following:
 - a. Proposed method of supporting crossed pipeline across open trench.
 - b. How support is to be attached to crossed pipeline and spacing of connections to existing pipeline.
 - c. Narrative describing how existing pipeline will be exposed, connected to temporary support system and disconnected from temporary support system.
 - d. Contact information for owner of existing pipeline.
 - e. Pipe support system plans and details, designed and stamped by a professional engineer, that are appropriate for the construction methods being employed to cross beneath the utility.
 - f. If Utility must be removed and replaced, the USP shall provide sufficient detail of means and methods to remove and replace utility to pre-existing conditions with salvaged or new components.

PART 2 - PRODUCTS

2.1 MATERIALS

- 1. Not Used.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Install undercrossing to meet requirements of authority or agency having jurisdiction over undercrossing.
 - 2. Observe work requirements stipulated in any permit condition.

3. When crossing under an existing pipeline or other utility with a new pipeline, provide temporary support provisions to avoid damage and minimize future .
- B. Supporting the existing pipe or utility across the proposed trench.
 1. Accomplish by limiting the proposed pipe trench width so that the existing pipe is self-supporting or specially designing a support. New pipelines shall be installed according to trench widths indicated on the Drawings and as specified in Section 31 23 33.
 2. Minimize the duration that the utility is exposed and temporarily supported.
- C. Contractor shall retain the services of a professional engineer to design temporary supports whenever the crossed pipeline is 18-inches in diameter or larger.
- D. Provide a temporary support whenever the crossed pipeline will have a joint exposed within the trench.
 1. Restore a firm foundation and embedment for crossed pipeline when backfilling trench. Backfill: See Specification Section 31 23 33.
 2. Provide flow fill embedment for existing crossed pipeline where depicted on the drawings.

END OF SECTION

SECTION 33 05 24

STEEL UTILITY PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Lined and coated gasketed and welded steel pipe, specials and fittings.

B. Related Requirements: Include, but are not necessarily limited to:

1. Section 09 90 04 – Painting.
2. Section 09 90 05 – Polyurethane Coating.
3. Section 10 14 00 - Identification Devices.
4. Section 26 42 17 – Impressed Current Cathodic Protection.
5. Section 31 23 33 – Utilities – Trenching and Backfilling.
6. Section 31 71 00 – Tunnel Excavation and Initial Support
7. Section 31 74 23 – Carrier Pipe Installation and Backfill.
8. Section 40 05 01 – Common Work Results for Process Piping.

1.2 REFERENCES

A. Definitions and Terminology:

1. Fittings and Specials: Including, but not limited to fittings, closure pieces, bends, elbows, reducers, tees, wyes, bifurcations, crosses, outlets, manifolds, nozzles, wall sleeves, bulkheads, vent pipes, and other piping and appurtenances fabricated from steel plate, sheet, or coil as required to provide the Work, complete.
 - a. Specials also include piping above ground or inside structures.
2. F_y: Material Yield Stress, PSI
3. Main Pipe Supplier (MPS): Manufacturer of the pipeline and as further defined in Paragraph 2.1.A.
4. Main Line: When used in reference to fittings, specials and elbows; refers to those components of the same diameter as the straight pipe sections they are to be connected to.
5. Weld After Backfill (WAB): Procedure where internal pipe welds are performed after the pipe has been backfilled and a heat shrink sleeve is applied to the exterior of the joint prior to backfill to protect the bare steel where the coating has been held back for welding.
6. Acronyms.
 - a. CJP: Complete Joint Penetration.
 - b. CLSM: Controlled Low Strength Material.
 - c. CWI: Certified Welding Inspector.
 - d. DFT: Dry Film Thickness.
 - e. LHA: Lining holdback area.
 - f. LT: Leak Testing.
 - g. MPS: Main pipe supplier.
 - h. MT: Magnetic Particle Testing.
 - i. NDE: Nondestructive Examination.
 - j. NDT: Nondestructive Testing.
 - k. NPS: Nominal Pipe Size.
 - l. PJP: Partial Joint Penetration.
 - m. PQR: Procedure Qualification Record.

- n. PT: Liquid Penetrant Testing.
 - o. RT: Radiographic Testing.
 - p. UT: Ultrasonic Testing.
 - q. VT: Visual Testing.
 - r. WAB: Weld After Backfill.
 - s. WBB: Weld Before Backfill.
 - t. WPQ: Welder/Welding Operator Performance Qualification.
 - u. WPS: Welding Procedure Specification.
- B. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
- 1. American Society of Mechanical Engineers (ASME):
 - a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
 - b. B1.20.1, Pipe Threads, General Purpose (Inch).
 - c. B16.47, Large Diameter Steel Flanges.
 - d. B16.5, Pipe Flanges and Flanged Fittings and Other Special Alloys.
 - e. B16.9, Factory Made Wrought Steel Buttwelding Fittings.
 - f. B16.11, Forged Steel Fittings, Socket-Welding and Threaded.
 - g. B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
 - h. B18.2.2, Nuts for General Applications: Machine Screw Nuts; and Hex, Square, Hex Flange, and Coupling Nuts (Inch Series).
 - i. B31.3, Process Piping.
 - j. B36.10, Welded and Seamless Wrought Steel Pipe.
 - k. Boiler & Pressure Vessel Code (BPVC)
 - 1) Section V, Nondestructive Examination.
 - 2) Section VIII, Division 1, Rules for Construction of Pressure Vessels.
 - 3) Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
 - 2. ASTM International (ASTM):
 - a. A6, General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
 - b. A20, Standard Specification for General Requirements for Steel Plates for Pressure Vessels.
 - c. A36, Standard Specification for Carbon Structural Steel.
 - d. A53, Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc Coated, Welded and Seamless.
 - e. A82, Standard Specification for Steel Wire.
 - f. A139, Standard Specification for Electric Fusion Arc – Welded Steel Pipe (Sizes 4-IN and Over).
 - g. A181, Standard Specification for Forged or Rolled Steel Pipe Flanges, Forged Fittings, and Valves and Parts for General Service.
 - h. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates, Shapes, and Bars.
 - i. A285, Standard Specification for Pressure Vessel Plates, Carbon Steel, Low and Intermediate-Tensile Strength.
 - j. A307, Standard Specification for Carbon Steel Externally and Internally Threaded Standard Fasteners.
 - k. A325, Standard Specification for High Strength Bolts for Structural Steel Joints.

- l. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
- m. A568, Standard Specification for General Requirements for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.
- n. A370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
- o. A435/A435M, Standard Specification for Straight Beam Ultrasonic Examination of Steel Plates.
- p. A516/A516M, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower Temperature Service.
- q. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
- r. A673, Sampling Procedure for Impact Testing of Structural Steel.
- s. A770/A770M, Standard Specification for Through Thickness Tension Testing of Steel Plates for Special Applications.
- t. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
- u. A1018/A1018M, Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Commercial, Drawing, Structural, High Strength Low Alloy, and High Strength Low Alloy with Improved Formability.
- v. C33, Standard Specification for Concrete Aggregates.
- w. C128, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.
- x. C144, Standard Specification for Aggregate for Masonry Mortar.
- y. C150, Specification for Portland Cement.
- z. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
- aa. D75, Standard Practice for Sampling Aggregates.
- bb. D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
- cc. D1330, Standard Specification for Rubber Sheet Gaskets.
- dd. E165, Methods for Liquid Penetrant Inspection.
- ee. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
- ff. E1255, Standard Practice for Radioscopy.
- gg. G14, Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
- 3. American Society for Nondestructive Testing Inc. (ASNT):
 - a. SNT-TC-1A, Recommended Practice for Personnel Qualification and Certification in Nondestructive Testing.
- 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. B2.1, Specification for Welding Procedure and Performance Qualification.
 - d. D1.1, Structural Welding Code-Steel.
 - e. QC1, Standard for AWS Certification of Welding Inspectors.
- 5. American Water Works Association (AWWA):
 - a. C200, Steel Water Pipe 6 inch and Larger.
 - b. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 inch and Larger - Shop Applied.
 - c. C206, Field Welding of Steel Water Pipe.

- d. C207, Steel Pipe Flanges for Waterworks Service Sizes 4 inch through 144 inch.
- e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
- f. C209, Tape Coatings for Steel Water Pipe and Fittings.
- g. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
- h. C216, Heat-Shrinkable Cross-Linked Polyolefin Coatings for Steel Water Pipe and Fittings.
- i. C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
- j. C219, Bolted Sleeve-Type Couplings for Plain-End Pipe.
- k. C222, Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings.
- l. C602, Cement–Mortar Lining of Water Pipelines in Place - 4 In. (100 mm) and Larger.
- m. C604, Installation of Steel Water Pipe – 4 In. (100 mm) and Larger.
- n. C606, Grooved and Shouldered Joints.
- o. M11 Steel Water Pipe – A Guide for Design and Installation.
- 6. National Association of Corrosion Engineers (NACE):
 - a. RP 02-74, High-Voltage Electrical Inspection of Pipeline Coatings.
 - b. TM 01-70, Visual Standard for Surfaces of New Steel Air Blast Cleaned with Sand Abrasive.
 - c. TM 01-75, Visual Comparator for Surfaces of New Steel Centrifugally Blast Cleaned with Steel Grot and Shot.
- 7. National Sanitation Foundation (NSF):
 - a. 60, Drinking Water Treatment Chemicals - Health Effects.
 - b. 61, Drinking Water System Components - Health Effects.
- 8. Society for Protective Coatings (SPCC):
 - a. SP1, Solvent Cleaning.
 - b. SP2, Hand Tool Cleaning.
 - c. SP3, Power Tool Cleaning.
 - d. SP6/NACE No.3, Commercial Blast Cleaning.
 - e. SP10/NACE No.2, Near-White Metal Blast Cleaning.
 - f. SP11, Power Tool Cleaning to Bare Metal.
- 9. International Organization for Standardization (ISO): 9001:2000, Quality Management Systems - Requirements.
- 10. Steel Pipe Fabricators Association (SFPA).

1.3 SYSTEM DESCRIPTION

- A. Furnish all materials, tools, labor, supervision, and appurtenances for and properly install, connect, adjust, test, and place in continuous satisfactory service all welded steel pipe and fittings at the locations and to the elevations indicated on the Drawings, specified, or required for the proper completion of the Work.
- B. Welded steel pipe and fittings are not necessarily completely indicated or detailed on the Drawings.
 - 1. Drawings are schematic only and indicate pipe and fittings in a general way.
 - 2. Furnish all materials, pipe and fittings required.
- C. Provide an installation, complete in every detail, whether indicated on the Drawings, or specified herein.
- D. MPS shall assume full responsibility for design and fabrication of steel pipe and fittings to the criteria specified herein.

- E. Contractor shall assume full responsibility for proper installation of all pipe and related materials, and for demonstrating compliance with specified performance.

1.4 QUALITY ASSURANCE

A. General.

1. Manufacture pipe and fabricate specials under the direction and management of one steel pipe supplier only.
 - a. Specials or fittings may be manufactured by a separate supplier but only under direction of Main Pipe Supplier (MPS).
 - b. Separate supplier must meet same qualifications as MPS.
2. Minimum responsibilities of the MPS include:
 - a. Ensure pipe, fittings, and specials are being manufactured in full accordance with the Drawings and Specifications.
 - b. Design and fabrication of the pipe and specials.
 - c. Prepare and submit submittal information and shop drawings.
 - d. Make any corrections that may be required to the submittal information and shop drawings.
 - e. Certify that the pipe and specials have been manufactured in accordance with the Specifications and Drawings.

B. Manufacturer's Qualifications.

1. MPS qualifications:
 - a. Minimum five years experience in supplying spiral weld pipe greater than 36 IN DIA.
 - 1) Experience shall include successful fabrication to AWWA C200 standards of at least 25,000 linear feet of 36-inch diameter or larger pipe, with wall thickness of 0.2 inches or greater, within past 5-year period.
 - 2) e. Experience shall be applicable to fabrication plant facilities and personnel, not company or corporation that currently owns fabrication facility or employs personnel.
 - b. ISO-9001 or SPFA certified.

C. Fittings Fabricator:

1. Experienced in fabricating fittings of similar diameters and wall thickness required for the Work.
2. Steel Pipe Fabricators Association (SPFA) Certification or ISO 9001:2000 Certification.
3. Demonstrate current production capability for volume of work required for this Project.
4. Experience shall include successful fabrication to AWWA C200 and AWWA C208 standards of at least
 - a. 25 fittings of 36-inch or larger pipe, with wall thickness 0.2 inch or greater, within past 5-year period.
 - b. Experience shall include successful fabrication of at least five crotch plate fittings requiring post weld heat treatment within past 5-year period.
 - c. Experience shall be applicable to fabrication shop facilities and personnel, not company or corporation that currently owns fabrication facility or employs personnel.

D. Manufacturer's Welders and Welding Operators

1. Welder's Qualifications & Welding Procedures:
 - a. As described in AWWA C200, qualify all welding procedures, welders, welding operators, and tackers in accordance with Section IX of the ASME Boiler and Pressure Vessel Code, under AWS B2.1, or AWS D1.1.

- b. Prequalified welding procedures required for, but not necessarily limited to, longitudinal and girth or spiral welds for pipe cylinders, reinforcing plates, ring flange welds, and plates for lug connections.
 - c. See Article 2.3F for Welding Procedure Specification (WPS)
- E. Field Welder's Qualifications.
 - 1. Qualification of Welders and Welding Procedure.
 - a. Qualify all welding procedures, welders, welding operators, and tackers under the provisions of AWS D1.1 and as defined in AWWA C206 not more than six months prior to commencing work on the pipeline.
 - b. All qualifications to be in accordance with all-position pipe tests as defined in Clause 6 of AWS D1.1.
 - c. Utilize machines and electrodes similar to those to be used in the Work in qualification tests.
 - d. Conduct all welding tests for qualification in the presence of the testing agency or in the presence of a certified welding inspector appointed by the testing agency.
 - e. Cost of qualifying to be borne by Contractor.
 - 2. Production Welding test: Require each welder employed by the Contractor to satisfactorily pass a welding test before being allowed to weld on the line.
 - a. Conduct welder qualification testing for field welding at the project site.
 - b. Results of previous qualification tests will not be accepted.
 - c. Provide the services of an independent testing laboratory to perform the welder qualification.
 - d. Submit copies of all test data and certifications.
 - e. All costs of welder qualification testing to be paid by the Contractor.
 - 3. Test Requirements:
 - a. Require each welder to make a position weld on a pipe nipple of the same diameter and specification as the pipe in the line.
 - b. Inspect and test each test weld using an accepted and approved testing method subject to the Engineer's acceptance, administered by an independent testing laboratory retained by the Contractor.
 - 1) See Subparagraph 3.12
 - c. Submit independent testing laboratory qualifications for approval by Engineer prior to any welding test being performed.
 - 4. After each welder has qualified in the preliminary tests referred to above, random and periodic inspections may be performed on joints in the line by Owner's Representative to verify quality of welds is meeting standards.
 - a. If a defective weld is found, all welds by that welder are to be inspected.
 - b. If a total of 3 or more failed welds are found, do not allow welder to continue welding on project.
 - 5. Furnish each welder employed a steel stencil for marking the welds, so that the work of each welder may be identified.
 - a. Each welder shall stencil the pipe adjacent to the weld at both spring lines with the stencil assigned.
 - b. In the event any welder leaves the job, void the welder's assigned stencil and do not duplicate if another welder is employed.
 - 6. Determine quality of the welding and procedures by testing the welder's ability to make sound welds under standard working conditions with the equipment to be used in the Work on this Project.
 - a. Prequalify all welding procedures used to install pipe under provisions of AWS D1.1.
 - 1) Provide welding procedures for field attachments and field welded joints.

F. QA/QC Plan Minimum Requirements.

1. MPS QC/QC Plan

- a. MPS to provide a QA/QC Plan that describes and defines the QA/QC procedures and personnel performing QA/QC activities described herein from acceptance of raw materials through pipe manufacture and delivery to the project site.
- b. Identify people performing QA/QC functions with sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.
- c. Describe MPS's written procedures defining a program for control of inspections performed.
- d. Design MPS's QA/QC program to ensure the achievement of adequate quality throughout applicable areas of the Contract. The QA/QC Plan shall:
 - 1) Describe the program and include procedures, work instructions and records.
 - 2) Describe methods relating to areas which require special testing and procedures as noted in the Specifications
- e. Identification and Control of Items and Materials:
 - 1) Describe procedures to ensure that items or materials that have been accepted at the manufacturing site are properly stored prior to use.
 - 2) Provide procedures that prevent the use of incorrect or defective materials.
- f. Identify contractual hold/inspection points, as well as any MPS imposed hold/inspections points.
- g. Include procedures to provide verification and control of testing provided by MPS including:
 - 1) Verifying and noting on Daily Report all required testing was performed and documenting results.
 - a) Include a sample of the MPS's Daily Reports.
 - 2) Provide location maps for all tests performed or location of Work covered by the tests.
 - 3) Maintaining copies of all test results.
 - 4) Submitting all tests to Owner.
 - 5) Ensuring Engineer receives independent copy of all tests.
 - 6) Ensuring testing lab(s) are functioning independently and in accordance with the Specifications.

2. Field QA/QC Plan

- a. Contractor to provide a QA/QC Plan that describes and defines the personnel requirements described herein covering receipt and storage of the pipe at the project site through installation including all welds and associated inspections.
- b. Indicate personnel with assigned QA/QC functions reporting to a Field QA/QC representative.
- c. Personnel:
 - 1) The Field QA/QC representative shall report to a Senior Manager of the Contractor with the authority to stop work.
 - 2) Provide persons performing QA/QC functions with sufficient qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions.
- d. The Field QA/QC Plan shall include MPS QA/QC representative(s) visiting the Site as often as necessary (but not less than the daily hours specified in the Contract Documents) to advise Owner's Construction Manager weather Work is being performed properly and to make multiple observations of Work in progress.
- e. Include procedures to provide verification and control of testing provided including:

- 1) Verifying and noting on Daily Report all required testing was performed and documenting of results.
 - a) Include a sample of the Contractor's Daily Reports.
- 2) Provide location maps for all tests performed or location of Work covered by the tests.
- 3) Maintaining copies of all test results.
- 4) Submitting all tests to Owner.
- 5) Ensuring Engineer receives independent copy of all tests.
- 6) Ensuring testing lab(s) are functioning independently and in accordance with the Specifications.
- f. Include a statement that the Field QA/QC representative has the authority to direct cessation or removal and replacement of defective Work.

G. Inspection and Tests.

1. Per Section 5 AWWA C200 and Section 5 AWWA C206.
2. Perform and document inspections and tests by qualified individuals.
 - a. At a minimum, "qualified" shall mean having performed similar QA/QC functions on similar type projects.
 - b. Maintain records of personnel experience, training and qualifications and make available for review by the Engineer upon request.
3. Maintain at MPS manufacturing facility adequate records of all such inspections and tests.
 - a. Make available for review by the Engineer upon request.
4. Procedures per ISO-9001 and SPFA including but not limited to:
 - a. Specific instructions defining procedures for observing work in process and comparing this work with the Contract requirements (organized by specification section).
 - b. Specific instructions for noting deficiencies and steps to be taken to have the deficiency corrected, repaired, or replaced.
 - c. Specific instructions for recording observations and requirements for demonstrating through the reports that the Work observed was in compliance or a deficiency was noted and action to be taken.
 - d. Procedures to preclude the covering of deficient or rejected Work.
 - e. Procedures for halting or rejecting Work.
 - f. Procedures for resolution of differences between the QA/QC representative(s) and the production representative(s).
5. Control of Measuring and Test Equipment:
 - a. Maintain, calibrate and adjust measuring and/or testing instruments to maintain accuracy within prescribed limits.
 - b. Perform and document calibration at specified periods against valid standards traceable to nationally recognized standards.
6. Supplier Quality Assurance:
 - a. Include procedures to ensure that procured products and services conform to the requirements of the Specifications.
 - b. Apply requirements of these procedures, as appropriate, to lower-tier suppliers and/or Subcontractors.
7. Nonconformances and Corrective Action:
 - a. Include procedures for handling of nonconformances.
 - b. Nonconformances are defined as documentation, drawings, material, equipment or Work not conforming to the specified requirements or procedures.

- c. The procedure shall prevent the use of nonconformances by identification, documentation, evaluation, separation, disposition and corrective action to prevent recurrence.
 - d. Promptly identify and report conditions having adverse effects on quality to the senior level management.
 - 1) Determine and document the cause of conditions adverse to quality and measures implemented to prevent recurrence.
- 8. Special Processes and Personnel Qualifications:
 - a. Include detailed procedures for the performance and control of special process (e.g. welding, soldering, heat treating, cleaning, plating, nondestructive examination, etc.).
 - b. Utilize personnel performing special process tasks that have the experience, training and certifications commensurate with the scope, complexity, or nature of the activity.
 - c. Contractor's Inspector for Field Welding:
 - 1) In accordance with AWS QC 1, with knowledge of welding code for the Work.
 - 2) After receiving CWI qualification, at least one Shop CWI and one Field CWI shall have 5 years' minimum professional experience related to welding inspection similar to the Work. Other CWIs may work under the supervision of 5-year CWI, provided they have 1 year of related professional experience after receiving CWI qualification.
 - 3) Responsibilities:
 - a) Verify conformance to use 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) Provide 100 percent VT before, during, and after field welding.
 - f) Coordinate NDT work and review test results.
 - g) Maintain records and prepare report confirming results of inspection and testing.
- 9. Audits:
 - a. MPS shall conduct internal audits to verify that QA/QC procedures are being fully implemented at its facility as well as at any fitting fabricator subcontractor's facility.
 - b. Make Audit records available to the Engineer upon request.
- 10. Acceptance of QA/QC Plan.
 - a. Engineer's review and acceptance of the MPS's QA/QC Plan shall not relieve the MPS from any of its obligations for the performance of the Work.
 - b. Do not start Work covered by the QA/QC Plan until Engineer's acceptance of MPS's QA/QC plan has been obtained.
 - c. Owner may perform independent quality assurance audits to verify that actions specified in MPS's QA/QC Plan have been implemented.
 - 1) No Owner audit finding or report will in any way relieve MPS from any requirements of this Contract.

1.5 SUBMITTALS

A. Action Submittals.

- 1. Shop Drawings showing pipe layout as described in Part 2 Paragraph 2.3 C Pipe Layout.
 - a. Submit shop drawings for steel pipe, fittings and specials as one package prepared by the Main Pipe Supplier only.
 - b. Submit shop drawing for specials or fittings if manufactured by a separate supplier (under direction of MPS) through the MPS.
- 2. Material list and steel reinforcement schedules for materials specified.

3. Fabrication Information.
 - a. Pipe and fitting details for temporary and permanent facilities indicating:
 - 1) Cylinder thickness.
 - 2) Position, type, size and area of reinforcement.
 - 3) Manufacturing tolerances.
 - 4) Maximum angular deflection limitations of field joints.
 - 5) Closure sections and cutoffs for field length adjustment.
 - 6) Bulkheads, including details for removal of test bulkheads and repair of linings.
 - 7) Weld lead outlets and plugs.
 - 8) Stulling size, spacing, and layout.
 - 9) All other pertinent information required for the manufacture and installation of the product.
 - b. Joint Details.
 - 1) Gasketed joints.
 - 2) Butt joints.
 - 3) Miter-cut ends for alignment conformance.
 - 4) Lap joints.
 - 5) Deep bell lap joints required for control of temperature stresses.
 - 6) Butt strap joints.
 - 7) Flanged joints.
4. Welding Data (Shop and Field Welding)
 - a. Submit welding data together with Pipe Shop Drawings as a complete package.
 - b. Show on a weld map, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tail of welding symbol.
 - c. Distinguish between shop and field welds.
 - d. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for all welds.
 - e. Welding and NDE symbols in accordance with AWS A2.4.
 - f. Welding terms and definitions in accordance with AWS A3.0.
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.
 - a) Provide within 1 week of receiving coil.
 - b. Coatings and Linings.
 - 1) Technical data sheets itemizing chemical composition, technical and performance information that indicates compliance with this Specification.
 - 2) Color chart, if applicable.
 - 3) Surface preparation requirements.
 - 4) Curing requirements.
 - 5) Manufacturer's name, product number or name.
 - 6) Coating or lining thickness.
 - c. Flanged Joints:
 - 1) For Each Flanged Connection: Reference standard, class, dimensional data, bolt hole number, pattern and diameter, bolt diameter and length, face condition (raised or flat).

- 2) Gaskets and Bolting: Technical data sheets itemizing chemical composition, technical and performance information that indicates compliance with this Specification.
 - d. Wall Sleeves: Dimensional data, including sleeve length, thickness, and diameter.
 6. Pipe handling equipment and methods for loading and unloading pipe.
 - a. Pipe support requirements for storage.
 - 1) Minimum allowable width, quantity and location of contact points to prevent excess deflections.
 - b. Pipe Moving support requirements.
 - 1) Minimum allowable sling width, quantity and location of contact points to prevent excess deflections.
 7. WAB Plan addressing the following:
 - a. Special installation techniques required for welding steel pipe after backfill, including, at a minimum:
 - 1) Low heat welding procedure, process, welding materials, number of passes, voltage, amperage, travel speed, and calculated heat input.
 - 2) Method of measuring pipe wall temperature.
 - 3) Method of assuring the clearance between the bell and spigot faying surfaces (joint gap) does not exceed 1/8-inch maximum.
 - 4) Testing Program.
 - b. Written acceptance from coating, lining, and heat-shrink sleeve manufacturers of the WAB Plan and written certification from each manufacturer that the proposed materials are intended for this application.
 - c. Coordination with Section 09 90 05 – Polyurethane Coating.
- B. Informational Submittals.
1. Certificates.
 - a. Manufacturer's Certificate of Compliance that products furnished meet requirements of this Specification.
 - b. Lining Materials: Certificate that lining system is currently approved for potable water contact in accordance with NSF 61 and satisfies current applicable governmental health and safety requirements for use in potable water.
 - c. Steel Pipe Installation: Certificate that training has been provided to Contractor's installation crews regarding proper pipe handling and storage procedures.
 2. MPS's written Quality Assurance/Control (QA/QC) Plan.
 - a. Design MPS's QA/QC program to ensure the achievement of adequate quality throughout applicable areas of the Contract.
 - b. Describe and define the QA/QC staff, their qualifications, their functional roles, and authorities.
 - c. Describe the program and include the items specified under Paragraph 1.4D, to include:
 - 1) Identification and control of items and materials.
 - 2) Inspection and tests.
 - 3) Control of measuring and test equipment.
 - 4) Supplier quality assurances.
 - 5) Nonconformances and corrective action.
 - 6) Special processes and personnel qualifications.
 - 7) Program audits.
 - 8) Documented control/quality records.
 3. Statements of Qualification.
 - a. Pipe manufacturer.

- b. Fittings and specials fabricator.
 - c. Welders or Welding Operators:
 - 1) Name of welder.
 - 2) Welding procedures/positions for which welder is qualified to weld.
 - 3) Assigned certification stamp number.
 - 4) Certification date.
 - 5) Current certification status.
 - 6) Current and correct continuity records.
 - d. Certified Welding Inspector (CWI) for shop welding with acuity records.
 - 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 is required when steel thickness exceeds 7/16-inch.
 - (1) For shop welding, address supplementary essential variables in addition to essential variables as indicated in ASME Section IX, QW-251.2.
 - (2) For field welding, include heat-input control PQR essential variables as indicated in AWS D1.1.
 - (3) For shop and field welding, provide heat-input table on WPSs for welder guidance.
 - c) Document heat-input control in PQRs for notch-tough welding 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.
 - (1) Conduct Charpy V-notch tests on weld metal and heat affected zone.
 - (2) Orient test coupons transverse to final direction of rolling.
 - (3) Full size Charpy specimen test acceptance shall be same as base metal specified herein.
 - 2) Written NDT procedures.
 - 3) Current WPQ.
 - b. Written description of proposed sequencing of events or special techniques including:
 - 1) Temperature stress control for pipe wall during installation.
 - 2) Minimizing distortion of steel.
 - 3) Monitoring pipeline temperatures during installation.
 - 4) Written weld repair procedures for the Work.
 - 5) Field coating application and repair.
 - 6) Field lining application, repair, and moisture control in accordance with AWWA C602 or AWWA C205.
 - 7) Written consumable control procedure for welding materials demonstrating:
 - a) How consumables will be stored to comply with manufacturer's written instructions.
 - b) How consumables will be dried in ovens prior to use.
 - c) How consumables which become wet will be reconditioned.
5. Design Calculations.
- a. Pipe: Design Calculations for pipe wall thickness under the most critical combination of internal pressure, external loads, buckling, and handling.

- b. Fittings and Specials: Design calculations for fittings and specials including outlet reinforcement details of collars, wrapper, and crotch plates as required.
 - c. Calculations to be sealed by a Registered Professional Engineer licensed in the state where the project is located.
- 6. 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.
 - 1) Weld tests, including initial weld examination and 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) Hydrostatic Leak Testing (LT).
 - c. Cement mortar lining compressive strength tests in accordance with AWWA C205.
 - d. Field-applied cement mortar lining moisture control in accordance with AWWA C602.
- 7. 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. Method of disposal of testing water if required by Owner.
- 8. Temperature Stress Control Plan: Submit at least 45 days prior to installing pipe and include at least the following information:
 - a. Step by step installation procedures and sequencing to demonstrate compliance with temperature control requirements, including:
 - 1) Pipe installation.
 - 2) Joint welding of standard joints and temperature control joints.
 - 3) Pipe bedding, embedment and Trench Zone backfill.
 - b. Methods to ensure compliance with procedures by installation personnel.
 - c. Equipment to be used to monitor pipe wall temperature.
 - d. Time of day, climatic, or seasonal installation limits to be used to achieve compliance with temperature control requirements.
- 9. Pipe manufacturer's certification of training of Contractor's pipe installation crews.

1.6 DELIVERY, HANDLING, AND STORAGE

- A. Pipe Marking.
 - 1. Legibly mark installation sequence number on pipe, fittings, and specials in accordance with piping layout.
 - 2. Mark special pipe sections and fittings at each end with notation "TOP FIELD CENTERLINE".

3. Where air-test holes are required, paint or mark 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.
5. Mark the minimum and maximum joint insertion points on the spigot end with a circumferential line.

B. Delivery.

1. Securely bulkhead or otherwise seal ends of pipe, specials, and fittings prior to loading at manufacturing site.
2. Keep pipe ends sealed until installation.
3. Unload pipe using equipment and methods as recommended by MPS and in accordance with MPS pipe handling submittal.
4. Inspect each pipe and fitting for damage.
5. Repair damage to pipe, fittings, or specials, including linings and coatings, found upon delivery to jobsite to the satisfaction of the Engineer or remove from site and replace at no additional cost to the Owner.
 - a. Remove or smooth out any burrs, gouges, weld splatter or other small defects prior to laying the pipe.

C. Storage.

1. Support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.
 - a. Support on sand or earth berms free of frozen material and rock exceeding 3 inches in diameter.
 - b. Support width and placement per pipe manufacturer's recommendations.
2. Carefully handle and protect pipe, fittings, and specials against damage to lining and coating/interior and exterior surfaces, impact shocks, and free fall.
 - a. Submit pipe handling equipment for acceptance by Engineer.
 - b. Move pipe with support using sling widths and pick point placements as recommended by pipe manufacturer to limit deflection during handling.
 - 1) If utilizing a single sling for installation, submit calcs from MPS demonstrating that this method does not cause excessive deflection.
 - c. Do not place pipe directly on rough ground but support on sand, bedding or earth berms free of frozen material and rock exceeding 3 inches in diameter per pipe manufacturer's recommendations.
 - d. Support in a manner which will protect the pipe against injury whenever stored at the trench site or elsewhere.
3. Acceptance at Site: Inspect all deliveries for acceptance of material on site.
4. Repair damage to pipe, fittings, or specials, including linings and coatings, found in stored pipe in accordance with manufacturer's instructions or remove from site and replace at no additional cost to the Owner.
5. Gasket Storage:
 - a. Store rubber gaskets in cool, well-ventilated place, and do not expose to direct rays of sun.
 - b. Do not allow contact with oils, fuels, petroleum, or solvents.
6. Pipe and Specials Protection:
 - a. Protect the openings of pipe and specials with suitable bulkheads where the pipe and specials have been cement-mortar lined in the shop to maintain a moist atmosphere and to prevent unauthorized access by persons, animals, water or any undesirable substance.
 - b. Maintain bulkheads, fix tears or replace bulkheads damaged.

- c. Introduce water into the pipe to keep the mortar moist where moisture has been lost due to damaged bulkheads.

1.7 SEQUENCING AND SCHEDULING

A. Notify Engineer in writing of the following pipe manufacturing events:

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 of specials.
 - b. Coating application.
 - c. Lining application.
 - d. Shop hydrostatic testing.
 - e. Shipping of pipe to site.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Main Pipe Suppliers:

1. American SpiraWeld Pipe.
2. Mid America Pipe.
3. Northwest Pipe.
4. Thompson Pipe Group.
5. Or approved equal.

2.2 GENERAL

- A. Manufacture, test, inspect and mark steel pipe, fittings, and specials to comply with AWWA C200, C208 and additional requirements of these Contract Documents.
- B. Provide pipe of diameter and at least the minimum wall thickness as indicated on the Drawings.
- C. In lieu of collar or crotch plate 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.
- D. Do not fabricate fittings or specials with material that includes the skelp end weld.
- E. Diameters:
 1. Unless shown otherwise, for pipes larger than 24 inch in diameter, the diameter shown shall be considered finished inside diameter after lining.
 2. For pipes 24 inch in diameter and less, conform to ASME B36.10.
 - a. Pipe 14 inch through 24 inch: nominal outside diameter
 - b. Pipe 12 inch diameter pipe and smaller: nominal inside diameter.

2.3 DESIGN CRITERIA

A. General.

1. Design steel pipe, fittings and specials to perform under the most critical combination of internal pressure, external loads, buckling, and handling as determined by the design procedures per AWWA M11 and the provisions of these Specifications.

B. Pipe. The following criteria shall be used in design calculations:

1. Working pressure as shown on the Drawings and using an allowable stress of $0.5 \times F_y$.
2. Maximum working plus transient pressure or total transient pressure as specified in the Drawings and using an allowable stress of $0.75 \times F_y$.

3. Hydrostatic field test pressure as specified in the Drawings and using an allowable stress of $0.75 \times F_y$.
4. Bedding Constant = 0.1
5. Unit Weight of backfill = 125 pounds per cubic foot
6. Unit weight of embedment material = 130 pounds per cubic foot
7. Deflection Lag Factor = 1.1
8. Live Loading = AASHTO HS-20
9. Minimum thickness for Handling shall be based on a diameter to thickness ratio (D/T) of 220.
10. Site specific criteria as follows:

Station	Modulus of Soil Reaction, E'	Minimum Cover, (ft)	Maximum Cover, (ft).
10+00 – 135+50	1,000	4	20
135+50 – 145+75	1,500	6	25
145+75 – 243+02.70	1,000	4	15

C. Fittings and Specials.

1. Design reinforcement in accordance with AWWA Manual M11, AWWA C200, and AWWA C208.
2. Design fittings, outlets (including reinforcement), and specials for the following conditions:
 - a. Working pressure as specified in the Drawings and using an allowable stress of $0.5 \times F_y$.
 - b. Maximum working plus transient pressure or total transient pressure as specified in the Drawings and using an allowable stress of $0.75 \times F_y$.
 - c. Hydrostatic field test pressure as specified in the Drawings and using an allowable stress of $0.75 \times F_y$.
3. Design temporary test bulkheads and temporary dished heads and test heads for field test pressure as shown in the Drawings and in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. Submit design calculations to the Engineer for review prior to manufacture of steel pipe and steel pipe fabricated specials.

1. See Subparagraph 1.5.B.5.

E. Pipe Layout: Design complete pipeline layout, in accordance with AWWA Manual M11, Latest Edition.

1. General:
 - a. Horizontal and Vertical Alignment: See Drawings.
 - b. Base stationing and elevation convention as shown on Drawings.
 - c. Laying Lengths: Maximum 50 FT standard barrel length.
2. Include, as minimum:
 - a. Specific number, location, and direction of each pipe, joint, and fitting or special.
 - b. Number each pipe in installation sequence.
 - c. Station and centerline elevation at changes in grade or horizontal alignment.
 - d. Station and centerline elevation to which bell end of each pipe will be laid.
 - e. Elements of curves and bends, both in horizontal and vertical alignment.
 - f. Location of mitered pipe sections, beveled ends and/or pulled joints for alignment conformance, butt straps, and deep bell lap joints for temperature stress control.
 - g. Location of closures, cutoff sections for length adjustment, access manways, vents, and weld lead outlets for construction.

- 1) Provide for adjustment in pipe laying headings and to conform to indicated stationing.
- 2) Changes in location or number will require Engineer approval.
- h. Location of bulkheads, both those shown and as required, for hydrostatic field testing of pipeline.

F. 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. 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. Qualify WPS used to install pipe in the field for heat input control in accordance with AWS D1.1 and the Weld After Backfill Plan.
5. Notch-tough welding that requires heat input control is required for welding of pipe and crotch plates with thickness equal to 7/16-inch or greater:
 - a. AWS D1.1 prequalified welding procedures are not allowed.
 - b. Qualify WPS used to shop fabricate pipe in accordance with ASME BPVC SEC IX and include Supplementary Essential Variables.
 - c. Qualify WPS used to install pipe in the field for heat input control in accordance with AWS D1.1.
 - d. Qualify PQRs for notch tough welding with consideration for thickness of steel, test temperature, and Charpy V-notch CVN values.
 - 1) Refer to AWS D1.1, Annex III Requirements for CVN Testing, Option A (three specimens).
 - 2) Using this test procedure select test temperature and minimum average energy level for Charpy Testing, the welding position as it may relate to heat input on the heat affected zone (HAZ) test results, and the orientation of the test plates as these relate to the longitudinal or transverse properties of the HAZ.
 - 3) See Part 2, Products, Article Pipe Barrel for Charpy V-notch acceptance criteria.

- G. Stulling (Strutting): Design and install stulling for pipe, specials, and fittings such that deflections in excess of 1/2 of the allowable deflection for installed pipe are avoided during handling, and storage.

2.4 MATERIALS

A. Pipe Barrel:

1. Steel: Provide steel coils for spiral welded steel pipe or steel plate for straight seam welded steel pipe per AWWA C200 and as follows:
 - a. From the table of allowable steels in C200, provide high strength low alloy steel (HSLAS).
 - b. Minimum Yield Strength: 42,000 PSI.
 - c. Minimum Tensile Strength: 60,000 PSI.
 - d. Minimum Elongation in 2 inch Gauge Length: 21 percent.
 - e. Weldability: Maximum carbon equivalent of 0.45, as measured using AWS D1.1, Annex XI, Guideline on Alternative Methods for Determining Preheat formula:

$$CE = C + (Mn + Si)/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$
 - f. Maximum carbon content not to exceed 0.25 percent.
 - g. Maximum sulfur content not to exceed 0.015 percent.
 - h. Pressure Vessel Quality as follows:

- 1) Continuous cast process, fully-killed, fine grained practice conforming to physical, manufacturing and testing requirements of AWWA C200 Table 1 with HSLAS classification and meeting the yield strength specified above.
 - a) Steel plates that are 3/4 inch thick or greater shall be normalized.
- 2) Toughness.
 - a) Charpy V notch Acceptance Criteria (Steel Mill):
 - (1) Required where wall or plate thickness equal to or greater than 0.4375 inch.
 - (2) Conduct per ASTM A673.

B. Fittings and Specials:

1. Conform to the requirements of Paragraph 2.4 A, unless otherwise indicated.
2. Collar or wrapper reinforcement: Conform to the requirements of Paragraph 2.4 A.
3. Crotch Plate: Fabricate from fully killed, fine grain, pressure vessel steel conforming to ASTM A516, Grade 70, and as follows:
 - a. Plates thicker than 0.75 inches shall be normalized.
 - b. Maximum sulfur content: 0.005 percent.
 - c. Maximum carbon content: 0.20 percent.
 - d. Maximum Manganese content: 1.20 percent.
 - e. Perform Charpy V-notch tests in direction transverse to final rolling per ASTM A370 on full size specimens of coupons taken from each plate.
 - 1) Acceptance: 25 FT-LBS at 30 degrees F.
 - f. Carbon equivalent: Less than the value in Table 2 of ASTM A20.

C. Outlets:

1. 24 inch and Smaller: Fabricate from ASTM A53/A53M, Type E or S, Grade B, standard weight steel pipe.
2. Larger than 24 inch: conform to the requirements of Paragraph 2.4 A.
3. Collar or wrapper reinforcement: Conform to the requirements of Paragraph 2.4 A.

D. Steel Butt-Weld Fittings:

1. 24 inch and Smaller: In accordance with ASME B16.9 with material conforming to ASTM A234.

2.5 FABRICATION

A. Pipe Smaller than 24-inch

1. Mill Type:
 - a. ASTM A53, Type E or S

B. Pipe Barrel Pipe 24-inch and larger (Fabricated):

1. Pipe sections may be spirally welded or fabricated from short cylindrical courses joined circumferentially by complete penetration butt joint welds with not more than two longitudinal seams per course.
 - a. Stagger longitudinal seams on both sides of the pipe.
2. Pipe sections may be rolled or pressed from no more than three sheets the full length of the pipe and welded with no more than three longitudinal seams.
 - a. Patching inserts, overlays, or pounding out of dents will not be permitted.
 - b. Repair of notches or laminations on second ends will not be permitted.
 - c. Remove damaged ends as a cylinder and properly prepare the section end.
 - d. Distorted or flattened lengths shall be rejected.
 - 1) Replace any buckled section as a cylinder.

3. Minimum Wall Thickness:
 - a. Wall thickness depicted on drawings or specified herein are minimum allowable.
 - b. Prepare calculations as described in Paragraph 1.5.B.5 based on the design criteria provided in 2.3.B and provide thicker wall pipe if calculations so require.
 - c. Manufacturing tolerance in minimum wall thickness minus 0.010 inch.
 - d. See Drawings for minimum wall thicknesses.
 - e. Where not specified or indicated on Drawings, use standard weight in accordance with ASME B36.10.
- C. Fittings and Specials:
 1. Shop fabricated.
 - a. No field fabrication will be allowed, unless approved by Engineer.
 2. Fabricate from materials or straight pipe in full conformance with requirements of these Contract Documents and dimensions of AWWA C208, unless otherwise indicated.
 3. Minimum Wall thickness:
 - a. Main lines: per 2.3.A.
 - b. Branches and outlets ≥ 24 IN: main line thickness.
 - 1) Standard weight acceptable if equal to or greater than the thickness of the main line.
 - c. Branches and outlets < 24 IN: Standard weight.
- D. Elbows, Unless Otherwise Indicated.
 1. Main line Pipe: per 2.3.A
 2. Minimum Radius: 2.5 times pipe diameter unless specifically indicated on Drawings.
 3. Radius Less than 2.5 Times Pipe Diameter:
 - a. Only where indicated on Drawings.
 - b. Minimum Radius: 1.0 times pipe diameter.
 4. Minimum Bend Wall Thickness: Greater of main line pipe or standard weight or as calculated using the equations in AWWA M11.
 5. Maximum Miter Angle: $11\text{-}1/4$ degrees on each section resulting in a maximum deflection angle of 22.5 degrees per miter weld as recommended in AWWA C208.
 6. Complete joint penetration (CJP) welds required on miter welds.
- E. Outlets.
 1. 24 Inches and Smaller: Fabricate from ASTM A53/A53M, Type E or S, Grade B, standard weight steel pipe.
 2. Larger than 24 Inches: Steel material shall conform to the requirements of Paragraph 2.4.
 3. Collar or wrapper reinforcement: Steel material shall conform to the requirements of Paragraph 2.4.
- F. Steel Butt-Weld Fittings.
 1. 24 Inches and Smaller: In accordance with ANSI/ASME B16.9.
 2. Standard weight.
 3. Taper pipe wall at welds at 4:1 for connection to pipe 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.

2.6 JOINTS

- A. Field Joints.
 1. Single or double lap welded where specified or shown on the drawings.
 2. Mechanically coupled or flanged where specified or required.

3. Butt-straps where specified or required for closures.
 4. Minimum pressure rating of joints: equal to pressure rating of adjoining pipe.
- B. Shop Joints.
1. Fabricate in accordance with AWWA C200 as modified herein.
 2. Utilize complete joint penetration (CJP) butt joints for longitudinal, girth, and spiral welds, unless otherwise indicated.
 3. Do not join lengths of pipe in the shop joined using lap joints.
- C. Preparation of Joints.
1. Bell and Spigot:
 - a. Utilize methods to form, shape, and size bell ends that do not impair the mechanical properties of the steel.
 - b. Unless otherwise approved by the Engineer, form bell ends by an expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape.
 - 1) No process will be permitted in which the bell is formed by rolling.
 - c. Faying surfaces of the bell and spigot lap joint: essentially parallel.
 - 1) Maximum bell slope variation from the longitudinal axis of the pipe: 2 degrees.
 - d. Center of bell to be concentric with the centerline of the pipe barrel.
 2. Butt Joint Welded:
 - a. Plain ends beveled as required by AWWA C200 and Contractor's field WPS.
 - b. Provide protection for factory beveled pipe ends so ends are not damaged during transport.
 3. Lap Welded Joint:
 - a. Single lap welded joint is the standard welded joint, unless otherwise indicated.
 - b. Prepare lap welded joints for field welding in accordance with the Drawings and AWWA C200.
 - c. Double lap welded joints and butt-strap joints shall be tapped and drilled for air testing from the inside or outside in accordance with AWWA C206, unless otherwise indicated in the Drawings.
- D. Beveled Ends (Mitered-End Cuts)
1. Moderate deflections and long radius curves may be made using beveled ends with the maximum total allowable angle as indicated.
 2. Use only with lap welded joints, unless specifically approved in writing by Engineer.
 3. Maximum Total Allowable Angle:
 - a. 3 degrees per pipe joint where gaskets joints are utilized on either side of mitered joint.
 - b. 5 degrees per pipe joint where for welded joints are utilized on adjacent joints.
 4. Combining miters and field joint pulls with shop fabrication will not be accepted without prior Engineer approval.
 5. Provide miter-cut that is cold expanded square with face of miter-cut on bell ends only.
 6. Mitering of spigot ends will not be permitted.
- E. Temperature Control Lap Joint:
1. Unless approved WAB plan is used, provide a special longer bell end (temperature control lap joint) at a maximum spacing of 400 FT to account for movement of the pipe due to temperature changes.
 2. MPS to determine the length required for the longer bell.
 - a. Minimum temperature control lap joint length: 3 inch longer than standard lap.
- F. Flanged Joints:

1. Flange classifications per criteria below.
2. Flange Coating and Lining.
 - a. Ring Flange - Edge and back of ring flanges:
 - 1) Near-white metal blasted, SSPC-SP10.
 - 2) Coated with DeVoe Bar-Rust 233H epoxy, or accepted equivalent, to a minimum 16 MIL DFT and maximum 25 MIL DFT.
 - b. Blind Flange - Edge, exterior face, and exposed interior face of blind flanges:
 - 1) Near-white metal blasted, SSPC-SP10.
 - 2) Coated with DeVoe Bar-Rust 233H epoxy, or accepted equivalent, to a minimum 16 MIL DFT and maximum 25 MIL DFT.
 - c. Shop coat machined flange faces with a rust preventive compound.
3. For pipe sizes between 4 inch and 60 inch and maximum working pressures not exceeding 300 PSIG, and for pipe sizes greater than 60 inch and maximum working pressures not exceeding 275 PSIG: Flat-faced carbon steel or alloy flanges when mating with flat-faced cast or ductile iron flanges.
 - a. Conform to AWWA C207 for flanges.
 - b. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.
 - c. For higher test pressures, use next higher rated AWWA flange or ANSI-rated flange.
 - d. Flat faces with bolt holes straddling vertical axis of pipe, unless otherwise shown.
 - e. Gaskets: non-asbestos type and conform to AWWA C207.
 - f. Bolting materials: conform to AWWA C207 field coated with AWWA C217 wax tape.
4. For pipe sizes between 4 inch and 24 inch and maximum working pressures greater than 300 PSIG:
 - a. Conform to ASME B16.5, Class 300 for flanges, bolting materials, and flange gaskets.
 - b. Do not expose ASME B16.5 flanges to test pressures greater than 150 percent of pressure rating.
 - c. If mating to a flat face flange, remove raised face and provide flat face finish in accordance with ASME B16.5.
 - d. Gaskets: conform to ASME B16.5, Nonmandatory Appendix B, Table B-1, Group 1.
 - e. Bolts: ASTM A193, B7 stud bolts with two ASTM A194 Grade 2H heavy hex nuts field coated with AWWA C217 wax tape.
5. For Pipe Sizes Between 24 inch and 60 inch and Maximum Working Pressures Greater than 300 PSIG:
 - a. Conform to ASME B16.47, Class 300, Series A for flanges, bolting materials, and flange gaskets.
 - b. Do not expose ASME B16.47 flanges to test pressures greater than 150 percent of pressure rating.
 - c. If mating to a flat face flange, remove raised face and provide flat face finish in accordance with ASME B16.47.
 - d. Gaskets: conform to ASME B16.47, Nonmandatory Appendix B, Table B-1, Group 1.
 - e. Bolts: ASTM A193, B7 stud bolts with two ASTM A194 Grade 2H heavy hex nuts field coated with AWWA C217 wax tape.
6. Blind Flanges.
 - a. Blind flanges: in accordance with the appropriate standard determined by the maximum operating pressure as described above.
 - b. Provide all blind flanges for pipe sizes 12 inch and greater with lifting handle or lifting eyes welded to the flange, as shown on the Drawings.

2.7 COATINGS

A. General.

1. The term "Coating" applies to materials applied to the exterior of the pipe.
2. Notify Engineer at least 5 days prior to application of coating products.
3. Holdback of coating from field welded joints: as shown in the Drawings.
4. Furnish inspection devices that are calibrated and in good working condition for detection of holidays and measurement of coating film thickness and adhesion testing.
5. Coat buried pipe and fittings passing through structure walls connected to exposed piping as indicated.
6. NSF Approved for pipes submerged or otherwise in contact with potable water.

B. Polyurethane coating in accordance with AWWA C222 and Section 09 90 05.

1. Minimum surface preparation:
 - a. SSPC-SP10, Near White Metal blast, 3.0 MIL profile.
 - b. Or MFR's standard, whichever is stricter.
2. Thickness:
 - a. One coat, 30 MIL total dry film thickness.
 - b. Where shown on the drawings, thicken to 60 MIL DFT when crossing existing cathodically protected pipelines.
 - 1) Extend thicken coating 100 FT each side of crossed pipe.
3. Apply filler at step-down areas.

C. Exposed Pipe in Vaults/Manholes Coating:

1. Paint per Section 09 90 04.

D. Field Coating of Joints.

1. Coat buried welded joints with a 2-layer heat-shrink coating system in accordance with AWWA C216
 - a. Type I or Type II:
 - 1) Layer 1: Heat-activated sealant adhesive.
 - 2) Layer 2: Cross-linked polyolefin backing.
 - 3) Type I: Tubular type installed prior to joining the pipe ends.
 - 4) Type II: Wraparound type wrapped circumferentially around the area to be coated; include a separate or pre-attached closure to secure overlap during heating.
2. Thickness: 90-mils, minimum.
3. Width: 2-inch overlap on existing coating, minimum.
4. Provide a heat-shrink sleeve compatible with the existing coating in accordance with the Manufacturer's recommendations.
5. Consider sleeve shrinkage during heating in determining sizing.
6. Filler:
 - a. At joint locations with a step-down, a moldable mastic filler shall be required prior to the application of the heat-shrink coating.
 - b. Maximum step-down size allowed without mastic filler: as specified by the Heat-Shrink Coating Manufacturer.
 - c. Filler to be approved by sleeve manufacturer.
7. Acceptable manufacturers:
 - a. Sleeves:
 - 1) Canusa-CPS
 - 2) Covalence

- b. Holiday Detector:
 - 1) Tinker & Rasor, Model APS
- E. Heat Shrinkable Polyolefin Coatings for WAB joints (Heat Shrink Wrap):
 - 1. Per AWWA C216 as modified herein.
 - 2. Provide products specifically designed for WAB application.
 - 3. Acceptable manufacturers:
 - a. Berry Plastics
 - 1) Primer: as recommended by sleeve manufacturer.
 - 2) Mastic: Polyken 939-125 filler.
 - 3) Heat Shrink Sleeve: Covalence WaterWrap/B.
 - 4) Minimum Total Thickness: 121 MIL ("fully-recovered" sleeve thickness).
 - 5) Minimum Width: Bare steel width plus 8 inch or 12 inch whichever is greater.
 - b. Canusa-CPS
 - 1) Primer: as recommended by sleeve manufacturer.
 - 2) Mastic: Aqua-Seal RG filler
 - 3) Heat Shrink Sleeve: Aqua-Shield AQW.
 - 4) Minimum Total Thickness: 105 MIL ("fully-recovered" sleeve thickness).
 - 5) Minimum Width: Bare steel width plus 8 inch or 12 inch whichever is greater.
 - c. Or approved equal.

2.8 LININGS

- A. General.
 - 1. The term "Lining" applies to material applied to the interior of the pipe.
 - 2. Notify Engineer at least 5 days prior to application of lining products.
 - 3. Holdback of lining from field welded joints: per Drawings.
 - 4. Furnish inspection devices that are calibrated and in good working condition for detection of holidays and measurement of coating film thickness and adhesion testing.
- B. Cement-mortar in accordance with AWWA C205
 - 1. Applied centrifugally.
 - 2. Thickness: Standard thickness in accordance with AWWA C205
 - 3. Lining machine type that has been used successfully for similar work and approved by Engineer.
 - 4. Taper cement mortar linings as required for valve interfacing.
 - 5. Maintain pipe in round condition during lining operation and thereafter by suitable bracing and strutting.
 - 6. Provide polyethylene or other suitable bulkhead on ends of pipe and on special openings to prevent drying out of lining.
 - a. Provide bulkheads substantial enough to remain intact during shipping and storage until pipe is installed.
 - 7. Terminate ends of lining square and uniform.
 - a. Feathered or uneven edges will not be permitted.
 - 8. Provide and install wire mesh reinforcement required in the lining of specials in accordance with AWWA C205.
 - 9. Material for field-applied cement-mortar lining at joints: in accordance with AWWA C205.

2.9 ACCESSORIES

- A. Couplings.
 - 1. For pipe with flange by flange ends (Dismantling Joints).
 - a. See Section 40 05 01
 - b. Self-contained flanged restrained joint fitting, including both flange components and sufficient harness bars to withstand the imposed thrust.

- c. Design pressure rating: equal to or greater than flange rating.
 - 2. Flange Adapters and Spigot Pieces:
 - a. Carbon steel, ASTM A283, Grade C.
 - b. Bolt hole pattern and flange rating to match connecting pipe and valves.
 - 3. Provide bolts, nuts, and washers (when required) of suitable quality, workmanship, and yield strength to ensure compatibility with the coupling design and rated pressure.
 - a. Select materials to minimize the possibility of galvanic corrosion.
 - 4. See Paragraph 2.6 F. of this Specification for gasket requirements.
 - 5. Coating for flange adapter and spigot pieces: See Section 09 90 05 - Polyurethane Coating.
- B. Stulling (Strutting):
- 1. Materials.
 - a. Shop Lined Pipe: Wood stulls and wedges.
 - 2. Install stulling in pipe, specials, and fittings as soon as practical after pipe is fabricated or, for shop lined pipe, after lining has been applied.
 - 3. At a minimum, place one set of stulls 2 feet from each end of pipe section and at maximum interval of 15 feet.
 - 4. Install stulling in a manner that will not damage the lining or pipe.
- C. Slab, Floor, Wall, And Roof Penetrations: See Section 33 05 24 - STEEL UTILITY PIPE.
- D. Test Station, Pipeline Markers and Pipe Locating Tape: See Section 10 14 00 – Identification Devices and 31 23 33 Utilities – Trenching and Excavation.
- E. Cathodic Protection: See Section 26 42 17 – Impressed Current Cathodic Protection.

2.10 SOURCE QUALITY CONTROL (PIPE MANUFACTURING)

- A. Steel Toughness Testing for Thickness Equal to or Greater than 0.4375 inch
 - 1. Include three impact specimens.
 - 2. Conduct test in direction transverse to final direction of rolling.
 - 3. Conduct Initial Charpy Testing at Frequency H per ASTM A673.
 - a. Take test coupons in accordance with ASTM A673.
 - 4. Do not use coils that do not qualify in production of pipe.
- B. Crotch Plate.
 - 1. Perform Through-Thickness tension testing with acceptance criteria per Article 5 of ASTM A770 on each plate.
 - 2. Conduct Straight-Beam Ultrasonic Examination with acceptance criteria per Article 6 of ASTM A435 on each plate.
 - 3. Do not use plates that do not qualify.
- C. Shop Hydrostatic Pressure Test: In accordance with AWWA C200 Section 5.2, except as follows:
 - 1. General: Unless specified otherwise, perform testing of pipe, fittings, and specials before lining and coating is applied.
 - 2. 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 and where new welds are tested as specified.

- c. Hydrostatically test fittings and specials with crotch plates, regardless of whether straight pipe sections used were previously tested.
- D. Joints, Lap-Welded:
 - 1. Fit test minimum of 5 joints, 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 a point.
 - 2) Minimum space at a 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: Spot radiographically examine pipe in accordance with ASME BPVC SEC VIII, Div. 1, Par. UW 52 or 100 percent ultrasonically examined.
 - 3. Fillet Welds: 100 percent examine using magnetic particle inspection method in accordance with ASME BPVC SEC VIII, Division 1.
 - 4. Groove Welds: Same as Butt Joint Welds.
 - 5. Air test collars and wrappers in accordance with AWWA C200.

PART 3 - EXECUTION

3.1 GENERAL

- A. Install piping complete with jointing materials and accessories, anchors, and other appurtenances.
- B. Prepare trench as specified in Specification Section 31 23 33.
- C. Demonstration of Contractor's proposed embedment compaction methods.
 - 1. Prior to laying main pipe, excavate an example trench similar in depth to project piping.
 - a. Example trench shall be on City of Thornton Property, near Station 86+75
 - b. Depth of cover shall be at least 10 feet
 - 2. Install example pipe with same bedding and embedment materials proposed for project.
 - 3. Demonstrate to Engineer proposed methods for embedment placement and compaction for Pipe Zone.
 - 4. Backfill trench and take deflection measurements as described in Subparagraph 3.2.S.
 - a. If deflection measurements exceed allowable, revise means and repeat demonstration until allowable deflection criteria can be met.
 - 5. Keep trench dry until pipe laying and joining is completed.
- D. Demonstration of proposed weld procedures to verify no damage to proposed heat shrink sleeves.
 - 1. Prior to laying main pipe, install proposed heat shrink sleeve on welded joint and weld interior of pipe per approved WAB plan.
 - 2. Inspect heat shrink sleeve for signs of damage in presence of Engineer.
 - 3. If damage found, revise installation procedure and re-demonstrate.
 - 4. Once a satisfactory installation has been achieved, update WAB plan accordingly.
- E. Unless otherwise permitted by Engineer, maximum length of open trench: 250 linear feet or the amount of pipe that can be installed in a single day, whichever is less.

3.2 LAYING PIPE

- A. Trenching, embedment, and backfilling of buried piping: conform to Specification Section 31 23 33, and to the details indicated on the Drawings.
 - 1. Do not install pipe when water is in the trench.
- B. Before placement of pipe in the trench, ensure each pipe or fitting is clean of any foreign substance, keep clean thereafter.
 - 1. Cover openings of pipes and fittings in the trench during non-working hours.
- C. Handle pipe with proper equipment in a manner to prevent distortion or damage.
 - 1. 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.
- D. Lift pipe during unloading or lifting into trench using one or more slings as required to prevent uncontrolled swinging, damage to pipe, or harm to workers.
 - 1. Design slings to bear uniformly against pipe.
- E. CLSM:
 - 1. The terms CLSM and Flow Fill are synonymous in this specification.
 - 2. If pipe zone or embedment material is CLSM, lay pipe directly on moist sandbag supports in preparation for CLSM.
 - 3. Place sandbag supports to provide at least 6 inches of CLSM below bottom of pipe.
 - 4. Space supports at a maximum interval of 8 feet and one set within 3 feet on both sides of each joint.
 - 5. Provide additional sandbags as needed to support pipe on line and grade.
 - 6. Place CLSM in lifts or provide hold downs to prevent pipe floatation.
- F. Form bell holes at the ends of pipe to prevent point loading at the bells or couplings.
 - 1. Make excavation outside normal trench section at field joints for field connections, welding, and application of coatings.
- G. Lay each section of pipe in the order and position shown on the shop drawings and pipe layout.
 - 1. Lay to the set line and grade.
 - 2. Installation tolerances as hereinafter specified.
- H. Stulls in pipe smaller than 30-inches may be removed immediately after laying, provided that the deflection of the pipe during and after backfilling does not exceed that specified.
 - 1. Remove stulls after backfill placement.
 - 2. Stulls shall remain the property of the Contractor.
- I. Locate horizontal deflections or fabricated angles on alignment as shown on the Drawings, except as may be required for beveling a single end either side of a deflection.
- J. Locate vertical deflections on alignment, and match pipe angle point locations indicated on Drawings.
- K. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades.
 - 1. Make changes by the deflection of joints using beveled joints or fittings.
 - 2. Do not install misfit joints that will be detrimental to the strength and water tightness of the finished joint, including the strength and water tightness of the protective lining at the finished joint.
- L. Make minor field adjustments by pulling standard joints.

1. The allowable deflection of field joints is as follows:
 - 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.
 - c. No minor deflections (pulls) allowed at beveled ends.
- M. For grades exceeding 10 percent lay pipe in an uphill direction except for short runs that may be permitted by the Engineer.
 1. Block pipe which is laid on a downhill grade and hold in place until sufficient support is furnished by the following pipe to prevent movement.
- N. Whenever pipe laying is stopped at the end of the day, seal the open end of the line to prevent entry by animals, dirt, and debris.
 1. Design seals to prevent drying out of the interior of the pipe.
 2. Maintain continuous dewatering when necessary to prevent groundwater or surface water from entering the pipeline.
 3. Maintain continuous dewatering until pipe trench is fully backfilled and any anti-floatation provisions shown on the drawings are installed.
 4. Remove water from the trench to the level indicated in Specification Section 31 23 33 prior to resuming pipe laying operations.
- O. Cold Weather Protection:
 1. Do not install pipe upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation.
 2. Do not lay pipe unless it can be established that the trench will be backfilled before the formation of ice and frost occurs.
- P. Alignment and Grade:
 1. Lay pipe to the lines and grades indicated on the Drawings.
 - a. Pipelines or runs intended to be straight shall be laid straight.
 - b. Curves in push on joint pipe may be formed by opening the joint.
 - 1) Maximum joint openings and deflections: 50 percent of that recommended by the pipe manufacturer.
 2. Use survey equipment to indicate alignment and grade.
 - a. Take at least one elevation reading on each segment of pipe.
 - b. Make periodic elevation measurements with surveying instruments to verify accuracy of grades.
 - c. Verify survey set up at least daily using an independent benchmark or temporary benchmark.
- Q. Tolerances:
 1. Alignment and Grade Tolerances.
 - a. Plus or minus 0.05 foot in grade.
 - 1) High and low points will not be acceptable, except where indicated on the Drawings.
 - b. Plus or minus 0.20 foot in alignment, except where indicated differently on the Drawings.
 2. Observe stricter tolerances than specified above as necessary to maintain minimum cover, to maintain required clearances, to place carrier pipe inside the casing pipe, to make pipe connections to existing piping, to maintain the correct slope in the run to prevent high or low points along the pipeline other than those locations indicated on the Drawings.
- R. Protection of Pipe:

1. Take precautions to protect the pipe from damages at locations where the Contractor proposes to cross the installed pipeline with heavy equipment.
 2. Acceptable precautions include:
 - a. Backfilling the pipe trench as necessary to protect the pipe.
 - b. Concrete encasing the pipe.
 - c. Placing steel plating over the pipe above the final pipe zone or embedment.
 3. Repair damage to the pipe caused by Contractor's operation.
- S. Pipe Deflection:
1. After completion of backfilling and before acceptance of the Work, test for excessive deflection on pipes larger than 30 inch in diameter by measuring the actual inside vertical diameter.
 - a. Perform twice per week throughout active pipe installation.
 2. Deflection measurements will be made by the Owner's Construction Manager Engineer.
 3. Maximum pipe diametral deflection: 2.75 percent of the actual inside diameter (before installation) measured in the vertical orientation and at any point in the pipe.
 4. Correct diametral deflection percent to less than 2.75 percent.
- T. Cleaning:
1. Remove stulling, soil, loose mortar, and any other debris from inside of the pipeline.
 2. Thorough sweep out and clean pipeline interior.

3.3 JOINTING

- A. General.
1. Welded Joints: Weld After Backfill (WAB) may be allowed if Contractor's WAB submittal is approved by Owner and Engineer.
 - a. For double-lap welded joints, perform exterior joint welding prior to backfilling.
- B. Flanged Joints:
1. Thoroughly clean flange faces of all foreign material before the joint is assembled.
 2. Center gasket and draw up connecting flanges watertight without unnecessarily stressing the flanges.
 3. Tighten all bolts in a progressive diametrically opposite sequence and torqued with a suitable, approved, and calibrated torque wrench.
 - a. Torque values: be as recommended by the pipe manufacturer.
 - b. Apply all clamping torque to nuts only.
 4. Apply wax tape to fully encapsulate all nuts and bolts per manufacturer's recommendations.
- C. Mechanical Couplings:
1. When installing couplings, take care that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter and the surfaces in contact with the gasket are smooth with no surface deformations.
 2. Install in conformity with the recommendation and instruction of the coupling manufacturer and as specified for flanges.
 3. Utilize type and size wrenches as recommended by the coupling manufacturer in bolting couplings.
 4. Tighten coupling bolts to secure a uniform annular space between the follower rings and the body of the pipe with bolts tightened approximately the same amount.
 - a. Tighten diametrically opposite bolts progressively and evenly.
 - b. For final tightening, use a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer.

- c. Apply clamping torque to the nut only.
- 5. Apply wax tape to fully encapsulate all nuts and bolts per manufacturer's recommendations.
- D. Field Welded Joints.
 - 1. Perform welding under the supervision of CWI.
 - 2. Welds: sound and free from embedded scale or slag, and watertight.
 - 3. Field-welded joints:
 - a. Either welded butt strap joints, welded butt joints, or welded lap joints.
 - b. Conform to AWS D1.1, AWWA C206, approved welding procedures, and referenced welding codes.
 - 1) In case of conflict, AWS D1.1 shall govern.
 - 4. Determine preheat and interpass temperature requirements for unlisted base metals according to AWS D1.1, Annex XI guideline on Alternative Methods for Determining Preheat.
 - 5. Repair, redo, and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.
 - 6. Where exterior welds are performed, provide adequate space for welding and inspection of the joints.
 - 7. When fitting up the ends of pipe to be welded or fitting butt-strap pieces, minor jacking or clamping will be allowed.
 - a. Cold working the metal with sledges or localized application of heat will not be allowed.
 - 8. Welded Lap Joints:
 - a. During installation of welded steel pipe in either straight alignment or on curves, lay pipe so that at any point around the circumference of the joint there is a minimum insertion as shown on the drawings.
 - b. Hold back the toe of the weld at least one inch from the nearest point of tangency of the bell radius set in AWWA C200.
 - 9. Prior to beginning the welding procedure, remove tack welds or joint stops used to position the pipe during laying.
 - a. Equally distribute annular space between the faying surfaces of the bell and spigot around the circumference of the joint by shimming, jacking, or other suitable means.
 - b. Perform welding in a manner that will maintain the equalized fit-up.
 - c. Make welds in accordance with ANSI/AWWA C206.
 - d. Where more than one pass is required, remove dirt, slag, and flux from base surface pass and make sure it is smooth and with a uniform surface before the succeeding bead is applied.
 - 10. Drape an 18 inch wide (minimum) strip of heat resistant material over the top half of the pipe on each side of the coating holdback during welding to avoid damage to the coating by hot weld splatter.
 - 11. Do not attach welding grounds to the coated part of the pipe.
 - 12. After the pipe and pipe joint are properly positioned in the trench, weld and provide external joint protection for joints except the special temperature control lap joint hereinafter specified.
 - 13. Backfill to at least 1 foot above the top of pipe the lengths of pipe between special temperature control joints.
 - 14. Weld special temperature control joints after the pipe is backfilled to at least 1 foot above the top of the pipe for the full distance to the temperature control joints upstream and downstream.
 - a. Provide joint protection for special temperature control joints after completion of the joint welds and tests as specified.

- b. Exercise care during the initial backfilling to prevent movement of the pipe and to prevent any backfill material from being deposited on the special temperature control joint.
- 15. Control of Temperature Stresses.
 - a. Control temperature stresses in accordance with AWWA C206, the approved temperature stress control submittal, and these Specifications.
 - b. Supply a special temperature control lap joint at intervals not exceeding 400 feet along welded reaches of the pipeline, at the first regular lap-welded field joints outside concrete encasements and structures, and where shown, unless otherwise approved by the Engineer.
 - 1) Lay joint with an initial lap of not less than 3 inches greater than the typical lap joint.
 - 2) Where temperature control lap joints occur in a traveled roadway or other inconvenient location, the location of the joint may be adjusted, as acceptable to the Engineer.
 - 3) Begin and complete the weld during the coolest interval of suitable length within the workday.
- 16. Field-welded lap joints: As shown in the Drawings.
- 17. Welding Procedures.
 - a. Upon completion of each field-welded joint, mark each joint with the welding operator's regular identification number and the last two digits of the year the Work was completed.
 - 1) Steel stamping directly on piping will not be acceptable unless "low stress" die stamps, such as interrupted dot or round-nose types, are used.
 - b. Test field welded joints in accordance with Paragraph entitled "Field Quality Control".
 - c. Allow NDT testing agency access to field welded joints to perform independent NDT.
 - d. Repair defective welds at no additional cost to the Owner.
 - e. Following successful tests of the joint, coat the exterior joint spaces as indicated.
 - 1) Holiday test dielectric coating, including heat shrink sleeves, as approved by the Engineer.
 - 2) After a successful Holiday test, backfilling may be completed.

3.4 WELDING AFTER BACKFILL (WAB)

- A. Following an approved submittal, WAB is allowed except where double welded lap joints are required or where access to the interior of the pipe does not allow for such activity to be completed in a quality of safe manner.
 - 1. Select welding procedure to meet the requirements for WAB coating protection, holdback coating temperature resistance, and heat input monitoring.
- B. Coat and protect WAB pipe joints as follows:
 - 1. Provide joint coating and heat shrink systems specifically designed for the WAB procedure.
 - 2. Provide heat shrink-wrap in a width such that when centered over the weld location the wrap extends a minimum of 4 inch over the adjacent pipe coating or as recommended by the heat shrink-wrap manufacturer.
 - a. Align overlapping ends of the wrap evenly.
 - 3. Filler mastic materials shall be nonflammable, high temperature materials with a flash point greater than 500 DEGF.
- C. Fully bury WAB Joints.
 - 1. Compact backfill material per requirements of these specifications prior to welding,
 - 2. Minimum cover on all sides: 12 inch soil or CLSM.
- D. Complete all WAB welding with a minimum of two weld passes.

1. Provide three passes or more for steel thickness greater than 0.375 inch, and as required to meet the specified welding procedures.
2. These requirements are in addition to the maximum coating temperature limitations.
- E. Control welding speed, amperage, and voltage to assure the maximum heat input will not result in a sustained surface temperature at the coating/steel interface that exceeds 500 DEGF.
- F. Control weld temperature and duration to prevent excessive carbonization of the heat shrink adhesive or adversely affecting integrity of the heat shrink sleeve.
 1. Carbonization is defined as the loss of volatile organic compounds that result in loss of tackiness, adhesion to the steel, and corrosion protection properties.
- G. Install heat shrink to eliminate any creases or folds which are visible in the joint coating backing material or that extend through both the inner protective layer and outer joint sleeve.
 1. If creases or folds are visible, with approval of the Owner or Owner specified representative, the finished heat shrink may be deemed acceptable after passing a holiday test.
 2. A slight surface deformation of the shrink sleeve may be deemed acceptable if the underlying layers are not compromised beyond the carbonization described above.
- H. A WAB Testing Program will be performed on an initial section of pipe placed to verify that the combined coating and heat shrink sleeve systems and WAB welding produce a result which meets the project requirements.
 1. Perform WAB Testing Program in the field using actual construction installation conditions.
 2. Demonstrate that the operation will not damage the coating system.
 3. Verify welding procedures and certify individual welders to perform the work with the WAB Testing Program.
 4. Temperature Verification:
 - a. During performance of the testing program, take the interior steel temperature along the weld using an infrared thermometer to determine highest interior weld temperature which produced the successful WAB result using the proposed welding procedure.
 - b. Take temperature approximately 3 inches below the actual welding arc, concurrent to the welding and documented for future reference.
 - c. This documented temperature will be the maximum limit allowed for the welders using this welding procedure.
 - d. Owner's inspector may perform random weld temperature verifications concurrent to the welding to assure the welding is being performed as required.
 5. Welder Demonstration Testing:
 - a. Have each welder proposed for WAB work perform a minimum of two separate field joint welds on WAB joints.
 - 1) Each welder must demonstrate acceptable welds before welders may proceed with the WAB production work.
 - 2) Minimum weld length (per test weld): 1/4 of the pipe circumference located in the upper half of the pipe.
 - b. Record the following information for each joint tested:
 - 1) Welder's name.
 - 2) Weld procedure used.
 - 3) Voltage and amperage settings of the welding equipment.
 - 4) Average electrode travel speed (inches per minute).
 - 5) Calculation of the Heat Input in Joules to the weld using the following equation:
 - a) Amperage (I) x Voltage (E) x 60 = Heat Input in Joules Travel Speed (V)
 - 6) Steel "pipe can" temperature measurements at 32nd circumference points (11.5 degree increments) around the circumference of the joint.

- a) Temperatures can be recorded by 'heat stick' methods or digital infrared thermometer.
 - b) Measure temperatures at the following locations:
 - (1) At the weld immediately following the welder's completion of the weld.
 - (2) At 1-inch, 2-inches and 3-inches from the weld, on each side of the weld, during the welding process.
 - c. WAB Testing for Certification of Procedure:
 - 1) Perform first joint weld by the welder using the proposed weld procedure.
 - a) If the first joint weld fails the coating system tests noted below, then re-evaluate weld procedure with the coating and heat shrink wrap manufacturers and revise to meet field conditions.
 - 2) Perform second joint weld by the welder using the revised weld procedure (if changed).
 - a) If this joint weld test also fails the coating system tests, then perform a third weld joint test.
 - b) If the welder fails to meet the performance requirements on this third test then remove welder from the project and resume welder certification process with a new welder who will be required to perform the same welder certification testing as noted above.
 - 3) Upon completion of the welder demonstration testing, excavate and expose the test pipe joints.
 - 4) Owner will inspect the weld test joints and perform tests to confirm compliance with AWWA C206 Standard and AWS D1.1 Welding Code.
 - 5) Owner will also perform a visual inspection and perform destructive and non-destructive tests in accordance with AWWA C216 and C222 to confirm there was no damage to the heat shrink sleeve or adjacent coatings.
 - a) No visible burns.
 - b) No excessive wrinkles.
 - c) No holidays.
 - d) No areas of disbonded coating or disbonding of the heat-shrink sleeves except for the limited carbonized zone described above.
 - d. Where a WAB test joint has passed the visual inspection test using adhesion pull testing methods as defined in AWWA C216.
 - 1) Perform adhesion testing at a point 2 inches from the center of the weld.
 - 2) Record and evaluate testing results as follows:
 - a) Record all adhesion pull test data.
 - b) Determine the minimum field adhesion from two 'passing' (visual inspection) pipe joints.
 - c) Compare this minimum value to 50 percent of the recommended adhesion values in C216.
 - d) Use the higher number as the field acceptance adhesion criteria.
- I. Follow-up WAB Testing:
- 1. After the start of pipeline construction and WAB Testing for Certification of Procedure, excavate and expose up to 5 joints in the first 3,000 feet of pipeline for further examination and testing.
 - 2. Joints to be excavated and exposed will be selected by the Owner at its discretion.
 - 3. Testing will be comprised of visual inspection and non-destructive electrical holiday tests.
 - a. Destructive testing will be performed if visual or electrical holiday tests indicate a compromised coating.

- b. If it is found that the Contractor's welding procedure damages the heat shrink sleeve coating system:
 - 1) Modify welding procedure or replace welding personnel, depending on the cause of the failure, to the satisfaction of the Owner.
 - 2) The Owner will be entitled to require Contractor to excavate and expose up to 10 additional joints for additional examination and testing.
 - 3) Additional joint exhumation, testing, and repairs at no additional cost to the Owner.
 - 4. Ongoing WAB Auditing.
 - a. Owner is entitled to audit joint installation performance throughout the project by requiring Contractor to excavate and expose up to 3 joints per 5,000 feet of pipeline for inspection and testing.
 - b. Joints to be excavate and exposed will be selected at the Owner's discretion.
 - c. Testing will be comprised of visual inspection and non-destructive electrical holiday tests.
 - d. Destructive testing will be performed if visual or electrical holiday tests indicate a compromised coating.
 - e. If it is found that the Contractor's welding procedure damages the heat shrink sleeve coating system:
 - 1) Modify welding procedure or replace welding personnel, depending on the cause of the failure.
 - 2) The Owner will be entitled to require Contractor to excavate and expose an additional 6 joints for examination and destructive testing at no additional cost.
 - f. If a welding procedure must be modified, test new welding procedure to the satisfaction of the Owner prior to completing any additional welded joints.
 - g. Make all repairs necessary to repair damaged coatings or sleeves caused during exhumation of joints for testing.
 - 1) Repair of coatings and sleeves at joints excavate and exposed during the Project Initiation Phase at no additional cost to Owner.
 - 2) Compensation will be allowed for repair of coatings and sleeves at joints excavated and exposed as part of on-going auditing if the joints are found to be satisfactory.
 - 3) Perform repair of coatings and sleeves at joints excavated and exposed during on-going auditing that are either found to be defective and provide additional exhumations due to discovery of defective joints at no additional cost to Owner.
 - h. Remove and replace joint heat shrink sleeves that are found to have installation defects or were subjected to destructive.
- J. An acceptable Testing Program at the start of the pipe laying process will allow the use of the Weld After Backfill process.
 - 1. However, the random pipe joint testing as defined in these specifications will continue.
 - 2. If Post-Test Program testing indicates a problem with a welder or the process, then recertify the welder and the process using the Weld After Backfill Field Testing and Certification process defined above.
 - 3. If it becomes apparent that the Contractor's welder or methods are not producing suitable results with the WAB process, then the right to use WAB will be rescinded, and the Contractor will be required to use the Weld Before Backfill (WBB) process.
 - a. The change to WBB will be performed by the Contractor at no additional cost to Owner.

3.5 REPAIR OF SHOP APPLIED COATINGS

- A. Coatings: In accordance with coating system provided for adjacent main line pipe.
- B. All Other Coatings: In accordance with coating manufacturer's recommendations.

3.6 LINING OF FIELD JOINTS

A. General.

1. Thoroughly wipe clean and remove all water, loose scale, dirt and other foreign material from interior and exterior joint recesses and the inside surface of the pipe.
2. Cement for joint grout: C595 Type IL with less than 15 percent Limestone
3. After the backfill has been completed to final grade, fill interior joint recess with mortar of stiff consistency mixed in proportions of one part cement to 2 parts sand.

B. Joint Lining.

1. Tightly pack mortar into joint recess and trowel flush with the interior surface.
 - a. Remove all excess mortar.
2. Maximum indentation or projection of mortar: 1/16 inch.
3. Pipe smaller than 24 inch diameter
 - a. Daub bell with mortar containing one part cement to 2 parts sand before the spigot is inserted into the bell.
 - b. Force spigot end to the bottom of the bell and swab out excess mortar on the inside of the joint.
4. Complete field joints in such a manner as to allow inspection without having to go into the pipe more than 300 feet from an entry/exit point.
 - a. Alternatively, pipe joints may be numbered, and videos taken of each joint after lining to allow for inspection without entering the pipe.

3.7 COATING OF FIELD JOINTS

A. In accordance with coating system provided for adjacent main line pipe.

B. Heat Shrink Wrap:

1. Preparation of uncoated pipe ends:
 - a. Bare surfaces to be free of mud, mill scale, paint, grease and other foreign materials.
 - b. Preclean according to SSPC-SP 1.
 - c. Prep surface to SSPC-SP3 or sleeve manufacturer's requirements, whichever is more strict.
2. Protect prepped ends from moisture prior to applying heat shrink sleeve.
3. Install per AWWA C216 and manufacturer's instructions.
 - a. Utilize only personnel to install heat shrink sleeves that have been trained by sleeve manufacturer.

3.8 INSTALLATION OF PIPE APPURTENANCES

A. Flexible Coupled Joints.

1. When installing flexible couplings, take care that the connecting pipe ends, couplings and gaskets are clean and free of all dirt and foreign matter with special attention being given to the contact surfaces of the pipe, gaskets and couplings.
2. Assemble and install couplings in conformity with the recommendation and instruction of the coupling manufacturer.
 - a. Limit allowable deflection flexible couplings for 50% of allowable manufacturer's deflection.
3. Utilize type and size wrenches recommended by the coupling manufacturer in bolting couplings.
4. Tighten coupling bolts to secure a uniform annular space between the follower rings and the body of the pipe with all bolts tightened approximately the same amount.
 - a. Tighten diametrically opposite bolts progressively and evenly.

- b. For final tightening, use a suitable, approved and calibrated torque wrench set for the torque recommended by the coupling manufacturer.
 - c. Apply clamping torque to the nut only.
- 5. Upon completion of the coupled joint, clean, prime and protect coupling and bare metal of the in accordance with the requirements of mainline pipe coating manufacturer.
- 6. Restrained flexible couplings to be fitted with gusset plates on either side of the pair of flexible couplings and harnessed together with properly sized and number of nuts/bolts to resist the thrust.

3.9 CATHODIC PROTECTION

- A. Apply to pipe as shown on the Drawings and as specified in Specification Section 26 42 17, Impressed Current Cathodic Protection.

3.10 TEST STATION/PIPELINE MARKERS

- A. Pipeline markers shall be installed at locations specified above and test station markers shall be installed where shown on the drawings except where these facilities will not be under asphalt or concrete pavement.

3.11 WARNING TAPE

- A. Install warning tape with all new pipelines.
 - 1. See Specification Section 10 14 00 and trench details on Drawings.

3.12 FIELD QUALITY CONTROL

- A. Field Welding.
 - 1. Perform tests and inspections indicated in this section by CWI.
 - 2. VT Inspect all welds (100 percent inspection) and mark to indicate acceptance or rejection.
 - 3. Test double welded butt-strap joints or double-welded lap joint welds by pressurizing to 40 PSI in the area between the two fillet welds as indicated and in accordance with other requirements of AWWA C206.
 - a. This test is in addition to the test requirements specified for lap welds and butt-strap joints.
 - b. Apply air or other Engineer-approved gas into connection between the two fillet welds.
 - c. If test passes and is accepted, then close threaded openings with flush pipe plugs or by welding.
 - d. If test fails, paint welds with soap solution and re-test.
 - 1) Mark leaks indicated by escaping gas bubbles.
 - 2) Perform corrections and repairs until accepted at no additional cost to the Owner.
 - 4. Inspect 100 percent of butt joint welds with full circumference RT or UT.
 - 5. Inspect 100 percent of welded lap joint and welded butt-strap joint welds with full circumference PT or MT.
 - 6. Weld Acceptance:
 - a. VT: Perform VT per AWS D1.1 Paragraph 6.9 Visual.
 - b. UT: Perform UT of CJP groove welds in accordance with AWS D1.1, Paragraph 6.13.1
 - c. RT: Perform RT of CJP butt joint welds in accordance with AWS D1.1, Paragraph 6.12.1.
 - d. PT or MT:
 - 1) Perform on fillet and PJP groove welds in accordance with AWS D1.1, Paragraph 6.10.
 - e. Acceptance: in accordance with standards specified above.
 - 7. Remove defective welds in manner that permits proper and complete repair by welding at no additional cost to the Owner.

8. Caulking or peening of welds is not permitted.
9. Pay for CWI retesting of unsatisfactory welds at no additional cost to Owner.

3.13 HYDROSTATIC TESTING

- A. Hydrostatic testing of steel pipe: See Specification Section 40 05 01.

END OF SECTION

SECTION 33 05 81
METALLIC CASTINGS FOR UTILITY STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Valve boxes and covers.
 2. Iron frames and covers for manholes.
 3. Steel frames and grates for utility structures.
- B. Related Requirements: Include, but are not necessarily limited to:
1. Section 03 15 19 - Anchorage to Concrete.
 2. Section 03 31 30 - Concrete Materials and Proportioning.
 3. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 4. Section 33 05 16 – Precast Concrete Manhole Structures.

1.2 REFERENCES

- A. Terminology:
1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
 - a. “Castings” means iron, steel, or other metallic items associated with Underground Facilities, such as frames and covers for manholes, frames and grates for stormwater drainage structures, valve boxes and covers, and similar items. Castings may also be required in applications other than Underground Facilities, when shown or indicated in the Contract Documents.
 - b. “Frame and cover” means a circular metallic frame, installed on, or mechanically attached to, the top of a manhole, vault, chamber, or other construction, into which a round, metallic cover is installed. In this Section, the terms, “frame and cover”, “cover and frame”, and derivative terms, have the same meaning.
 - c. “Frame and grate” means a metallic frame, regardless of shape, installed on, or mechanically attached to, a stormwater drainage structure, or cast into the top slab of a stormwater drainage structure, or otherwise incorporated into other construction, into which a metallic grate is installed. In this Section, the terms, “frame and grate”, “grate and frame”, and derivative terms, have the same meaning.
 - d. “Valve box and cover” means a specially-fabricated, vertical, pipe-type casting, typically installed over a buried valve to provide access to the valve actuator’s operating stem. Valve boxes include an associated, iron cover. In this Section, the terms “valve box and cover”, “box and cover”, and derivative terms have the same meaning.
- B. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. LRFD Bridge Design Specifications.
 - b. M105, Standard Specification for Gray Iron Castings.
 - c. M306, Standard Specification for Drainage, Sewer, Utility, and Related Castings.
 2. ASTM International (ASTM):
 - a. A36, Standard Specification for Carbon Structural Steel.
 - b. A48, Standard Specification for Gray Iron Castings.
 - c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

- d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - e. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - f. A240, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - g. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - h. A283, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
 - i. A536, Standard Specification for Ductile Iron Castings.
 - j. C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - k. C1619, Standard Specification for Elastomeric Seals for Joining Concrete Structures.
 - l. D2000, Standard Classification System for Rubber Products in Automotive Applications.
 - m. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - n. F1336, Standard Specification for Design and Performance of Underground Precast Utility Structures.
 - o. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
3. National Association of Architectural Metal Manufacturers (NAAMM):
- a. NAAMM MBG-531, Metal Bar Grating Manual.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordination with Utility owners (when other than the Owner):
 - a. Coordinate with utility owners affected by the Work and obtain from such entities requirements for providing metallic castings for utility structures.
 - b. Obtain and pay for work permits, street opening permits, and other permits required by utility owners and owners of affected streets, highways, and other rights of way.
 - c. Give written notices required by utility owners and owners of streets, highways, and other rights of way.
- 2. Notice to Emergency Services:
 - a. Give required advance, oral and written notices to fire departments, police departments having jurisdiction, ambulance services, and other emergency services as applicable, of proposed construction operations that may impact or affect emergency services' ability to perform their respective functions.
 - b. Give such notices as indicated in the Specifications for the associated type of buried utility Work required.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

B. Qualifications:

- 1. Manufacturers:
 - a. Castings manufacturer shall be current, valid corporate member of American Foundry Society (AFS), and maintain personnel actively trained using AFS training programs and resources.
 - b. Castings manufacturer shall be entity regularly engaged in manufacturing castings of the type and material required, with not less than five years' experience manufacturing similar castings to that required for the Project. Manufacturer must have not less than 50 installations of substantively similar castings to those required for the Work in North America in satisfactory operation for not less than five years each.

- c. Upon Engineer's request, promptly furnish, as Submittal, documentation of compliance with qualifications requirements. For references furnished, indicate for each: utility owner name and facility manager name (if other than utility owner) including entity name, contact person sufficiently familiar with durability and condition of castings installed for such utility, contact telephone number and email address, utility location (municipality and state), casting type, material, size, and manufacturer's model number or item designation, load ratings, and year casting was installed.
- d. Obtain all castings (for example, valve boxes and covers, frames and covers, steel frames and grates, and others), of each casting type, from a single castings manufacturer, unless otherwise acceptable to Engineer.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Schedule (in tabular or narrative format), of castings proposed, apportioned by castings type (for example, valve boxes and covers, frames and covers, steel frames and grates, and others), indicating, for each type of casting: Project-specific locations, materials (indicating reference standard with which material complies), size, load rating, features and appurtenances, manufacturer and model number or item designation, type of gasket material proposed (when applicable) and manufacturer, material of bolts and studs (when applicable), bid/pay item under which compensation will be requested, and other pertinent information.
 - b. Detailed, scale drawings for specialized or custom castings required, indicating dimensions, weights, materials, layout and patterns of frames, covers, and grates (as applicable), and other pertinent information.
- 2. Product Data:
 - a. Submit manufacturer's published information, including catalog excerpts, specifications, and indication of specific reference standards with which materials comply, for each item specified in this Section. Furnish such information for each size and type of item required.
 - b. Manufacturer's detailed drawings for standardized castings commonly furnished by manufacturer, as relevant to the Work.
 - c. Manufacturer's published catalog information and specifications for each size and type of casting and gasket material required, including load rating.
 - d. Clearly mark on product data Submittals proposed items and features, and clearly indicate, via cross-outs or other method, items and features not proposed for the Work.

B. Informational Submittals: Submit the following:

- 1. Certificates:
 - a. Upon Engineer's request, furnish manufacturer's certification that materials and fabrication comply with reference standards indicated for the item, together with documentation of compliance with previously performed factory testing and mill testing, in accordance with reference standards indicated for the associated item, of similar materials and fabrications.
 - b. For iron castings, concurrent with shipment of fabricated items from the factory, submit manufacturer's certification required by AASHTO M306, Section 9.
- 2. Manufacturer Instructions:
 - a. Instructions for handling, storing, and installing, items furnished under this Section.
- 3. Source Quality Control Submittals:
 - a. Written results of tests and inspections performed at the factory or place of production, when requested by Engineer, required under this Section, including clear indication whether such results comply with criteria for acceptance indicated in the Contract Documents.

4. Field Quality Control Submittals:
 - a. Written results of field tests and inspections required under this Section, including clear indication whether such results comply with criteria for acceptance indicated in the Contract Documents.
 5. Qualifications:
 - a. Manufacturers, when requested by Engineer.
- C. Closeout Submittals: Submit the following:
1. Keys:
 - a. When locking frames and covers are required, furnish to Owner three keys for each type of locking mechanism provided. Furnish, as Submittal, documentation of delivery of keys to such entity, in accordance with requirements for documenting delivery of spare parts and extra materials.

PART 2 - PRODUCTS

2.1 VALVE BOXES AND COVERS

- A. Manufacturers:
1. Subject to compliance with the Contract Documents, provide required quantity of one of the following:
 - a. Bingham & Taylor.
 - b. EJ Group.
 - c. Neenah Foundry.
 - d. Or equal.
- B. Description:
1. This Article addresses valve boxes and covers for the following applications:
 - a. Inline valves required in buried waterlines and other, buried piping operating under pressure.
 - b. Buried valves associated with hydrants.
 - c. Buried valves that are a component of tapping sleeves and valves.
 - d. Permanent blow-off assemblies.
 - e. Valves in vaults with penetrations through top slab..
 2. Provide all labor, materials, construction equipment and machinery, tools, services, and appurtenances necessary, required, or both, to furnish and install valve boxes and covers.
 3. Locations of valve box and cover Work are shown on the Drawings and may also be indicated elsewhere in the Contract Documents.
 4. Coordinate valve boxes and covers with each, associated buried valve and Section 40 05 51 – Common Requirements for Process and Utility Valves, unless otherwise indicated in this Section.
- C. Performance Criteria:
1. Rated for H-20 loading in accordance with AASHTO LRFD Bridge Design Specifications.
- D. Materials:
1. Ductile iron ASTM A536, Grade 80-55-06.
- E. Fabrication:
1. Cover:
 - a. Type: Locking, unless indicated otherwise elsewhere in the Contract Documents for specific valves.
 - b. Diameter: Appropriate for associated valve box.

- c. Text: Cast into top of cover text indicating service of associated Underground Facility, such as "WATER", "NON-POTABLE", "G.W. MON." (for groundwater monitoring wells and piezometers), or others as appropriate. When required text on valve box cover is unclear, obtain written interpretation or clarification from Engineer before purchasing covers.
 - d. Further mark covers in accordance with AASHTO M306, Section 10.
- 2. Valve Box:
 - a. Valve Box Base Type: arch type.
 - b. Diameter: five inches, unless larger size is shown or indicated elsewhere in the Contract Documents for certain valves or applications.
 - c. Wall thickness: Not less than 3/16-inch.
 - d. Bituminous protective coating, inside and outside.

2.2 IRON FRAMES AND COVERS FOR MANHOLES

- A. Manufacturers:
 - 1. Subject to compliance with the Contract Documents, provide required quantity of one of the following:
 - a. East Jordan Iron Works
- B. Description:
 - 1. This Article addresses frames and covers for the following applications:
 - a. New concrete manholes.
 - 2. Provide all labor, materials, construction equipment and machinery, tools, services, and appurtenances necessary, required, or both, to furnish and install iron frames and covers.
 - 3. Locations where iron frames and covers are required are shown or indicated on the Drawings, or as required in this Article.
- C. Performance Criteria:
 - 1. Type: Round, solid.
 - 2. Ductile Iron
 - 3. AASHTO H-20 rated
 - 4. Text on Cover: "City of Thornton - Water"
 - 5. Clear opening as shown on the drawings
 - 6. 1 pick hole
 - 7. Hinged with EPDM Sealing Gasket
 - 8. Stainless Steel Cam Lock
 - a. Lock shall be McGard ManLock – Bolt Drawing # 127003F1
 - 9. 30-inch and larger units to be provided with mechanical lift assistance
- D. Materials:
 - 1. Frames and Covers:
 - a. Ductile Iron: ASTM 536.
 - 2. Materials for Attaching Frames to Associated Manhole or Similar Construction:
 - a. Grout frames in place using non-shrink grout complying with Section 03 31 30 - Concrete Materials and Proportioning.
 - b. Where gasketed frame flanges are required, provide gasketing complying with ASTM C1619 Class C.
 - c. Alternatively, where gasketed frame flanges are required, provide preformed flexible pipe joint sealing compound in lieu of rubber gaskets, as follows:

- 1) Products and Manufacturers: Subject to compliance with the Contract Documents, the following products and manufacturers are acceptable:
 - a) Kent Seal No. 2 Butyl Sealant, by Hamilton Kent.
 - b) Ram-Nek Joint Sealant, by Henry Waterstops & Pipe Joint Seals.
 - c) Pro-Stik Butyl Sealant, by Press-Seal Corp.
 - d) Bidco C-56 Sealant, by Trelleborg.
 - e) Or equal.
 - 2) Materials: ASTM C990, butyl rubber joint sealant, furnished as preformed "rope", with easily removable backing paper. Material shall be specifically manufactured for sealing joints of concrete pipe and concrete manhole sections.
 3. Cover Hardware and Accessories:
 - a. Where locking covers are required, provide locking mechanisms of one of the following:
 - 1) Type 316 stainless steel, ASTM A240, ASTM A276, ASTM A193.
 4. Coatings: Where coating of frames and covers is required, provide frame and cover manufacturer's standard, asphalt-based, bituminous coating material.
 5. Additional, Interior Covers:
 - a. Where secondary inner cover is required, secondary inner cover shall be fully compatible with materials of frame and main exterior cover.
- E. Fabrication: Provide fabrication as indicated below:
1. Fabrication - General:
 - a. Provide frames, covers, and appurtenances suitable for installation on associated manhole as shown on the Drawings.
 - b. When requirements for materials and fabrication conflict, obtain interpretation or clarification from Engineer before proceeding.
 - c. Mark castings in accordance with AASHTO M306, Section 10.
 2. Frames and Covers:
 - a. Provide frames and covers in accordance with AASHTO M306.
 - b. Frame Height: Not less than four-inches.
 - c. Where full-penetration pick holes are required, provide in each cover one pick holes, 5/8-inch diameter, with rounded edges.
 - d. Where non-penetrating pick holes are allowed, provide in each cover one non-penetrating pick hole, allowing between 0.5-inch and one-inch solid grip using pick or lifting hook.
 3. Attaching Frames to Associated Manhole or Similar Construction:
 - a. Gasketing:
 - 1) Provide gasket not less than 0.25-inch thick and not less than half the width of the flange.
 - 2) Length of inside edge of gasket: equal to circumference of inside diameter of frame.
 - 3) Clearly show or indicate in Shop Drawings or product data Submittals whether underside of frame includes recessed space for gasket.
 4. Cover Hardware and Accessories:
 - a. Locking Covers:
 - 1) Provide the following type of lock for each frame and cover:
 - a) Bolted cover with tamper-resistant bolts or recessed hex heads.
 - (1) McGard ManLock or approved equal..
 5. Coatings:

- a. Where coating of frames and covers is required, apply required coating to thickness normally furnished by castings manufacturer, and using castings manufacturer's standard procedures.
- 6. Additional Interior Covers:
 - a. Secondary Inner Cover:
 - 1) When secondary inner cover is required, such cover shall comply with requirements in this Article for frames and covers, and requirements of this provision.
 - 2) Secondary inner cover shall be easily removeable when main exterior cover has been removed, with effort similar to that required for removing main exterior cover.
 - 3) For secondary inner cover, provide seating surface integral in same frame as main exterior cover.
- 7. Fabrication Tolerances:
 - a. Comply with fabrication tolerances in AASHTO M306, Section 5.4.

2.3 ACCESSORIES

A. Manholes:

- 1. Precast Concrete Manholes: Comply with Section 33 05 16 – Precast Concrete Manhole Structures and the Drawings.

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections:

- 1. For iron castings, perform shop tests and inspections as required in AASHTO M306.
- 2. For steel frames and covers, perform shop tests and inspections as required in NAAMM MBG-531 and AASHTO M306, as applicable to steel frames and grates for stormwater drainage structures.
- 3. Perform manufacturer's standard shop tests and inspections.
- 4. Promptly upon Engineer's request, submit written results of required tests and inspections and obtain Engineer's acceptance prior to shipping items from the shop or factory.

B. Defective Work:

- 1. The following constitutes basis for Engineer rejecting castings as defective Work:
 - a. Castings damaged during shipping, handling, storage, installation, and otherwise damaged when in Contractor's care, custody, or control.
 - b. For iron castings, reasons for rejecting castings as defective Work are set forth in AASHTO M306.
 - c. For steel frames and grates, reasons for rejecting castings as defective Work are set forth in NAAMM MBG-531 and AASHTO M306, as applicable to steel frames and grates for stormwater drainage structures.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Installing the Work constitutes Contractor's approval of underlying work, substrates, and field conditions prevailing at the time of the Work.

3.2 PREPARATION

A. Excavation and Related Work:

- 1. Perform excavating and filling Work in accordance with Section 31 23 33 – Utilities - Trenching and Backfilling.

3.3 INSTALLATION

A. Installation Requirements:

1. Castings Installation – General:
 - a. Install items in accordance with the Contract Documents, manufacturer's written instructions, Laws and Regulations, and applicable permits issued by authorities having jurisdiction. Where such requirements conflict, obtain interpretation or clarification from Engineer prior to commencing the associated Work.
 - b. Unless otherwise shown or indicated, or acceptable to Engineer, install frames centered on top opening of associated manhole, stormwater drainage structure, or opening in other construction where metallic castings are required.
 - c. Install metallic castings for proper drainage of stormwater runoff.
 - d. Where manhole covers with hinged or ball-joint-type connections to frame are provided, install casting so that hinge or other, similar joint, is on side opposite wall of manhole, so that cover opens away from manhole rungs or location where portable ladder would be inserted.
2. Rim Elevations:
 - a. In meadows and other, unpaved areas in natural, undeveloped condition, install frames to provide rim elevations as shown on the Drawings. When rim elevation is not shown or indicated, install frames so that associated manhole covers are- four inches above finish grade.
 - b. Install valve boxes that are outside of paved areas and sidewalks to provide cover elevation 0.25-inch above adjacent finish grade.
 - c. Provide appropriate grade rings or similar means of establishing required frame elevations.
 - d. For frames, provide appropriate shims as necessary to provide required rim elevations.
 - e. Comply with this Article's "Installation Tolerances" provision relative to rim elevations.
3. Valve Boxes and Covers:
 - a. Center valve boxes on associated valve and operating stem, or centered on other facility, such as piezometer.
 - b. Where arch-type valve boxes are required, properly install valve box on valve or other facility, such as piezometer, without damaging either item.
 - c. Properly install covers on valve boxes, ensuring each cover is fully seated.
4. Fastening Frames to Structures with Grout:
 - a. Perform surface preparation and place grout in accordance with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
 - b. Place grout for entire width of frame flange. Ensure surface irregularities in top of concrete or other construction on which frame will be installed are completely filled with non-shrink grout.
 - c. Provide full contact between frame and concrete or other construction on which frame will be installed, to prevent frame and cover, or frame and grate (as applicable), from subsequent rocking and displacement.
 - d. After installing frame, provide chamfer of non-shrink grout sealing outside edge of flange to concrete or other construction on which frame will be installed.
 - e. Grout shall achieve required compressive strength before frame and cover, or frame and grate, as applicable, is subjected to live loading.
5. Gasketed Frames:
 - a. Where gasketed frames are required, install inside face of gasket equal with inside edge of frame.
 - b. Properly position gasket material before installing associated frame.
 - c. When frame includes recess for gasketing, ensure gasket is properly installed within recess.
 - d. Prior to installing frame atop gasket, place non-shrink grout, to depth equal to gasket thickness, between outside edge of gasket and outside edge of flange, to completely fill

- space between underside of frame flange and underlying manhole, stormwater drainage structure, or other construction. Perform surface preparation and place grout in accordance with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
- e. Install frame without disturbing gasket and grout.
- 6. Mechanically Fastening Frames to Structures:
 - a. Where frame flanges are required with holes for bolts or other anchors, provide adhesive anchors in accordance with Section 03 15 19 - Anchorage to Concrete.
 - b. Where adhesive anchors are required, such anchor shall extend from flange frame down into precast concrete drainage structure, extending through grade rings or other material provided for adjusting frames and grates to final, finished grade.
 - c. Where bolted frame flange also requires gasket, install gasket and frame, and ensure grout under flange has achieved required compressive strength, prior to installing adhesive anchors.
- 7. Covers and Grates:
 - a. Install cover or grate, as applicable, after frame is installed and secured in place.
 - b. Install per lock manufacturer's recommendations.
- 8. Where additional inner cover is required for manholes, install inner cover and verify proper installation of inner cover before installing main external cover.
- 9. Where metallic castings require coating, field-test repair damaged coatings in accordance with written instructions of metallic casting manufacturer and written instructions of coating manufacturer.

3.4 FIELD QUALITY CONTROL

A. Field Tests and Inspections:

- 1. Compliance with Indicated Tolerances:
 - a. Perform field measurements, to determine compliance with installation tolerances in this Section and required rim elevations. Record results for each valve box cover, manhole cover, and grate for stormwater drainage structures, clearly indicating the structure or similar item, rim elevation based on Project datum, and elevation of grade or other finished surface adjacent to valve box, manhole frame, or frame of stormwater drainage structure, as applicable.
- 2. For locking covers and locking grates, when applicable, demonstrate in presence of Owner proper operation and functionality of locks.
- 3. Submit written results of required tests and inspections and obtain Engineer's acceptance prior to requesting inspection for Substantial Completion.

B. Defective Work:

- 1. The following constitute basis for Engineer rejecting castings as defective Work:
 - a. Castings damaged during shipping, handling, storage, installation, and otherwise damaged when in Contractor's care, custody, or control.
 - b. For iron castings, reasons for rejecting castings as defective Work are set forth in AASHTO M306.
 - c. For steel frames and grates, reasons for rejecting castings as defective Work are set forth in NAAMM MBG-531.
 - d. Where frames are required to be bolted to associated manhole, stormwater drainage structure, or other construction, improperly installed adhesive anchors, or frames not properly secured with appurtenant fastening hardware, such as nuts.
 - e. Visible discharge of groundwater between frame and top of associated manhole, stormwater drainage structure, or similar construction.
 - f. Reasonable evidence or signs that castings become dislodged under operating conditions, such as when subjected to vehicular traffic loading.
 - g. Castings evidencing rocking or other signs of improper seating or installation.

- h. Castings evidencing dirt, debris, or other foreign matter.
 - i. Where bolted covers or bolted grates are required, bolts or studs extending above top of associated cover or grate.
 - j. Where locking covers or locking grates are required, non-functional locks or locks requiring unusual effort to operate.
 - k. Other non-compliance with the Contract Documents.
 - 2. Promptly upon Contractor becoming aware of defective castings Work, remedy such defect so that associated casting complies with the Contract Documents.
- C. Supplier's Services:
- 1. Furnish at the Site, services of castings manufacturer's factory-trained representative to assist Contractor as necessary in identifying appropriate remedies for defective castings Work, and assist Contractor as appropriate with implementing such remedies.

3.5 ADJUSTING

- A. Adjusting – General:
- 1. Adjust castings as necessary to provide required rim elevations, in accordance with the Contract Documents.

3.6 CLEANING AND WASTE MANAGEMENT

- A. Cleaning:
- 1. Prior to requesting inspection for Substantial Completion, and commencing beneficial use by Owner, remove dirt, debris, and other foreign matter, including excess bituminous joint adhesive and sealants on isolation joint filler material, from metallic castings, including openings in grates serving stormwater drainage structures and vents in manhole covers (when applicable). Do not dispose of such material, or discharge waste into, associated manhole, stormwater drainage structure, or other construction.

3.7 PROTECTION

- A. Protection – General:
- 1. Unless otherwise approved by Owner and Engineer, until Substantial Completion, prohibit discharge of stormwater runoff into grates associated with stormwater drainage structures.
 - 2. Protect metallic castings from damage after installation, until Substantial Completion of adjacent Work. To extent practicable, prevent construction vehicles, construction equipment and machinery, delivery vehicles, and similar mobile equipment from transiting over, and parking upon, installed metallic castings.
 - 3. Comply with Section 01 50 10 - Protection of Existing Facilities.

END OF SECTION



DIVISION 40

PROCESS INTERCONNECTIONS



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SECTION 40 05 01
COMMON WORK RESULTS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Common work results for buried and exposed process piping, including:
 - a. Dielectric flange kits.
 - b. Pipe saddles (for gage installation).
 - c. Dismantling Joints.
 - d. Water for testing.
 - e. General procedures for installing buried piping.
 - f. General procedures for installing non-buried piping.
 - g. Connections to existing piping
 - h. Field testing of piping.
 - i. Cleaning of piping.

B. Related Requirements: Sections include, but are not necessarily limited to:

1. Section 09 90 04 – Painting.
2. Section 09 90 05 – Polyurethane Coating.
3. Section 10 14 00 - Identification Devices.
4. Section 31 23 33 Utilities - Trenching and Backfilling.
5. Section 33 05 19 - Ductile Iron Utility Pipe.
6. Section 33 05 24 - Steel Utility Piping.
7. Section 40 05 51 - Common Requirements for Process and Utility Valves.
8. Section 40 42 00 - Pipe, Duct and Equipment Insulation.
9. Section 40 73 00 - Pressure Instrumentation.

1.2 REFERENCES

A. Reference Standards:

1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760).
 - b. M190, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
 - c. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
 - d. M294, Interim Specification for Corrugated Polyethylene Pipe 12 to 24 Inch Diameter.
2. American Iron and Steel Institute (AISI).
3. American Public Health Association (APHA), American Waterworks Association (AWWA), Water Environment Federation (WEF):
 - a. APHA/AWWA/WEF - Standard Methods for Examination of Water and Wastewater.
4. American Society of Mechanical Engineers (ASME):
 - a. B16.3, Malleable Iron Threaded Fittings.
 - b. B16.5, Pipe Flanges and Flanged Fittings.
 - c. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
 - d. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.

- e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
- f. B31.3, Process Piping.
- g. B40.100, Pressure Gauges and Gauge Attachments.
- h. Boiler and Pressure Vessel Code.
- 5. Association of Materials Protection and Performance (AMPP) (National Association of Corrosion Engineers (NACE)):
 - a. NACE SP0286, Electrical Isolation of Cathodically Protected Pipelines.
- 6. ASTM International (ASTM):
 - a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - b. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - c. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - d. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - e. A197, Standard Specification for Cupola Malleable Iron.
 - f. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 - g. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - h. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
 - i. A518, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
 - j. A536, Standard Specification for Ductile Iron Castings.
 - k. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
 - l. A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
 - m. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 - n. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
 - o. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
 - p. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - q. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - r. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- 7. American Water Works Association (AWWA):
 - a. C200, Standard for Steel Water Pipe - 6 inches and Larger.
 - b. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.
 - c. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
 - d. C600, Installation of Ductile-Iron Mains and Their Appurtenances
 - e. C604, Insulation of Buried Steel Water Pipe
 - f. C800, Standard for Underground Service Line Valves and Fittings.
- 8. American Water Works Association/American National Standards Institute (AWWA/ANSI):

- a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
- b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
- d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
- e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.
- f. C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
- g. Manual M11, Steel Pipe: A Guide for Design and Installation.
- h. Manual M41, Ductile-Iron Pipe and Fittings.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Coordinate flange dimensions and drilling between piping, valves, and equipment.
- 2. Completion of the Work of this Section and Engineer's acceptance of associated field testing and inspection results is required prior to Contractor requesting inspection for Substantial Completion of the associated Work.

1.4 QUALITY ASSURANCE

A. Qualifications:

- 1. General Contractor Experience with Steel Piping:
 - a. Completion of at least two (2) individual raw or treated water welded-steel pressure pipeline projects for the installation of a minimum of 5,000 lineal feet (each project) of 30-inch diameter or larger, welded steel pipe material, constructed within the last 7 years.
 - b. Completion of two (2) individual welded steel pressure pipeline projects, 30-inch diameter or larger with a construction cost of \$5 million or greater within the last 7 years.
 - c. Project Manager and Superintendent for installer of piping shall be persons possessing not less than five years of similar, relevant experience serving in said role for installing Steel Pipe
 - d. Submit documentation describing project and roles
 - e. Submit documentation of compliance with qualifications requirements of this provision.
 - 1) For each project, indicate owner (including organization name, current contact person knowledgeable concerning installers work, city and state, telephone number, and email address), project designation, and narrative summary of quantities of piping work performed. including indication of sizes, pipe materials, and pipe lining (if any), together with other pertinent information.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

- 1. Shop Drawings:
 - a. Schedule (in tabular format or narrative format) indicating each required piping system, indicating system location, service, pipe material, joint types, pipe lining (if any), pipe coating (if any), and other pertinent data.
 - b. Fabrication and Layout Drawings:
 - a) See Section 33 05 19 Ductile Iron Utility Pipe.
 - b) See Section 33 05 24 – Steel Utility Pipe
- 2. Product Data:

- a. Submit manufacturer's published information, including catalog excerpts, specifications, and indication of specific reference standards with which materials comply, for each item specified in this Section, unless such information is furnished as part of a Submittal under another Specifications section.
 - 1) Furnish such information for each size and type of item required.
 - b. Clearly mark on product data Submittals proposed items and clearly indicate, via cross-outs or other method, items not proposed for the Work.
3. Testing Plans:
- a. On copy of piping schedule submitted with Shop Drawings, indicate proposed field tests for piping, together with proposed test pressures (where applicable), wetting period (when applicable), duration of pipe expansion period (when applicable), duration of timed testing period, and other pertinent information necessary to properly communicate Contractor's intent to comply with the Contract Documents relative to field testing of piping.
 - b. Indicate proposed locations and lengths of piping segments for each test, together with indication of proposed dates for such testing.
 - c. Submit description of proposed testing methods, procedures, and apparatus, indicating limitations of procedures and apparatus, and obtain Engineer's approval prior to testing.
 - d. For each test, provide brief, narrative description of how water will be conveyed to and, where necessary, from, the piping being tested including indication of proposed rate of water withdrawal from source, proposed rate of water discharge from piping after testing and temporary equipment proposed for use. Where the Contract Documents establish maximum allowable flow rates, clearly indicate how monitoring such compliance will be performed. Where temporary flow meter is proposed or required, include in testing plan copy of current, valid calibration of each flow meter proposed for use.
 - e. Where potable water will be used for testing, include in testing plan written approval of owner of water utility for use of source and indication of whether water utility or Contractor will furnish and install temporary backflow preventers. Where temporary backflow preventers will be provided by Contractor, include copy of current, valid certification (by duly certified backflow preventer technician) for backflow preventer(s) proposed for use, including indication of specific, identification data for such equipment.
 - f. Proposed location(s) for discharge of test water, flush water, including copy of approval for such discharge from authority having jurisdiction, where applicable.
 - g. Include copies of forms proposed for reporting results of field testing of piping.
 - h. Where piping will be filled with water for testing, indicate Contractor's proposed means and locations for expelling air from piping.
 - i. It is anticipated that at the completion of testing, test water will have elevated pH. Identify proposed means for neutralizing pH prior to discharge (if any).
 - j. Obtain Owner and Engineer's approval of such Submittal not less than 48 hours before commencing testing. Submit one such Submittal for entirety of piping Work, unless otherwise allowed by Engineer.
 - k. Engineer's approval of such Submittal is only for the limited purposes of endeavoring to verify compliance with the Contract Documents, and Engineer's design intent, relative to determining acceptability of the Work.
 - 1) Engineer's review, comments upon (or lack thereof), and assignment of disposition to such Submittal does not, in any way, mitigate Contractor's sole responsibility for construction means, methods, techniques, procedures, and sequences, and associated safety and protection measures.

B. Informational Submittals:

1. Supplier Instructions:

- a. Instructions for handling, storing, installing, and placing into operation materials specified in this Section.

2. Field Quality Control Submittals:
 - a. Results of tests, inspections, and other quality control activities required by the Contract Documents and performed at the Site.
 3. Qualifications:
 - a. Each installer of piping.
 - b. Subcontractor's retained for performing specific field quality control activities, in accordance with qualifications requirements in this Section's "Field Quality Control" Article.
- C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
 - a. Submit for pipe and piping system components in accordance with Section 01 78 23 - Operation and Maintenance Data.
 2. Record Documentation:
 - a. Submit record documents of piping layout Shop Drawings showing and indicating changes made during fabrication and installation, in accordance with Contract Modifications, allowance authorizations (if any), and field conditions encountered. Such Submittal is in addition to record documents required under Section 01 77 19 – Closeout Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Dielectric flange kit:
 - a. PSI.
 - b. Maloney.
 - c. Central Plastics.
 - d. Or equal.
 2. Pipe saddles (for gage installation):
 - a. Dresser Style 91 (steel and ductile iron systems).
 - b. Or equal.
 3. Dismantling Joint
 - a. Romac DJ400.
 - b. Smith Blair 972.
 - c. Or equal.

2.2 PIPING SCHEDULE

- A. Piping system materials are shown on the drawings

2.3 COMPONENTS AND ACCESSORIES

- A. Insulating Components:
1. Dielectric flange kits:
 - a. Flat faced.
 - b. 1/8 inches thick dielectric gasket, phenolic, non-asbestos.
 - c. Suitable for pressures indicated on the drawings.
 - d. 1/32 inches wall thickness bolt sleeves.
 - e. 1/8 inches thick phenolic insulating washers.
 - f. See Section 26 42 17 for additional requirements

B. Reducers:

1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
2. Connection size requirements may change from those shown on Drawings depending on equipment furnished.

C. Protective Coating and Lining:

1. See Sections 09 90 04 and 09 90 05 for required coatings.

D. Underground Warning Tape:

1. See Sections 10 14 00 - Identification Devices and 32 23 33 Utilities – Trenching and Backfilling.

E. Pressure Gages:

1. Comply with Section 40 73 00 - Pressure Instrumentation.

F. Valves:

- a. See individual valve specifications
- b. See Section 40 05 51 - Common Requirements for Process and Utility Valves.

2.4 WATER

A. Water for Testing:

1. Comply with reference standards indicated for required types of testing in this Section's "Field Quality Control" Article, for associated types of pipe, unless otherwise required in the Contract Documents.
2. Project-Specific Water Source(s):
 - a. The following may be used as source(s) of water for testing:
 - 1) North Weld County Water District (NWCWD) distribution system.
 - a) 8" Main along CR 52.
 - b) Contractor is responsible for all temporary piping and permits needed to connect water supply to pipeline section(s) for filling.
 - c) New hydrant required
 - (1) Contractor to coordinate with NWCWD for location, materials and connection approval.
 - d) Backflow preventer required
 - e) Maximum fill rate shall not exceed 1,800 gallons per minute.
 - (1) Coordinate with NWCWD as they may require a lower withdraw rate in order to maintain distribution system pressures.
 - 2) Larimer County Canal (LCC).
 - a) Coordinate with LCC and City of Thornton for seasonal availability of water
 - b) Contractor will have to supply pump, temporary piping and power to move water from canal to pipeline.
 - c) Maximum fill rate shall not exceed 1,800 gallons per minute
 - b. Do not use water source not acceptable to Engineer (following Engineer's consultation with Owner or Owner's Construction Manager).
3. Limitations on Water Conveyance Rates:
 - a. In addition to limitation(s), if any, on rate of water withdrawal from source, indicated above, maximum rates of water conveyance through temporary equipment and materials shall:
 - 1) Not cause damage or erosion at point of discharge. Provide appropriate energy-dissipating materials as necessary.

- 2) Not cause temporary equipment and materials used for conveyance to exhibit undue strain or movement during operation.
4. Temporary Equipment and Materials for Conveyance of Water for
 - a. Provide, operate, and maintain temporary equipment and materials necessary for conveying water used for testing, including conveyance to piping and discharge from piping.
 - b. Sizes, capacity, and materials of temporary equipment shall be suitable for the intended purpose and Contractor's means, methods, procedures, techniques, and sequences of construction.
 - c. Provide temporary piping, couplings, valves, pumps, and appurtenances necessary.
 - d. Temporary Flow Meter: Provide on temporary piping used for withdrawing water from source a temporary flow meter, calibrated within the past 12 months by technician certified by flow meter manufacturer, to continuously measure and record flow rate. During water withdrawal from source, allow Engineer and Owner continuous access to temporary flow meter. Supervise and monitor water withdrawal and filling of piping. Record for each withdrawal: Time water withdrawal commenced and was completed, total volume of water withdrawn, and maximum flow rate recorded during withdrawal process. Include with Submittal of results of testing a copy of flow meter calibration and copy of conveyance monitoring data required in this paragraph.
5. Temporary Backflow Prevention:
 - a. At each location where potable water is withdrawn for testing, install and use temporary backflow preventer on water source, to prevent contamination of the water source.
 - b. Contractor shall furnish temporary, reduced-pressure zone type backflow preventers as necessary and required. Each temporary backflow preventer shall have been certified, within the past 12 months, by a backflow preventer technician certified in accordance with Laws and Regulations. Include in testing plan Submittal a copy of backflow preventer certification.

PART 3 - EXECUTION

3.1 BURIED PIPING INSTALLATION

- A. Unless otherwise shown on the Drawings, provide a minimum of 5 feet of earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.
- B. Laying Pipe In Trench:
 1. Perform excavation and backfilling in accordance Section 31 23 33 - Trenching and Backfilling
 2. Clean each pipe length thoroughly and inspect for compliance to specifications.
 3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
 4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
 5. Lay pipe in only suitable weather with good trench conditions.
 - a. Never lay pipe in water except where approved by Engineer.
 6. Seal open end of line with watertight plug if pipe laying stopped.
 7. Remove water in trench before removal of plug.
- C. Lining Up Piping:
 1. Lay piping on route lines shown on Drawings.
 2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets in accordance with approved lay drawings.
 3. Place Pipe Zone and Trench Zone fill to limit maximum deflection to values stated in pipe material specifications.

4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
 5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.
- D. Install underground hazard warning tape as shown on the Drawings.
- E. Install insulating components where dissimilar metals are joined together and where shown on the Drawings.

3.2 NON-BURIED PIPING INSTALLATION

- A. Install piping in vertical and horizontal alignment as shown on Drawings.
- B. Alignment of piping smaller than 4 inches may not be shown; however, install according to Drawing intent and with clearance and allowance for:
1. Expansion and contraction.
 2. Operation and access to equipment, doors, windows, hoists, moving equipment.
 3. Headroom and walking space for working areas and aisles.
 4. System drainage and air removal.
- C. Enter and exit through structure walls, floor and ceilings using penetrations and seals as shown on the Drawings.
- D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.
- E. Pipe Support:
1. Use methods of piping support as shown on Drawings.
 2. Provide drainage for process piping at locations shown on Drawings in accordance with Drawing details.
 3. For applications defined above and for other miscellaneous piping which is not addressed by a specific piping service category in PART 1, provide galvanized piping and fittings.
 - a. Size to handle application with 3/4 inches being minimum size provided.
- F. Unions:
1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.
 2. Mechanical type couplings may serve as unions.
 3. Additional flange unions are not required at flanged connections.
- G. Provide full face gaskets on all systems.
- H. Anchorage and Blocking:
1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.
- I. Equipment Pipe Connections:
1. Equipment - General:
 - a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
 - b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
 - c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
 - 1) Provide tightening torque in accordance with manufacturer's recommendations.

- d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
- e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
- f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
- g. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
 - 1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
 - 2) Realign as necessary, install flange bolts and make equipment connection.
- J. Provide insulating components where dissimilar metals are joined together.
- K. Instrument Connections:
 - 1. See drawing details.

3.3 CONNECTIONS WITH EXISTING PIPING

- A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.
- B. Perform connections with existing piping at time and under conditions which will least interfere with service to customers affected by such operation.
- C. Undertake connections in fashion which will disturb system as little as possible.
- D. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.
- E. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.
- F. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.4 PRESSURE GAGES

- A. Provide at locations shown on the Drawings and specified.
- B. Comply with Section 40 73 00 – Pressure Instrumentation.

3.5 FIELD QUALITY CONTROL

- A. Field Testing of Piping - General:
 - 1. Test at the Site, following piping installation, all piping, except as expressly indicated otherwise elsewhere in the Contract Documents.
 - 2. Perform testing of piping in presence of Engineer or Owner's Construction Manager.
 - 3. Provide construction equipment and machinery, apparatus, and services necessary, required, or both, for field testing of piping, including:
 - a. Test pumps, compressors, hoses, temporary piping, calibrated monitoring and indicating devices, meters, test containers, valves, fittings, and temporary pumping systems required to maintain facility and system operations.
 - b. Temporary bulkheads, bracing, blocking, and thrust restraints.
 - 4. When fuel is needed to operate temporary pumps for testing and related operations, provide fuel as necessary.
 - 5. Contractor shall provide means to convey water for hydrostatic testing into piping being tested.

6. Remedy observed and apparent leaks and remedy piping failing to comply with required acceptance criteria. Retest after implementing remedies until acceptable test results are obtained.
 7. Unless otherwise shown or indicated, field testing of piping shall exclude existing piping systems connecting to new piping being tested.
 8. Test Pressures:
 - a. Pipe shall be hydrostatically tested.
 - b. The required pressure gradient elevation is shown on the drawings in the Hydraulic Profile Sheet in the Drawings.
 - 1) The required test pressure at the point of measurement shall be equivalent to the difference in elevation between the required test gradient line and the elevation at the point of measurement.
 9. Scheduling and Sequencing of Field Testing of Piping:
 - a. Test exposed, non-insulated piping, and obtain Engineer's acceptance of results, as condition precedent to requesting Substantial Completion of such piping.
 - b. Test exposed, insulated piping following installation of such piping and prior to insulation installation.
 - c. Test concealed interior piping prior to concealment and, if piping is insulated, prior to insulation installation.
 - d. Test buried piping after backfilling.
 10. Instrumentation Used for Field Testing of Piping:
 - a. Perform field testing of piping systems that will operate under pressure or vacuum using calibrated pressure or vacuum measuring equipment, as applicable, and calibrated volumetric measuring equipment. Such calibrations shall have been issued not more than six months prior to the testing for which they are used.
 - b. Required value of parameter to be measured shall be in upper half of range of the associated item of pressure-, vacuum-, volume-measurement, and other measuring instrumentation used in field testing of piping.
- B. Hydrostatic Testing of Piping:
1. Preparation for Testing:
 - a. For steel pipe, comply with procedures in AWWA Manual M11, and the Contract Documents.
 - b. For other piping, comply with procedures in AWWA Manual M41, and the Contract Documents.
 - c. Prior to testing, provide adequate thrust restraint and verify joints are properly installed.
 2. Test Procedure:
 - a. Fill piping slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
 - b. Expel air from piping as necessary. Do not tap pipe for expelling air.
 - c. Examine exposed joints and valves and remedy to eliminate visible or otherwise apparent leakage.
 - d. After required wetting period, add water as necessary to pressurize piping to required test pressure. Maintain test pressure for stabilization period of ten minutes before beginning testing.
 - e. Timed test period shall not begin until after piping is filled, exposed to required wetting period (if any), air is expelled, and pressure stabilized.
 - f. Timed Test Period: After stabilization period, maintain test pressure for not less than two hours. During timed testing period, add water as necessary to maintain pressure within five psig of required test pressure. Test pressure shall remain steady for one hour, indicating no leakage.

- g. Pump from test container to maintain test pressure. Measure volume of water pumped from test container and record on test report. Record pressure at test pump at 15-minute intervals for duration of test.
 3. Allowable Leakage Rates: Leakage is defined as the quantity of water supplied to pipe segment being tested to maintain pressure within five psig of test pressure during timed test period. Allowable leakage rates for piping are:
 - a. Steel Pipe: No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
 - b. Ductile Iron Pipe: Rates based on formula or table in AWWA Manual M41:
 - 1) Pipe joined with rubber gaskets as sealing members, including the following joint types:
 - a) Bell and spigot and push-on joints.
 - b) Mechanical joints.
 - c) Bolted sleeve type couplings.
 - d) Grooved or shouldered couplings.
 4. Record date, time, and location of each test, indicating piping segment tested, general description of apparatus used, pressure and leakage measurements obtained, remarks concerning conditions encountered during testing of each pipe segment, whether each pipe segment successfully passed the test, and names and employers of individuals performing and witnessing such testing. Furnish such results as Submittal.
- C. "Out-of-Roundness" Deflection Testing for Steel Pipe:
1. Within 5 days of completing backfilling, check each section of pipe for "out-of-roundness" deflection.
 2. Test Procedure:
 - a. Mandrel: Use rigid ball or mandrel for testing, which shall have diameter that will not pass if pipe is deflected more than allowable as described in Section 33 05 24. Perform test without mechanical pulling devices.
 3. Test Results:
 - a. If measuring device passes through pipe without obstruction, piping passes the test.
 - b. When pipe fails testing, re-excavate and re-round piping that failed test. Re-perform testing until acceptable results are obtained.
 - c. Record date, time, and location of each test, indicating piping segment tested, general description of measuring device used, remarks concerning conditions encountered during testing of each pipe segment, whether each pipe segment successfully passed the test, and names and employers of individuals performing and witnessing such testing. Furnish such results as Submittal.
- D. Examination of Welds for Piping:
1. Personnel performing examination of welds shall be qualified to not less than Level II in accordance with ASNT SNT-TC-1A.
 2. Comply with ASME Boiler and Pressure Vessel Code Section V, "Nondestructive Examination", and applicable articles for examination of welds.
 3. See Section 33 05 24.
 4. If defect is detected in the proportion of welds indicated immediately above, examine all welds by liquid penetrant examination.
 5. Upon completion of liquid penetrant examination, remove penetrant test materials by flushing, washing, or wiping clean with suitable solvents.
 6. Record date, time, and location of each test, indicating piping segment and welds tested, general description of procedure used, remarks concerning conditions encountered during testing of each weld, whether each weld successfully passed the test, and names and employers of individuals performing and witnessing such testing. Furnish such results as Submittal.

E. Dielectric Testing of Piping:

1. Provide electrical check between metallic non-ferrous pipe and appurtenances and ferrous elements of the Work to verify electric and dielectric discontinuity.
2. Procedure:
 - a. Visually inspect piping to be tested for apparent defects or damage. Remedy apparent defects and damage before proceeding with testing.
 - b. Ensure personnel are aware of testing and Contractor's safety precautions are in place.
 - c. Isolate piping from electrical grounding, casings, dissimilar metals, and where isolation is required. Visually inspect isolators to confirm installation of hardware.
 - d. Provide mechanical joints with not less than two conductors or welded clips per joint. More than two conductors per joint will be necessary for larger-diameter pipe.
 - e. Perform testing in accordance with AMPP NACE SP0286.
 - f. Options for Testing Joint Bonds: Perform one of the following, at Contractor's option:
 - 1) Digital Low-resistance ohm Meter:
 - a) Perform testing using digital low-resistance ohm meter.
 - b) Criteria for Acceptance: Remedy unacceptable transmittance of electrical current when ohms transmitted exceed 110 percent of theoretical.
 - c) Following implementation of remedy, retest piping segment until acceptable results are obtained.
 - 2) Circulating Current Test:
 - a) Perform circulating current test, by providing battery to circulate electric current, while measuring voltage drop of piping segment tested.
 - b) Subsequently calculate and report linear resistance.
 - c) Criteria for Acceptance: When linear resistance exceeds theoretical value, piping segment fails the test.
 - d) Subsequently electrically isolate and retest to identify locations of leakage current. Remedy and retest entire piping segment until acceptable results are obtained.
 - g. Document test results, including date, time, location of piping segment tested, results of visual inspections, test voltage, duration, leakage current, results of associated calculations (when applicable), observations, results of testing (whether piping segment passed or failed), remedies implemented, and results of retesting (if any), and names and employers of personnel performing and witnessing testing. Furnish results as Submittal.
 - h. Immediately following testing, properly discharge residual voltage from piping before handling. Reconnect piping segment tested to balance of piping system.

F. Manufacturer's Services:

1. Provide services of pipe manufacturer's qualified, factory-trained pipe installation specialist when pipe installation commences for:
 - a. Steel pipe.

3.6 CLEANING

A. Cleaning of Piping:

1. Cleaning of Piping – General:
 - a. Clean interior of piping systems thoroughly before installing.
 - b. Before jointing piping, thoroughly clean and wipe joint contact surfaces and properly dress and make joints.
 - c. Maintain pipe in clean condition during installation.
 - d. Cap or plug openings in pipe at end of each workday. Prevent entry of dirt, dust, particulates, water, humans, animals, and insects.

- e. Following installation, piping 24-inch diameter and larger shall be inspected from inside and debris, dirt, and foreign matter removed.
- f. Following installation, thoroughly clean all piping.

3.7 LOCATION OF BURIED OBSTACLES

- A. Furnish exact location and description of buried utilities encountered and thrust block placement.
- B. Reference items to definitive reference point locations such as found property corners, entrances to buildings, existing structure lines, fire hydrants and related fixed structures.
- C. Include such information as location, elevation, coverage, supports and additional pertinent information.
- D. Incorporate such information on Record Drawings required under Section 01 77 19 – Closeout Requirements.

3.8 PIPE MATERIAL SUMMARY

- A. Pipe Materials are defined in the Drawings.

END OF SECTION

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SECTION 40 05 51
COMMON REQUIREMENTS FOR PROCESS AND UTILITY VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Valving and valving appurtenances.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 01 78 23 – Operation and Maintenance Data
 - 2. Section 09 90 04 - Painting.
 - 3. Section 40 05 01 - Common Work Results for Process Piping.
 - 4. Section 40 05 57 - Actuators for Process Valves and Gates.
 - 5. Section 40 05 52 - Miscellaneous Valves.
 - 6. Section 40 05 61 - Gate Valves.
 - 7. Section 40 05 62 - Plug Valves.
 - 8. Section 40 05 63 - Ball Valves.

1.2 REFERENCES

- A. Definitions:
 - 1. The following are definitions of abbreviations used in this Specification Section or one of the individual valve sections:
 - a. CWP: Cold water working pressure.
 - b. RW: Raw Water
 - c. SWP: Steam working pressure.
 - d. WOG: Water, oil, gas working pressure.
 - e. WWP: Water working pressure.
- B. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B1.20.1, Pipe Threads, General Purpose.
 - b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
 - d. B16.34, Valves-Flanged, Threaded and Welding End.
 - 2. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
 - c. D638, Standard Test Method for Tensile Properties of Plastics.
 - d. D648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
 - e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
 - f. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
 - 3. American Water Works Association (AWWA):
 - a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.

- b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
- c. C504, Standard for Rubber-Seated Butterfly Valves.
- d. C507, Standard for Ball Valves, 6 inches through 48 inches (150 mm through 1200 mm).
- e. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
- f. C550, Standard for Protective Coatings for Valves and Hydrants.
- g. C606, Standard for Grooved and Shouldered Joints.
- 4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
 - a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- 5. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. MG 1, Motors and Generators.
- 6. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Shop Drawings:
 - a. See Section 40 05 57 - Actuators for Process Valves and Gates.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Valve pressure and temperature rating.
 - d. Valve material of construction.
 - e. Special linings.
 - f. Valve dimensions and weight.
 - g. Valve flow coefficient.
- B. Informational Submittals:
 - 1. Test reports if required in the individual valve specification.
- C. Closeout Submittals:
 - 1. Operation and Maintenance Data:
 - a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

- A. Refer to individual valve Specification Sections.

2.3 FABRICATION

- A. End Connections:
 - 1. Provide the type of end connections as shown on the Drawings.
 - 2. Comply with the following standards:
 - a. Threaded: ASME B1.20.1.

- b. Flanged: ASME B16.1, Class 150 unless otherwise noted or AWWA C207.
 - c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
- B. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.
- C. Nuts, Bolts, and Washers:
 - 1. Wetted or internal to be bronze or stainless steel.
 - a. Exposed to be zinc or cadmium plated.
 - 2. Buried:
 - a. Tee-Head bolts for mechanical joints: Per AWWA/ANSI C111/A21.11.
 - b. Other bolts and nuts: ASTM A307 ASTM A193/A194 Grade B8 Class 1.
 - c. Wax Tape Coatings per AWWA C217.
 - 3. Exposed: Mechanical galvanized ASTM B695, Class 40 ASTM A193/A194 Grade B8, Class 1.
 - 4. Heads and dimensions per ASME B1.1.
 - 5. Threaded per ASME B1.1.
 - 6. Project ends 1/4 to 1/2 inches beyond nuts.
- D. On Insulated Piping: Provide valves with extended stems to permit proper insulation application without interference from handle.
- E. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Painting Requirements: Comply with Section 09 90 04.
- C. Setting Buried Valves:
 - 1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
 - 2. Set valves and valve boxes plumb.
 - 3. Place valve boxes directly over valves with top of box being brought to surface of finished grade.
 - 4. Install in closed position.
 - 5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
 - 6. After installation, backfill up to top of box for a minimum distance of 4 feet on each side of box.
- D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.
- E. Wax Tape Coating System:
 - 1. After installation, coat all buried nuts and bolts with a wax tape coating system in accordance with:
 - a. AWWA C217.
 - b. Manufacturer's printed instructions.
 - 2. Cut strips of wax tape and apply them around all bolts and nuts so that there are no voids or spaces under the tape.
 - 3. Apply a sufficient amount of tape to completely encapsulate all bare metal.
- F. For threaded valves, provide union on one side within 2 feet of valve to allow valve removal.

G. Install valves accessible for operation, inspection, and maintenance.

3.2 FIELD QUALITY CONTROL

A. Wax Tape Coating Testing:

1. Inspect each wax tape-wrapped component.
 - a. Verify primer was applied to substrate surfaces.
 - b. Ensure the wax tape has fully encapsulated all portions of the substrate.
 - c. Ensure that the wax tape is in intimate contact with the substrate.
 - d. Verify that the wax tape has been applied to the specified thickness.
2. Do not backfill until this inspection is complete and the wax tape application is approved by the Engineer.

3.3 ADJUSTMENT

A. See section 40 05 57 for adjustment requirements.

3.4 VALVE SCHEDULE

A. See tables in drawing details

END OF SECTION

SECTION 40 05 52
MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Air release and vacuum relief valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 01 61 00 - Common Product Requirements.
 - 2. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
 - 2. American Water Works Association (AWWA):
 - a. C512, Standard for Air-Release, Air-Vacuum, and Combination Air Valves for Waterworks Service.
 - b. C550, Standard for Protective Interior Coatings for Valves and Hydrants.
 - 3. Canadian Standards Association (CSA).
 - 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00B and Section 40 05 51.
- B. Action Submittals
 - 1. Dimensioned fabrication Drawings showing the entire assembly including, but not limited to, a materials list, sizes, piping connections, ASTM designations where appropriate, thicknesses, materials of construction, gasket/seal materials, and description of major components and other structural members, appurtenances, and devices.
 - 2. Performance data for each device over the specified range of pressure, capacity and flows.
 - 3. Installation procedures.
 - 4. Factory test reports.
 - 5. Manufacturer affidavit of compliance to the specifications and requirements herein.
 - 6. Valve Submittal Requirements
 - a. Valve name, size, parts, materials, pressure rating, identification number (station) and specification section number.
 - b. Manufacturer calculations in sizing.
 - c. Assembly drawings showing relationships of moving parts, connections, and mounting.
 - d. Lining and coating product literature.
 - e. A tabular valve schedule indicating the station and model number of proposed valve to be installed at each station including, pressure rating classification, nominal size, and AWWA flange class.
 - f. f. Manufacturer certified material and pressure test performance reports.
- C. Contract Closeout Information:

1. Operation and Maintenance Data:
 - a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 AIR RELEASE AND VACUUM RELIEF VALVES

A. Air Valves - General:

1. Comply with AWWA C512.
2. Isolation Valves: For each combination air valve, provide isolation valve where the air valve connects to the process pipe.
 - a. Provide appropriate connection to the process pipe, such as tee fitting, or other connection approved by Engineer.
 - 1) Isolation valves' type(s) shall be as shown or indicated in the Contract Documents.
 - 2) Unless indicated otherwise in the Contract Documents, isolation valve shall be same materials required for associated air valve and appropriate for the valve's service, environment, and use.
 - 3) Where isolation valve size is not expressly shown or indicated, unless otherwise recommended in writing by air valve manufacturer and approved by Engineer, isolation valve diameter shall be the same as nominal size of associated air valve.
 - 4) Isolation valves shall have rigid-type connections to process pipe and air valve, that support disassembly for maintenance and troubleshooting.

B. Combination Air Release And Vacuum Relief Valves – Solid Cylindrical Floats Type

1. Description and Service
 - a. The large orifice shall allow air to escape during pipeline filling and allow air intake during pipeline draining. Valve shall close watertight when liquid enters the valve.
 - b. The small orifice shall release air accumulations after the pipeline is filled, under pressure, and in operation.
 - c. Equipped with an integral surge alleviation mechanism that automatically dampens surge pressures due to rapid air discharge or the subsequent rejoining of separated water columns.
 - d. Manufacturer:
 - 1) RF Valves, Vent-O-Mat RBX series,
 - 2) International Valve, Vent-Tech WTR-C series.
2. Valve Body
 - a. Compact, tubular, single-chamber, 304 Stainless Steel Barrel, Tie Rods, and hardware.
 - b. Top and Bottom Flanges: Mild Steel, Fusion Bond epoxy coated.
 - c. 316 Stainless Steel Nozzle.
 - d. ABS Polyloc Top Cover.
 - e. Body secured by stainless steel 304 tie rods, bolts, and nuts.
3. Size: As shown in the Drawings.
 - a. Rated Maximum Operating Pressure to be determined based on project specific information.
4. End Connections: Flanged or Threaded as shown on the Drawings
 - a. Flanged: ANSI B16.5 Class 150
 - b. Threaded: NPT Male, ASME B1.20.1.
5. Bolting Material: Flange connection bolts and nuts shall be stainless steel per ASTM A276, Type 304.
6. Internal Parts

- a. Floats: High density polyethylene
- b. Screws: Stainless steel 304
- c. Top cover: Plastic
- d. Nozzle: Stainless steel 304
- e. O-ring seal: Nitrile rubber
- f. Nozzle seat: Rubber
- g. O-ring seat: Nitrile rubber
- h. Other wetted internal parts: 304 stainless steel
- 7. Appurtenances
 - a. Equipped with 1/4-inch NPT female test cock connection.
- 8. Design requirements:
 - a. Size: As shown on the Drawings.
 - b. Working pressure: 250 psig.
 - c. Working pressure plus transient pressure: 300 psi
 - d. Release 381 scfm at 2 psig differential at 250 psig pressure in associated piping.
 - 1) Air vacuum capacity: 230 SCFM at 3.5 psi differential from atmospheric.
 - e. Provide control for slow release of air through valve to prevent valve slamming shut from excessive air or water velocity through valve.
 - f. Orifice sizing as shown on drawings
- 9. Lining and Coating
 - a. Epoxy lining: Tnemec Potopox 140 F or approved equivalent.
 - b. Except for machined surfaces, shop-coat with a two-part thermosetting polyamide epoxy in two or more uniform coats to a minimum dry film thickness of 7 to 12 mils.
 - c. Flange faces: Shop-coat with a rust preventative compound.

2.2 ACCESSORIES

- A. Furnish any accessories required to provide a completely operable valve.

2.3 FABRICATION

- A. Completely shop assemble unit including any interconnecting piping, speed control valves, control isolation valves and electrical components.
- B. Provide internal epoxy coating suitable for potable water for all iron body valves in accordance with AWWA C550.

2.4 SOURCE QUALITY CONTROL

- A. Shop hydrostatically test to 300 psi.

2.5 MAINTENANCE MATERIALS

- A. Provide one set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: See Specification Section 01 61 00 and Specification Section 40 05 51.

3.2 FIELD QUALITY CONTROL

- A. Clean, inspect, and operate valve to ensure all parts are operable and valve seats properly.
- B. Check and adjust valves and accessories in accordance with manufacturer's instructions and place into operation.

END OF SECTION

SECTION 40 05 57
ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Actuators for valves and gates.
 - a. Manual actuators.
 - b. Electric actuators.
 - c. Cylinder actuators.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 01 61 00 - Common Product Requirements.
 - 2. Section 01 81 33 - Cyber Security Requirements.
 - 3. Section 09 90 04 - Painting.
 - 4. Section 33 05 81 - Metallic Castings for Utility Structures.
 - 5. Section 40 05 51 - Common Requirements for Process and Utility Valves.
 - 6. Section 40 05 52 - Miscellaneous Valves.
 - 7. Section 40 05 61 - Gate Valves.
 - 8. Section 40 05 62 - Plug Valves.
 - 9. Section 40 05 63 - Ball Valves.

1.2 REFERENCES

- A. Definitions:
 - 1. The following are definitions of abbreviations used in this Section:
 - a. CPU: Central Processing Unit.
 - b. NRTL: Nationally Recognized Testing Laboratory.
 - c. OEM: Original Equipment Manufacturer.
 - d. OIT: Operator Interface Terminal.
- B. Referenced Standards:
 - 1. American National Standards Institute/Underwriters Laboratory (ANSI/UL):
 - a. 429, UL Standard for Safety Electrically Operated Valves.
 - b. 50, UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
 - c. 50E, UL Standard for Safety Enclosures for Electrical Equipment, Environmental Considerations.
 - 2. ASTM International (ASTM):
 - a. A266, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - b. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - d. A564, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
 - e. A693, Standard Specification for Precipitation-Hardening Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 - 3. American Water Works Association (AWWA):

- a. C500, Standard for Metal-Seated Gate Valves for Water Supply Valves.
- b. C541, Standard for Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
- c. C542, Standard for Electric Motor Actuators for Valves and Slide Gates.
- d. C550, Standard for Protective Coatings for Valves and Hydrants.
- e. C560, Standard for Cast-Iron Slide Gates.
- f. C561, Standard for Fabricated Stainless Steel Slide Gates.
- g. C562, Standard for Fabricated Aluminum Slide Gates.
- h. C563, Standard for Fabricated Composite Slide Gates.
- 4. National Electrical Manufacturers Association (NEMA):
 - a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
 - b. MG 1, Motors and Generators.
- 5. National Fire Protection Association (NFPA):
 - a. 70, National Electrical Code (NEC).

1.3 QUALITY ASSURANCE

A. Qualifications:

- 1. Manufacturer: actuator manufacturers must have at least 100 installations with each type of proposed actuators.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

- 1. Provide actuators that are fully compatible with valve or gate for which it is intended.
- 2. Contractor to coordinate valve/gate manufacturer and actuator manufacturer for proper sizing of actuator.
 - a. See below for safety factors.
- 3. Mounting hardware by actuator manufacturer.
- 4. Install actuators at valve/gate manufacturers facility to allow for testing prior to shipping to site.

1.5 SUBMITTALS

A. Action Submittals:

- 1. Shop Drawings.
 - a. Layout drawings with dimensions.
 - 1) Include those dimensions necessary for interfacing with valve/gate.
 - b. Include wiring and control diagrams for electric, cylinder actuators, and electro-hydraulic actuators.
- 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Torque or thrust output.
 - c. Travel speed.
 - d. Input power (voltage, phase, frequency).
 - e. Input current draw.
 - f. Control methodology.
 - g. Control Accessories.
 - h. Short Circuit Current Rating (SCCR) nameplate marking in accordance with NFPA 70.
 - 1) Include any required calculations in accordance with Section 01 61 00.

3. Samples of the factory finish colors available at no additional cost to Owner for selection by Engineer.
 4. Test reports.
- B. Informational Submittals:
1. Manufacturer's installation instructions.
 2. Acknowledgement that the Manufacturer meets the number of installations criteria.
 - a. Submit for each different manufacturer.
 - b. Submit detailed installation list if requested by Engineer.
 3. Recommended storage procedures.
 4. Certificate of Proper Installation that includes verification from actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the actuator responds correctly to the position command.
 5. Test Reports.
- C. Closeout Information:
1. Operation and Maintenance Data:
 - a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - b. Lubrication Guide.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Manual Valve Actuators:
 - a. By valve manufacturer.
 2. For other types of actuators, refer to the individual article for that actuator type for acceptable manufacturers.

2.2 MATERIALS

- A. Refer to individual Articles for materials.

2.3 VALVE ACTUATORS

- A. Valve Actuators - General:
1. Provide actuators as shown on Drawings or specified.
 2. Counter-clockwise opening as viewed from the top.
 3. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
 - a. Paint in a contrasting color such as white.
 4. Size actuator to produce required torque with a maximum pull of 80 pounds at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 pounds on handwheel or chainwheel or 300 foot-pounds torque on the operating nut.
 5. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.
 6. Valve Lockout Devices:
 - a. Device manufactured from same material as valve actuator, preventing access to valve actuator, to accept lock shackle.
 7. Extension stem:
 - a. Install where shown or specified.

- b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
 - c. Pin all stem connections.
 - d. Center in valve box or grating opening band with guide bushing.
 - e. Universal Joint for Valve Extension Stems Under Deflection:
 - 1) Description:
 - a) Where valve operating stem extensions have potential to be offset from alignment of valve operating stem by greater than five degrees, provide universal joint-type flexible, mechanical connection between valve stem and stem extension, to properly accommodate angular misalignment.
 - b) Suitable for buried and exposed valve stem extensions.
 - 2) Performance Criteria:
 - a) Capable of transmitting required torque without backlash or slippage.
 - b) Suitable for withstanding torque of not less than 500 foot-pounds without failure or permanent deformation.
 - c) Suitable for 1,000 full articulation cycles under load without loss of function or excessive wear.
 - d) Suitable for accommodating angular misalignment of up to 15 degrees in any direction.
 - 3) Materials:
 - a) Body and Yokes: Type 316 stainless steel.
 - b) Pins and Fasteners: Type 316 stainless steel.
 - c) Stainless steel components shall be passivated for corrosion resistance.
 - d) Bushings, when applicable: Bronze or self-lubricating polymer suitable for buried service.
 - 4) Fabrication:
 - a) Keyed, pinned, or bolted connection interfaces, preventing rotation slippage.
 - b) Joint shall fit within associated valve box or extension casing.
 - c) Seal or shield joints to prevent ingress of soil, water, and other matter.
 - d) Foster easy field assembly and disassembly using standard tools.
 - e) Compatible with extension stems and valve stems of sizes ranging from 0.5-inch to 2 inches square or round, as required.
 - 8. Coatings: Provide actuator manufacturer's standard factory finish suitable for long-term exposure in the installation environment at final location at the Site.
- B. Buried Valve Actuators:
- 1. Provide 2 inch standard actuator nuts in accordance with AWWA C500, Section 3.16.
 - 2. Provide at least 2 tee handle keys for actuator nuts, with 5 feet extension between key and handle.
 - 3. Extension stem:
 - a. Provide for buried valves greater than 4 feet below finish grade.
 - b. Extend to within 6 inches of finish grade.
 - 4. Cast Iron Valve Box:
 - a. Comply with requirements for valve boxes and covers in Section 33 05 81 - Metallic Castings for Utility Structures.
 - 5. Box base to enclose buried valve gear box or bonnet.
 - 6. Provide concrete pad encasement of valve box as shown on Drawings for all buried valves unless shown otherwise.
- C. Exposed Valve Manual Actuators:

1. Provide for all exposed valves not having electric, cylinder or electro-hydraulic actuators.
 2. Provide handwheels for gate and globe valves.
 - a. Size handwheels for valves in accordance with AWWA C500.
 3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 inches diameter and smaller.
 - a. Provide lever actuators for butterfly valves with a minimum of five intermediate lock positions between full open and full close.
 - b. Provide at least two levers for each type and size of valve furnished.
 4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 inches diameter and larger.
 5. Provide gearing for gate valves 20 inches and larger in accordance with AWWA C500.
 6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
 7. Provide chain actuators for valves 6 feet or higher from finish floor to valve centerline.
 - a. Cadmium-plated chain looped to within 3 feet of finish floor.
 - b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
 - c. For smaller valves with lever or handle actuators, provide offset tee handles with attached chain for operation from the operating floor.
 - d. Provide chain storage device for each chain.
 - 1) Chain-Away Bucket by Chain Away Corporation.
 - 2) Chain-Up by Trumbull Manufacturing.
 - 3) Or equal.
 8. Provide cast iron floor stands where shown on Drawings.
 - a. Stands to be furnished by valve manufacturer with actuator.
 - b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.
- D. Source Quality Control – General:
1. Actuators for Valves: Prior to shipping equipment from the production or fabrication facility, perform manufacturer's standard factory tests and inspections and submit documentation of successful completion to Engineer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Location and Orientation:
 1. Provide actuators and operators as shown on the Drawings.
 2. When not expressly shown on the Drawings, orient valve actuators so valve operator is in a position reasonably convenient for facility personnel.
 - a. Unless otherwise shown, install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.
 3. When orientation of actuator, operator location, or both are unclear, submit to Engineer a request for interpretation and obtain Engineer's response before furnishing the associated Submittal and in no event, later than purchasing the associated valve and actuator.
 4. Contractor is responsible for costs and delays incurred to remedy valve actuators furnished or installed in inconvenient or difficult-to-access positions and locations unless the Contract Documents require otherwise.
 5. Contractor is not responsible for providing permanent platforms, stairs, or other extraordinary, permanent access measures unless so required by the Contract Documents.

C. Touch Up Painting Requirements:

1. Repair scuffs and scratches on factory-applied finishes using materials furnished by the actuator manufacturer, applied in accordance with the written instructions of both the actuator manufacturer and the Supplier of the touch-up material(s).

- D. Install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.

3.2 FIELD QUALITY CONTROL

- A. Demonstrate that all powered valves operate properly after installation.

3.3 ADJUSTMENT

- A. Adjust valves/gates, actuators, and appurtenant equipment to comply with Section 01 75 00.

1. Operate valve, open and close at system pressures.

END OF SECTION

SECTION 40 05 61

GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gate valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. American Water Works Association (AWWA):
 - a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - b. C504, Standard for Rubber-Seated Butterfly Valves.
 - c. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
 - d. C515, Standards for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Systems.
 - 3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
 - b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
 - c. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 DEFINITIONS

- A. NRS: Non-rising Stem.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, NON-POTABLE, AND WASTEWATER)

- A. Resilient Wedge Gate Valves, 2 to 48 inches (Water, Wastewater Application):
 - 1. Comply with AWWA C515.
 - 2. Materials:

- a. Stem and stem nut: Bronze.
 - 1) Wetted bronze parts in low zinc bronze.
 - 2) Aluminum bronze components: Heat treated per AWWA C504.
- b. Body, gate: Ductile iron.
- c. Resilient wedge: Fully encapsulated rubber wedge Ethylene Propylene Diene Monomer (EPDM).
- 3. Design requirements:
 - a. Minimum 250 PSIG working pressure.
 - b. Buried: NRS, O-ring stem seal, 2 inches square operating nut.
 - c. Exposed: NRS, O-ring, stem seal, handwheel.
 - d. Counter clockwise open rotation.
 - e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
 - 1) Comply with AWWA C550.
 - 2) Wetted bronze parts in low zinc bronze.
 - 3) Aluminum bronze components: Heat treated per AWWA C504.
- 4. Manufacturers:
 - a. Clow.
 - b. Mueller.
 - c. American Flow Control.
 - d. M & H.

2.3 ACCESSORIES

- A. Refer to Drawings for type of actuators.
 - 1. Furnish actuator integral with valve.
- B. Refer to Specification Section 40 05 51 for actuator requirements.

2.4 FABRICATION

- A. General:
 - 1. Provide valves with clear waterways the full diameter of the valve.
- B. Spot valves in accordance with MSS SP-9.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Specification Section 40 05 51.
- B. Do not install gate valves inverted or with the stems sloped more than 45 degrees from the upright unless the valve was ordered and manufactured specifically for this orientation.

END OF SECTION

SECTION 40 05 62

PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plug valves.
- B. Related Requirements:
 - 1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
 - 2. ASTM International (ASTM):
 - a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
 - b. A536, Standard Specification for Ductile Iron Castings.
 - c. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
 - 3. American Water Works Association (AWWA):
 - a. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
 - 2. See Section 40 05 51.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.

2.2 NON-LUBRICATED ECCENTRIC PLUG VALVES

- A. Manufacturers:
 - 1. DeZurik.
 - 2. Henry Pratt.
 - 3. Millikin.
- B. Materials:
 - 1. Body: Cast-iron ASTM A126, Class B.
 - 2. Plug: One-piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.

3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.
4. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel or bronze.
5. Valve seats: Welded-in overlay of 90% nickel, (minimum 1/8 inches thick).
6. Stem seal: per AWWA C517, Section 4.4.7.

2.3 ACCESSORIES

- A. Refer to Drawings for type of actuator.
 1. Furnish actuator integral with valve.
- B. Refer to Section 40 05 51 for actuator requirements.

2.4 DESIGN REQUIREMENTS

- A. Non-Lubricated Eccentric Plug Valves:
 1. Port area:
 - a. Valves 4 inches through 20 inches: Equal to or exceed 80% of full pipe area.
 2. Valve body: Fitted with bolted bonnet.
 3. End connections: See Section 40 05 51.
 4. Stem seal: Adjustable and replaceable without disassembling valve or bonnet.
 5. Designed for seating drip tight in designated flow direction.
 6. Rating:
 - a. 1/2 through 12 inches, 285 psi working pressure.
 - b. .
 7. Actuator:
 - a. Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
 - b. Positive identification on actuator indicating valve position.
 - c. Adjustable stop to set closing torque.

2.5 FABRICATION

- A. See Section 40 05 51.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. See Section 40 05 51.
- B. Install valves with valve stem horizontal, plug seat on inlet side and with plug rotating up into the open position for valves in horizontal lines.
- C. Install valve with actuator above pipe or plug centerline.

END OF SECTION

SECTION 40 05 63

BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Ball valves.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - c. A276, Standard Specification for Stainless Steel Bars and Shapes.
 - d. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
 - 2. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
 - a. SP-110, Ball Valves; Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 DEFINITIONS

- A. PVDF: Polyvinylidene fluoride.
- B. PTFE: Polytetrafluoroethylene.
- C. RPTFE: Reinforced PolyTetraFluoroEthylene.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 40 05 51.
- B. Contract Closeout Information:
 - 1. Operation and Maintenance Data:
 - a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

2.2 METALLIC BALL VALVES 1/4 TO 3 INCHES DIAMETER

- A. Comply with MSS SP-110.
- B. Manufacturers:
 - 1. Apollo.
 - 2. Jamesbury.
 - 3. Watts.

4. Stockham.

5. Nibco.

C. Materials (All Stainless Steel):

1. Body: Three-part stainless steel, ASTM A351 CF8M.

2. Ball: Stainless steel ASTM A276.

3. Seats: RPTFE.

D. Design Requirements:

1. Rated for a minimum of:

a. 500 psi CWP.

b. 150 psi of saturated steam.

c. 29 inches vacuum.

2. Two-position lockable handle.

3. Stem with blowout-proof design.

4. Balancing stop for all applications.

5. Bodies with mounting pad for applications requiring actuators.

2.3 ACCESSORIES

A. Refer to Drawings and valve schedule for type of actuators.

1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 51 for actuator requirements.

2.4 SOURCE QUALITY CONTROL

A. Product Testing: MSS SP-110.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

END OF SECTION

SECTION 40 42 00
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Insulation:
 - a. Piping insulation.
 2. Adhesives, mastics, sealants, and finishes.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
1. ASTM International (ASTM):
 - a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
 - b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
 - c. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
 - d. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
 - e. C1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
 - f. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - g. E96, Standard Test Methods for Water Vapor Transmission of Materials.
 - h. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
 2. National Fire Protection Association (NFPA):
 - a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
 3. Underwriters Laboratories, Inc. (UL):
 - a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
 4. National Commercial and Industrial Insulation Standards (2013 seventh edition).
 - a. Published by Midwest Insulation Contractors Association (MICA).
 - b. Endorsed by National Insulation Association (NIA).
 - c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

- A. Shop Drawings:
1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Submit complete specification of insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.
 2. Submit itemized schedule of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
 3. Certifications: Products will meet the requirements of the Contract Documents.

B. Informational Submittals:

1. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Fiberglass insulation:
 - a. CertainTeed Corporation.
 - b. Johns Manville.
 - c. Owens Corning.
 - d. Knauf.
2. Adhesives, mastics, sealants, and finishes:
 - a. Foster Products.
 - b. Childers.
 - c. Dow Corning.
 - d. Johns Manville.
 - e. Knauf.

2.2 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:

1. Preformed fiberglass pipe insulation:
 - a. Density: 4 pounds/CUFT.
 - b. Temperature rated: 650 degrees F.
 - c. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT²-DEGF) at mean temperature of 75 degrees F.
 - d. Fire hazard rating:
 - 1) UL 723, ASTM E84, NFPA 255.
 - 2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
2. Moisture adsorption:
 - a. ASTM C553.
 - b. Not greater than 5% moisture by volume when exposed to moisture laden air at 120 degrees F and 96% RH.
3. Fungi and bacteria resistance:
 - a. ASTM C665.
 - b. Does not breed or promote growth.
 - c. Flame attenuated glass fibers bonded with thermosetting resin.
4. Piping jackets (general applications):
 - a. Aluminum: 16 mil embossed aluminum.
5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:

1. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
 2. Provide release for insulation application after installation and testing is complete.
 - a. Apply insulation on clean, dry surfaces after inspection.
 3. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
 - a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
 - b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
 4. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.
- C. Piping Insulation - Fiberglass:
1. Apply over clean dry pipe.
 - a. Butt all joints together firmly.
 2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
 3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
 4. Aluminum pipe jacket:
 - a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
 - b. Provide smooth and straight joint with a minimum 2 inches overlap.
 - c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 inches back from edge.
 - d. Center spacing of screws 5 inches maximum or as required to provide smooth tight-fitted joints.
 - e. Place joints on least exposed side of piping to obtain neat appearance.

3.2 REPAIR

- A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

- A. Pipe, Fittings and Valves:

1. Fiberglass.

APPLICATION	PIPE SIZE	THICKNESS	JACKET
Raw Water in Access Manway	Over 1-1/2 inches	2 inches	Alum

END OF SECTION

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SECTION 40 66 05
NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Computer network requirements, which include, but are not necessarily limited to:
 - a. Managed Ethernet Switches.

B. Related Sections include but are not necessarily limited to:

1. Section 01 33 00 – Submittal Procedures.
2. Section 26 05 00 – Common Work Results for Electrical.

1.2 REFERENCES

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. 802.3, Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
 - 1) 802.3u: IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation, Type 100BASE-T.
 - 2) 802.3x: IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation.
2. National Institute of Standards and Technologies (NIST):
 - a. 800-82, Guide to Industrial Control Systems (ICS) Security.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
 - a. Network Diagrams:
 - 1) Provide in both AUTO CAD and PDF formats.
 - 2) Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in Network Diagrams.
 - 3) Logical Network Diagram(s) - Depict information flow through network(s), and include:
 - a) Major network devices, subnets, and VLANs.
 - b) Include all wireless communication devices.
 - c) Include the following information for each networked device:
 - (1) Device ID.
 - (2) Device description.
 - (3) Manufacturer/model number.
 - (4) Ports and Protocols
 - 4) Physical Network Diagram(s):
 - a) Show all network components, ports, protocols, connections and cables.
 - (1) Include all wireless communication devices.

2. Product Data:
 - a. Network requirements verification plan.
 - b. Comprehensive asset inventory of all networked components:
 - 1) Provide in Excel spreadsheet format.
 - 2) Coordinate with the Owner or Engineer to determine the preferred method of delivery to assure security of information contained in asset inventory.
 - 3) Include:
 - a) Device ID.
 - b) Manufacturer.
 - c) Model Number.
 - d) Serial Number.
 - e) Device Use description.
 - f) Firmware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed within the following Articles are acceptable.

2.2 ETHERNET SWITCHES

- A. Provide Ethernet switches as shown on the Drawings and the Schedule herein.
- B. Managed SCADA Network Ethernet Switches:
 1. Moxa EDS-G4012 Series, no "or equal."
 2. Design and fabrication:
 - a. Support Ethernet 100/1000 Mbps.
 - b. Two backbone ports for connection to single mode fiber via type LC connectors (ST not allowed).
 - c. 100/1000 Mbps twisted pair ports (RJ45) as required for communication with devices as depicted in the Contract Documents.
 - 1) Unless otherwise noted, provide at least two spare 100/1000 Mbps port (twisted pair) at each Ethernet switch.
 - d. Support SNMP v3 and Web based management.
 - e. Rapid Spanning Tree Protocol.
 - f. IGMP (Internet Group Management Protocol) support for IP multicast filtering to enable switches to automatically route messages only to appropriate ports.
 - g. Check all received data for validity.
 - 1) Discard invalid and defective frames or fragments.
 - h. Monitor connected TP/TX line segments for short-circuit or interrupt using regular link test pulses in accordance with IEEE 802.3.
 - i. Monitor attached fiber optic lines for open circuit conditions in accordance with IEEE 802.3.
 - j. As applicable, meet requirements of IEEE 802.3.
 - k. One rack unit (RU) form factor.
 - l. Power switch with 24 VDC power input.
 - m. Provide LED status lights to indicate:
 - 1) Power: Supply voltage present.
 - 2) Fault.
 - 3) Port status.

- n. Environmental rating:
 - 1) Operating temperature: 32 degrees F to 140 degrees F.
 - 2) Humidity: 95% relative humidity, non-condensing.
- 3. Function in self-healing ring structure.
 - a. If one section in the ring fails, the ring structure changes to a line structure within 0.5 seconds.
- 4. DIN Rail mounted.
- C. Small Form-Factor Pluggable (SFP) Modules:
 - 1. Provide SFPs as required to support the communication capability shown on the Drawings. Use SFPs instead of media converters. Media converter use is prohibited unless approved in writing.
 - a. Provide Moxa 1000Base-ZX10 SFP modules, no "or equal".
 - 2. Hardware Features:
 - a. Provide at least two SFP ports per switch supplied with 1 Gbps fiber transceivers for connection to single mode fiber via type LC connectors. Quantity as required for communication with devices as depicted in the Contract Documents.
 - b. Environmental rating:
 - 1) Operating temperature: 32 degrees F to 140 degrees F.
 - 2) Humidity: 95% relative humidity, non-condensing.
- D. Configuration:
 - 1. Diagnostic data for the associated media type available through the command line interface of the switch.
 - 2. All managed switch unused ports shall be administratively disabled. Sticky MAC or similar port configuration shall be utilized to bind ports to MAC address of connected device per NIST 800-82.
 - 3. Change default usernames and passwords.
 - 4. Accessories: Provide port locks for all unused ports.
- E. Ethernet Remote I/O with Ethernet Switch Modules:
 - 1. Moxa, ioLogik E1200 series, no "or equal."
 - 2. Design and fabrication:
 - a. Hardware:
 - 1) Power switch with one 24VDC power input.
 - 2) No fans or moving parts.
 - b. Performance:
 - 1) Support peer-to-peer networking.
 - 2) User-definable MODBUS TCP addressing.
 - a) Mode: Server (Slave).
 - b) Functions supported: 1 through 6, 15, 16, and 23.
 - c) Client connections: Up to 10.
 - d) Ethernet/IP:
 - (1) Mode: Adapter.
 - e) Scanner connections: 9 (for read-only), 1 (for read/write).
 - 3) Uses active push communications to SCADA for communicating changes in state or when configured events occur.
 - 4) Ability to daisy chain multiple modules.

- 5) Capable of performing basic switching without special programming or configurations. Additional features available through software set includes, but is not limited to:
 - a) RESTful API.
 - b) SNMPv1/v2c.
 - c) SNMPv1 Trap.
 - d) HTTP.
 - e) DHCP Client.
 - f) BOOTP.
 - g) IPv4.
 - h) TCP/IP.
 - i) UDP.
- 6) Security:
 - a) Access control list.
 - b) Authentication: Local database.
- c. Enclosure:
 - 1) Rating: UL Listed.
 - 2) Plastic.
 - 3) Wiring:
 - a) I/O connections: 16 to 26 AWG.
 - b) Power connections: 12 to 24 AWG.
 - 4) LED indicators:
 - a) Power.
 - b) Ready.
 - c) Port 1.
 - d) Port 2.
- d. Environmental rating:
 - 1) Operating temperature: -40 degrees F to 167 degrees F.
 - 2) Humidity: 95% relative humidity, non-condensing.
- e. Connections:
 - 1) Two switched Ethernet ports.
 - 2) Copper: RJ-45.
 - a) Auto-negotiating.
 - b) Quantity: as required to provide network connections indicated on the Drawings, minimum two.
 - c) MAC address: One (Ethernet bypass).
 - d) Magnetic isolation protection: 1.5 kV, built-in.
- f. Ethernet software features:
 - 1) Configuration:
 - a) Web console (HTTP).
 - b) Windows Utility (ioSearch).
 - c) MCC Tool.
 - 2) Industrial protocols supported:
 - a) Modbus TCP Server (Slave).
 - b) Ethernet/IP Adapter.
 - c) Moxa AOPC (active tag).
 - d) MXIO Library.

- g. Input/output interfaces:
 - 1) Inputs/outputs: Screw fastened terminal blocks.
 - 2) Digital inputs:
 - a) Dry or wet contact.
 - b) Counter frequency: 250 Hz.
 - c) Digital filtering time interval: user configurable.
 - d) Points per module: 4, 8, or 16 channels, depending on selected module.
 - 3) Digital outputs:
 - a) Sink or source, depending on selected model.
 - b) I/O mode: DO or pulse output.
 - c) Current rating: 200 mA or 500 mA, depending on selected model.
 - d) Pulse output frequency: 500 Hz, maximum.
 - e) Over-current protection: 1.5 or 2.6 A per channel, depending on selected model.
 - f) Over-temperature shutdown: 175 degrees C, typical, 150 degrees C, minimum.
 - g) Over-voltage protection: 35 VDC.
 - h) Points per module: 4, 8, or 16 channels, depending on selected module.
 - 4) Relay outputs:
 - a) Contact configuration: Form A, normally open (NO).
 - b) Output: Relay or pulse, user configurable.
 - c) Output current rating: 5A at 30 VDC, 110 VAC, 250 VAC.
 - d) Output frequency: 0.3 Hz.
 - e) Points per module: 6.
 - 5) Analog inputs:
 - a) I/O mode: Current or voltage.
 - b) I/O type: Differential.
 - c) Resolution: 16 bits.
 - d) Input range: 4 to 20 mA (with burn-out detection), 0 to 20 mA, or 0 to 10 VDC.
 - e) Sampling rate: 12 samples/second per module.
 - f) Input impedance: 10 mega-phms, minimum.
 - g) Points per module: 4 or 8, depending on selected module.
 - 6) Analog outputs:
 - a) I/O mode: Current or voltage.
 - b) I/O range: 4 to 20 mA (with burn-out detection), 0 to 20 mA, or 0 to 10 VDC.
 - c) Resolution: 12 bits.
 - d) Input range: 4 to 20 mA (with burn-out detection), 0 to 20 mA, or 0 to 10 VDC.
 - e) Load (current mode):
 - (1) Internal power: 400 ohms, maximum.
 - (2) 24 VDC external power: 1,000 ohms, maximum.
 - f) Voltage output: short-circuit protection: 10 mA.
 - g) Points per module: 4.
- h. DIN rail mounted.
- i. Software:
 - 1) Provide one copy of OPU UA server software.
 - 2) Moxa model MX-AOPC UA Server.
 - 3) Licensed to the Owner.

- 4) Change default usernames and passwords.

2.3 ACCESSORIES AND MAINTENANCE MATERIALS

- A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.
- B. Furnish Owner with the following extra materials:
 1. One spare Ethernet switch of each type utilized.

PART 3 - EXECUTION

3.1 DEMONSTRATION

- A. Demonstrate system in accordance with Section 01 75 00 - Checkout and Start-Up Procedures.

3.2 FIELD QUALITY CONTROL

- A. Verify network is configured per requirements herein.
- B. Submit verification plan.

END OF SECTION

SECTION 40 73 00
PRESSURE INSTRUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pressure Transmitters.
 - a. Pressure Transmitters (Gauge, Vacuum, and Absolute).
 - 2. Pressure Indicators.
 - a. Pressure Gauges – Mechanical.
 - 3. Isolation Devices.
 - a. In-Line Isolation Sleeve (Annular Seal).

1.2 REFERENCES

- A. Referenced Standards:
 - 1. American Society of Mechanical Engineers (ASME):
 - a. B16.5, Pipe Flanges and Flanged Fittings
 - 2. ASTM International (ASTM):
 - a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

1.3 SUBMITTALS

- A. See Specification Section 01 33 00B – Submittal Procedures Guide.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the manufacturers listed in the Articles describing the elements are acceptable.

2.2 PRESSURE TRANSMITTERS

- A. Pressure Transmitters (Gauge, Vacuum, and Absolute):
 - 1. Manufacturers:
 - a. Emerson Rosemount (3051).
 - b. Emerson Rosemount (2051 Series).
 - c. Endress + Hauser (Cerabar PMP71B Series).
 - d. Yokogawa (EJA Series).
 - e. ABB (266 Series).
 - 2. Materials:
 - a. Process flanges and adapters: 316 stainless steel.
 - b. Vent/drain valve: 316 stainless steel.
 - c. Isolating diaphragm: 316 stainless steel.
 - d. Housing: Aluminum.
 - e. Fill fluid:
 - 1) Manufacturer's standard fill.
 - a) Ensure fill is suitable for application temperatures (below freezing).
 - 3. Design and fabrication:

- a. Smart transmitters utilizing microprocessor based electronics.
 - b. Signal Output:
 - 1) Isolated 4-20 mA DC proportional to pressure with HART.
 - 2) PROFINET with Ethernet-APL.
 - 3) Bluetooth.
 - a) Free application (no subscription required to operate).
 - b) Firmware updated at time of installation.
 - c) Default usernames and passwords and pairing PINs (if applicable) will be updated, with Owner's approval, at time of installation.
 - c. Nonvolatile EEPROM memory.
 - d. Power supply: 24 VDC Loop Power.
 - e. Adjustable zero and span.
 - f. Local Display:
 - 1) 5-digit LCD.
 - 2) Scaled in engineering units.
 - g. Temperature limits:
 - 1) -4 to 175 degrees F (with digital display).
 - h. Overpressure limits: Withstand 150% of stated maximum service pressure without damage.
 - i. Humidity limits: 0 to 100% relative humidity.
 - j. Damping: Adjustable between 0 and 60 seconds.
 - k. Reference Accuracy (includes effects of linearity, repeatability and hysteresis): $\pm 0.075\%$ of calibrated span for 5:1 rangeability.
 - l. Total Performance Accuracy (includes effects of linearity, repeatability and hysteresis): $\pm 0.3\%$ of calibrated span for 5:1 rangeability.
 - m. Stability: $\pm 0.15\%$ of upper range limit over 5 years.
 - n. Temperature effect:
 - 1) Total effect including span and zero errors: + 0.2% of upper range limit per 100 DEGF for minimum 5:1 rangeability.
 - o. Minimum 1/2 inches pressure connection.
 - p. Equip with test jacks or accessible terminals for testing output.
 - q. Equip with isolation valve and test connections with isolation valves and/or plugs.
4. Schedule:

TAG NUMBER	SERVICE	RANGE	PROCESS CONNECTION	VALVE MANIFOLD
PIT-001	Raw Water in Vault	0-300 PSI	SEE DETAIL	SEE DETAIL

2.3 PRESSURE INDICATORS

- A. Pressure Gauge - Mechanical:
- 1. Manufacturers:
 - a. Ametek / USGauge (Solfrunt Model 1980).
 - b. Ashcroft (Type 1279 or 1379).
 - 2. Materials:
 - a. Bourdon tube, socket, connecting tube: 316 stainless steel.

- b. Case: Phenolic.
- 3. Accessories:
 - a. Provide valve at point of connection to equipment and at panel if panel mounted.
- 4. Design and fabrication:
 - a. All components suitable for service at:
 - 1) 150 degrees F
 - 2) 0 degree F..
 - 3) The maximum process temperature to which the gauge is to be exposed.
 - b. Provide viewer protection from element rupture.
 - c. Calibrate gauges at jobsite for pressure and temperature in accordance with manufacturer's instructions.
 - d. Unless otherwise required by codes, provide stem mounted or flush mounted, as required, with dial diameter as follows:

PIPE SIZE	DIAL SIZE	GAUGE CONNECTION
1-1/2 inches or less	2-1/2 inches	1/4 inches
Larger than 1-1/2 inches	4-1/2 inches	1/2 inches

- e. Equip with white faces, black numerals and black pointers.
- f. Gauge tapping position to be clear of equipment functions and movements, and protected from maintenance and operation of equipment.
 - 1) Gauge to be readable from an accessible standing position.
- g. Gauge accuracy: 1% of full range.
- h. Select gauge range so that:
 - 1) The normal operating value is in the middle third of the dial.
 - 2) Maximum operating pressure does not exceed 75% of the full scale range.
- 1. Schedule:

TAG NUMBER	SERVICE	PRESSURE RANGE (PSI)	CASE SIZE (IN)	PROTECTOR REQUIREMENTS	SNUBBER REQ'D
PG-001	RAW WATER, BELOW GRADE MANWAY	0-300 PSI	4 ½"	IN-LINE ISOLATION SLEEVE	NO
PG-002	RAW WATER, BLOW-OFF VAULT	0-300 PSI	4 ½"	IN-LINE ISOLATION SLEEVE	NO
PG-003	RAW WATER, BLOW-OFF VAULT	0-150 PSI	4 ½"	IN-LINE ISOLATION SLEEVE	NO
PG-004	RAW WATER, PRESSURE SENSOR VAULT	0-300 PSI	4 ½"	IN-LINE ISOLATION SLEEVE	NO

2.4 ISOLATION DEVICES

- A. In-Line Isolation Sleeve (Annular Seal):
 - 1. Manufacturers:
 - a. Red Valve – SPS Series 40.
 - b. Approved equal

2. Materials:
 - a. Body: Carbon Steel.
 - b. Flanges: Carbon Steel.
 - c. Flexible liner: Buna-N.
3. Design and fabrication:
 - a. Provide full 360 degree annular pressure sensor with flexible in-line sleeve.
 - b. Sensor shall not restrict the process flow (non-intrusive).
 - c. Seal shall have ANSI Class 150 flanges.
 - 1) Line size as shown on the Drawings.
 - d. Instrument connection: 0.5 inches female NPT.
 - e. Fill fluid:
 - a) Ethylene glycol.
 - f. Pressure rating: To meet requirements of schedule.

2.5 ACCESSORIES

- A. Furnish all mounting brackets, hardware and appurtenances required for mounting primary elements and transmitters.
 1. Materials, unless otherwise specified, shall be as follows:
 - a. Bolts, nuts, washers, expansion anchors: 316 stainless steel.
 - b. Mounting brackets:
 - 1) Standard: 316 stainless steel.
 - c. Mounting plates, angles:
 - 1) 316 stainless steel.
 - d. Instrument pipe stands:
 - 1) 316 stainless steel.
- B. Tubing Support Angles and Brackets:
 1. Any of the following materials are acceptable:
 - a. Aluminum support with dielectric material between support and tubing.
 - b. Type 316 stainless steel.
 - c. Fiberglass.
- C. Tubing Tray or Channel:
 1. Aluminum.
 2. Provide dielectric material between tray or channel and tubing.
- D. Provide handheld communicator compatible with all intelligent transmitters furnished.
 1. Hand held communicator shall provide capability to check calibration, change transmitter range, and provide diagnostics.
 2. If these features are provided with the intelligent transmitter, the hand held communicator is not required.
- E. Cable lengths between sensors and transmitters shall be continuous (without splices) and as required to accommodate locations as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide pressure gages at locations indicated on Drawings or otherwise specified.

- C. Install instrument mounting pipe stands level and plumb.
- D. Instrument Valves:
 - 1. Orient stems for proper operation.
 - 2. Install arrays orderly and neat in appearance with true horizontal and vertical lines.
 - 3. Provide a minimum of 2 inches clearance between valve handle turning radii where there are multiple valve handles appearing in a straight line.
 - 4. Valves shall have bonnets and any soft seals removed during welding or soldering into the line.
 - a. When cool, reassemble the valves.
 - 5. Support each valve individually.
 - a. The tubing system does not qualify as support for the valve.
- E. Locate instrument piping and tubing so as to be free of vibration and interference with other piping, conduit, or equipment.
- F. Keep foreign matter out of the system.
- G. Remove all oil on piping and tubing with solvent before piping and tubing installation.
- H. Plug all open ends and connections to keep out contaminants.
- I. Threaded Connection Seals:
 - 1. Use Tite-Seal or acceptable alternate.
 - 2. Use of lead base pipe dope or Teflon tape is not acceptable.
 - 3. Do not apply Tite-Seal to tubing threads of compression fittings.
- J. Instrument Mounting:
 - 1. Mount all instruments where they will be accessible from fixed ladders, platforms, or grade.
 - 2. Mount all local indicating instruments with face forward toward the normal operating area, within reading distance, and in the line of sight.
 - 3. Mount instruments level, plumb, and support rigidly.
 - 4. Mount to provide:
 - a. Protection from heat, shock, and vibrations.
 - b. Accessibility for maintenance.
 - c. Freedom from interference with piping, conduit and equipment.

3.2 TRAINING

- A. Provide on-site training in accordance with Specification Section 01 75 00.

END OF SECTION

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