TECHNICAL SPECIFICATIONS

COLORADO RIVER CONNECTIVITY CHANNEL (CRCC) AT WINDY GAP PROJECT

GRAND COUNTY, COLORADO

WATER DIVISION 5
WATER DISTRICT 51

DAM ID 510132
SEO FILE NO. C-1521A

I hereby state that the accompanying specifications were prepared by me or under my direct supervision

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Approved on the 13th day of June 2022

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COLORADO RIVER CONNECTIVITY CHANNEL (CRCC) AT WINDY GAP

TECHNICAL SPECIFICATIONS
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SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Project description, work summary, and work by Owner.

1.2 BACKGROUND

A. Windy Gap Reservoir is located approximately 3 miles west of the town of Granby, Colorado. The facility is owned and operated by the Municipal Subdistrict of Northern Colorado Water Conservancy (Northern Water). The primary purpose of the facility is to pump water to Lake Granby; water is stored and then transferred to the Front Range via the Colorado-Big Thompson system. The existing dam generally functions as a run-of-river structure and the uncontrolled spillway structure operates frequently. The existing Windy Gap facility currently delivers an average of 36,530 acre-feet (ac-ft) of water annually.

1.3 PROJECT DESCRIPTION

A. The new Colorado River Connectivity Channel Project (CRCC Project) consists of constructing the following:

1. A relocated southern dam embankment to accommodate diversion of the Colorado River.
2. A new upstream river diversion structure to provide functionality to direct and split streamflow into the CRCC or into Windy Gap Reservoir depending on operational and pumping demands.
3. An overflow spillway to pass river flows into the reservoir for floods in excess of the 5-yr frequency flood event.
4. A new connectivity channel and floodplain to provide a continuous channel adjacent to the Windy Gap Dam facility while promoting natural geomorphic and ecological river processes.
5. Improvements to the Fraser River stream gage located upstream of its confluence with the Colorado River to provide a means for aquatic life migration.

B. Major work items associated with the CRCC Project include:

1. Mobilization.
2. Erosion and sediment controls.
3. Construction of the Fraser River Gage pool and riffle fishway.
4. Clearing and grubbing.
5. Development of borrow areas for fill material and a quarry for riprap and bedding materials.
6. Construction of a new dam embankment including:

    a. Foundation excavation and preparation.
    b. Construction of shells, core, filter, slurry wall, select dam fill, riprap and riprap bedding zones.
    c. Construction of a new connection to the existing western dam embankment.
    d. Construction of downstream stabilization buttress.

e. Sheet pile wall and launching riprap at the southern toe of the new embankment.
f. Construction of dam crest roads with a road base surface.
g. Construction of the west access road with a road base pavement surface.
h. Construction of drainage features.

7. Construction of launching riprap at the existing embankment.
8. Construction of a new reinforced concrete diversion structure including:

a. Foundation excavation and preparation.
b. Installation of sheet piles at southern side of the diversion structure.
c. Construction of the concrete structure, handrails and installation of vehicle bridge and guardrails.
d. Construction of the low flow conduit/bypass.
e. Construction of the diversion structure to reservoir channel.
f. Supply and installation of a new top actuated (hydraulically) hinged crest gate, and top actuated (hydraulically) sluice gate.
g. Supply and installation of trash racks.
h. Installation of all electrical equipment and related items including beneath ground services including cable, conduit, trenching, backfill, gate actuators, sensors, controls, instruments, monitoring devices, power supply and lighting.
i. Construction of a new control building, parking area and Highway 40 access road with a road base pavement surface.
j. Construction of the Highway 40 culvert drainage channel.

9. Construction of a new spillway overflow section including:

a. Foundation excavation and preparation.
b. Construction of shells.
c. ACB erosion protection.
d. Road base pavement surface.

10. Construction of the CRCC including:

a. Construction of new river channel, ponds and floodplain.
b. Construction of channel with select CRCC fill, general CRCC fill, riffle zones, boulder clusters and woody debris.
c. Construction of topsoil zones.
d. Construction of a new grade control structure with sheet piles, concrete cap and rockfill.
e. Installation of new plantings, habitat features and erosion control features.

11. Construction of a new river crossing.
12. Installation of instrumentation including piezometers, station markers and survey monuments.
13. Demolition and removal of a portion of the existing southern dam embankment and salvaging of excavated material for reuse

14. Distribution of topsoil, seedbed preparation and seeding of disturbed areas.
15. Construction of the spillway low block raise including concrete demolition and construction.
16. Construction of environmental mitigation features.
17. Demobilization.

1.4 OWNER OCCUPANCY

A. The Owner will occupy the premises full time during the period of construction and will work with the contractor in an effort to manage reservoir water elevations during construction.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 20 00
PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.1 DESCRIPTION

A. Measurement and payment criteria applicable to work performed under a unit price payment method.

B. Measurement and payment criteria applicable to work performed under a lump sum payment method.

C. List of unit price and lump sum pay items.

D. Schedule of value requirements for lump sum pay items.

1.2 AUTHORITY

A. Measurement methods delineated in the individual Specification Sections are intended to complement the criteria of this Section. In the event of conflict, the requirements of the individual Specification Section shall govern.

B. Take measurements and compute quantities for unit price pay items. The Engineer will verify measurements and quantities of work performed by the Contractor for payment purposes.

C. Assist the Engineer in the taking of measurements by providing necessary equipment, workers, and survey personnel as required.

1.3 NON-PAYMENT FOR REJECTED PRODUCTS

A. Payment will not be made for certain items, including but not limited to:

1. Products that are wasted or disposed of, or otherwise handled in a manner that is not acceptable.
2. Products determined to be unacceptable in the opinion of the Engineer, before or after placement.
3. Concrete that is delivered without a batch ticket or a ticket that does not show actual batch weights aggregate absorption, and aggregate moisture content.
4. Excavation or fill made for the convenience of the Contractor.
5. Over-excavation and backfill of over-excavation not approved by the Engineer.

1.4 QUANTITIES OF UNIT PRICE ITEMS

A. Quantities indicated in the Bid Form are for bidding and Contract purposes only.

1.5 MEASUREMENT OF QUANTITIES FOR UNIT PRICE ITEMS

A. Measurement Devices:

1. Weigh scales: inspected, tested, and certified by the applicable Colorado Department of Agricultural Weights and Measures Department within the past year.
2. Platform scales: of sufficient size and capacity to accommodate the conveying vehicle.

3. Metering devices: inspected, tested, and certified by the applicable New Mexico Department of Agricultural Weights and Measures Department within the past year.

B. Measurement by Volume

1. Measured by cubic dimension using mean length, width, and height or thickness.
2. Excavation quantities will be based on the calculated volume between the baseline survey, as defined in Section 01 71 23: Layout of Work and Surveying and the excavation limits shown on the Drawings, or to the most practicable lines, grades and dimensions as prescribed by the Engineer, and will include only material that is actually removed within the prescribed pay lines.
3. Fill quantities will be based on the calculated volume between the excavation limits or the approved base surface and the fill limits shown on the Drawings, or to the most practicable lines, grades and dimensions as prescribed by the Engineer, and will include only material that is actually placed within the pay lines.
4. Compute embankment excavation and fill quantities in accordance with the requirements of Section 01 71 23: Layout of Work and Surveying.
5. Where concrete for structures is to be placed directly upon or against the excavations and the character of the material cut into is such that the material cannot be trimmed efficiently to accurate dimensions, as determined by the Engineer, measurement for payment thereof will be made to the prescribed average dimension lines. The prescribed average dimension lines shall not exceed 6 inches outside the neat lines of the concrete for the purposes of measurement, for payment.
6. Measurement, for payment, of excavations upon or against which concrete is not required to be placed will be limited to the neat lines shown on the Drawings, or to the most practicable lines, grades, and dimensions as established by the Engineer.

C. Measurement by Area:

1. Measured by square dimension using mean length and width or radius. Items which are measured by the acre, such as revegetation, shall be measured horizontally.

D. Linear Measurement:

1. Measured by linear dimension, at the item centerline or mean chord. Items which are measured by the lineal foot, such as conduits/pipes, fence, etc., shall be measured parallel to the base or foundations upon which the items are placed, unless otherwise specified or shown on the Drawings.

E. Stipulated Sum/Price Measurement:

1. Items measured by weight, volume, area, or linear means or combination, as appropriate, as completed items or units of the Work.

1.6 LUMP SUM ITEMS

A. Lump sum items shall not be measured for payment. However, measurements may be made to monitor work progress for payment.

1.7 PAYMENT

A. Payment includes: Full compensation for furnishing the required labor, materials, products, tools, equipment, plant, transportation, services, incidentals, erection, application or installation of an item of the work, overhead and profit, and other costs of whatsoever nature for the items of work completed, will be included in the various bid items.

B. Contractor shall submit a Schedule of Values for the lump sum bid items listed in the Bid Schedule within 30 days of the Notice to Proceed. The Schedule of Values is intended to help the Engineer assess the intermediate value of work completed for the purpose of making progress payments.

C. Payment for lump sum price items will be made on the basis of the Contract lump sum prices in the Bid Form. If the Contractor requests progress payments for lump sum items, such progress payments will be made in accordance with a detailed program of payment apportioning in the schedule of values that, at a minimum, includes the various subdivisions identified in each lump sum bid item in the Description of Bid Items.

1.8 DEFINITION OF BID ITEMS

A. The intent of this Section is to explain, in general, what is and what is not included in a bid item, and the limits or cutoff points where one bid item ends and another begins. If no bid item exists for a portion of the work, include the costs in a related bid item.

B. BID ITEMS:

1. General

a. 1.1 - Mobilization and Demobilization (Mid 2022-2023)

1) This item includes mobilization (mid 2022 and 2023) and demobilization (last 2022 and 2023) of the Contractor and subcontractor personnel, equipment, and temporary construction facilities to the project site per Section 01 71 10: Mobilization, Preparatory Work and Demobilization. The cost of the work specified in Division 1 - unless specifically covered in other bid items, will not be paid separately, but shall be included in the lump sum price bid in the schedule of values for Mobilization, Demobilization, and Preparatory Work.
2) Measurement: Fifty percent of the lump sum price to be paid at the time of first monthly progress payment; additional thirty percent paid when one-half the original contract amount is earned. The remaining twenty percent will be paid upon Substantial Completion of the Project
3) Payment: Payment shall be made at the contract price per lump sum

b. 1.2 - Erosion Control Initial & Interim BMP's Installation & Setup - Fraser Gauge

1) This item is for Erosion Control Initial & Interim BMP's Furnishing, Installation, Setup and Removal at the Fraser Gauge
2) Measurement: Measurement for payment based on the approved schedule of values

3) Payment: Payment shall be made at the contract price per lump sum

c. 1.3 - Erosion Control Initial & Interim BMP's Installation & Setup - Dam & CRCC

1) 1.3.1 - Silt Fence

a) Silt Fence includes furnishing and installation
b) Measurement: Payment shall be based on the approved length of silt fence installed. Measurement based on agreed in place measurement by Contractor and Engineer
c) Payment: Payment shall be made at the contract unit price per lineal feet

2) 1.3.2 - Sediment Control Log

a) Sediment Control Log. Includes furnishing and installation
b) Measurement: Payment shall be based on the approved length of sediment control log installed. Measurement based on agreed in place measurement by Contractor and Engineer
c) Payment: Payment shall be made at the contract unit price per lineal feet

3) 1.3.3 - Vehicle Tracking Pads

a) Vehicle Tracking Pads. Includes installation
b) Measurement: Measurement for payment shall be based on the approved number of tracking pads installed. Payment will consist of 75% of unit cost after installation and 25% of unit cost after removal
c) Payment: Payment shall be made at the contract unit price per item

4) 1.3.4 - Tree Protection Fencing

a) Tree and Wetland Protection Fencing. Includes furnishing and installation
b) Measurement: Payment shall be based on the approved length of tree protection fencing installed. Measurement based on agreed in place measurement by Contractor and Engineer
c) Payment: Payment shall be made at the contract unit price per lineal feet

5) 1.3.5 - Stabilized Staging Area

a) Stabilized Staging Area. Includes furnishing and installation
b) Measurement: Measurement for payment shall be based on the approved area of stabilized staging area installed. Measurement based on agreed in place measurement by Contractor and Engineer
c) Payment: Payment shall be made at the contract unit price per square yard

6) 1.3.6 - Temporary Stabilization Seeding or Tackifier

   a) Temporary Stabilization Seeding or Tackifier. Includes furnishing, installation & removal
   b) Measurement: Measurement for payment shall be based on the approved area, by survey or approved field measurement, of temporary stabilization seeding or tackifier installed
   c) Payment: Payment shall be made at the contract unit price per acre

7) 1.3.7 - Street Sweeping

   a) Street Sweeping. Includes installation & removal
   b) Measurement: Measurement for payment will be based on the approved number of hours street sweeping is undertaken. Hours will be documented by the Contractor and approved by the Engineer
   c) Payment: Payment shall be made at the contract unit price per hour

8) 1.3.8 - Turbidity Curtain

   a) Turbidity Curtain. Includes furnishing & installation
   b) Measurement: Payment shall be based on the approved length of turbidity curtain installed. Measurement based on agreed in place measurement by Contractor and Engineer
   c) Payment: Payment shall be made at the contract unit price per lineal feet

9) 1.3.9 - Rock Check Dams

   a) Rock Check Dams. Includes furnishing & installation
   b) Measurement: Measurement for payment shall be based on the approved number of rock check dams installed
   c) Payment: Payment shall be made at the contract unit price per item

10) 1.3.10 - Erosion Control & BMP Maintenance

   a) Erosion Control & BMP Maintenance based on 20 months of inspections and documentation under Environmental Program & Staffing. This item also includes removal of Erosion Control & BMP features at Substantial Completion
   b) Measurement: Measurement for payment based on the number of months maintenance is undertaken and as approved by the Engineer. During seasonal suspension months payment will be prorated for effort needed as approved by the Engineer
   c) Payment: Payment shall be made at the contract price per month

11) 1.3.11 - Project Security and Access Control

a) This item is for Project Security and Access Control. This item includes a manual double leaf swing barrier gate with locks @ US HWY40 and 300 lf of type 7 concrete barrier
b) Measurement: Measurement for payment based on the approved schedule of values
c) Payment: Payment shall be made at the contract price per lump sum

d. 1.4 Temporary Water Diversion and Control

1) 1.4.1 - Early Construction - Channel Realignment within Reservoir

a) This item is for Early Construction - Channel Realignment within Reservoir
b) Measurement: Measurement for payment based on the approved schedule of values
c) Payment: Payment shall be made at the contract price per lump sum

2) 1.4.2 - Temp Diversion at Diversion Structure

a) This item is for Temp Diversion at Diversion Structure
b) Measurement: Fifty percent of the lump sum price to be paid at the time of initial construction of the temp diversion; additional thirty percent paid when one-half the diversion structure scope is completed. The remaining twenty percent will be paid upon removal of the temp diversion
c) Payment: Payment shall be made at the contract price per lump sum

3) 1.4.3 - Temp Water Control at Fraser River Gauge

a) This item is for Temp Water Control at Fraser River Gauge
b) Measurement: Fifty percent of the lump sum price to be paid at the time of initial construction of the temporary diversion; additional thirty percent paid when one-half the Fraser gauge scope is completed. The remaining twenty percent will be paid upon removal of the temporary diversion.
c) Payment: Payment shall be made at the contract price per lump sum

4) 1.4.4 - Temp Water Control at CRCC Connections

a) This item is for Temp Water Control at CRCC Connections
b) Measurement: Measurement for payment based on the approved schedule of values
c) Payment: Payment shall be made at the contract price per lump sum

5) 1.4.5 - Temp Water Control at Overflow Spillway / Fish Passage Channel

a) This item is for Temp Water Control at Overflow Spillway / Fish Passage Channel
b) Measurement: Measurement for payment based on the approved schedule of values
c) Payment: Payment shall be made at the contract price per lump sum

e. 1.5 Project Dewatering

1) 1.5.1 - Dam Embankment Dewatering

a) This item is for Dam Embankment Dewatering
b) Measurement: Fifty percent of the lump sum price to be paid at the time of initial installation of a dewatering system; additional thirty percent paid when one-half the dam embankment scope is completed. The remaining twenty percent will be paid upon removal of the water control system.
c) Payment: Payment shall be made at the contract price per lump sum

2) 1.5.2 - Diversion Structure Dewatering

a) This item is for Diversion Structure Dewatering
b) Measurement: Fifty percent of the lump sum price to be paid at the time of initial installation of a dewatering system; additional thirty percent paid when one-half the diversion structure scope is completed. The remaining twenty percent will be paid upon removal of the water control system.
c) Payment: Payment shall be made at the contract price per lump sum

3) 1.5.3 - CRCC Dewatering

a) This item is for CRCC Dewatering
b) Measurement: The lump sum price will be split 50/50 for construction season 1 and season 2. Twenty five percent of the lump sum price to be paid at the time of initial installation of a dewatering system in construction season 1; additional twenty five percent paid when the CRCC scope is completed in construction season 1. The same process will be implemented for construction season 2.
c) Payment: Payment shall be made at the contract price per lump sum

f. 1.6 Clearing and Grubbing

1) 1.6.1 - Type A Clearing and Grubbing

a) This item is for Type A clearing and grubbing (including borrow areas), in compliance with the Drawings and Specifications. Type A clearing and grubbing is for less wooded and vegetated areas

b) Measurement: Measurement for payment will be based on the approved plan and measured area, calculated by survey or approved field measurement, of Type A clearing and grubbing
c) Payment: Payment will be made at the contract unit price per acre

2) 1.6.2 - Type B Clearing and Grubbing

a) This item is for Type B clearing and grubbing (including borrow areas), in compliance with the Drawings and Specifications. Type B clearing and grubbing is for heavily wooded and vegetated areas
b) Measurement: Measurement for payment will be based on the approved plan and measured area, calculated by survey or approved field measurement, of Type B clearing and grubbing.
c) Payment: Payment will be made at the contract unit price per acre.

g. 1.7 - Tree Removal

a) This item is for tree removal including disposal or storage/chipping for reuse. The minimum diameter to meet the definition of a tree for removal is 8-inches at breast height
b) Measurement: Measurement for payment shall be based on the approved trees for removal and number of trees removed
c) Payment: Payment shall be made at the contract unit price per item

h. 1.8 Generate Topsoil

1) 1.8.1 - Strip and Harvest, Haul to stockpile and Mix Topsoil

a) This item is for stripping, stockpiling and mixing of topsoil/growth medium
b) Measurement: Measurement for payment will be based on the approved measured volume, calculated by survey and topsoil depth or approved field measurement, of stripped topsoil
c) Payment: Payment shall be made at the contract unit price per cubic yard

2) 1.8.2 - Borrow & Screen Topsoil for Oversized Rubbish, Haul to Stockpile & Mix

a) This item is for borrow, screening, stockpiling and mixing of topsoil/growth medium
b) Measurement: Measurement for payment will be based on the approved measurement of volume, calculated by survey or field measurement as approved by the Engineer, of topsoil borrow
c) Payment: Payment shall be made at the contract unit price per cubic yard

i. 1.9 - Project Access, Staging, and Haul Road Development

1) This item is for project access, staging, and haul road development to Windy Gap site and to borrow and/or quarry areas
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

j. 1.10 - Project wide survey and construction staking

1) This item is for project wide survey and construction staking
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

k. 1.11 - Project Wide Traffic Control and Maintenance

1) This item is for project wide traffic control and maintenance. Includes Traffic Signs, Barricades, Message Board, Traffic Control Super, and Inspections
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

l. 1.12 - Traffic Control Flaggers

1) This item is for traffic control flagging
2) Measurement: Measurement for payment shall be based on the approved number of persons and hours worked
3) Payment: Payment shall be made at the contract price per hour

m. 1.13 - Project Wide Dust Control & construction water storage

1) This item is for project wide dust control & construction water storage
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

n. 1.14 - Owner's Office Supplies

1) This item is for the owner's office supplies (18-month minimum period)
2) Measurement: Measurement for payment based on the approved number of months the owner's office is required
3) Payment: Payment shall be made at the contract unit price per month

2. Dam Embankment

a. 2.1 - Remove Existing Embankment

1) This item is for removal of existing embankment fill (see Drawing C-44 for extent of dam removal) and includes sorting of shell, riprap, slurry wall to finish grade and road base materials into stockpiles for reuse or waste
2) Measurement: Measurement for payment will be based on the approved excavation volume, based on the baseline survey and the subgrade neat lines on the drawings
3) Payment: Payment shall be made at the contract unit price per cubic yard

b. 2.2 - Dam Foundation Excavation (within Reservoir Footprint)

1) This item is for the removal and stockpiling of foundation excavation material associated with the dam embankment within the existing reservoir footprint (STA 15+00 to 35+00) for reuse or waste
2) Measurement: Measurement for payment will be based on the approved foundation and excavation volume, based on survey before and after excavation
3) Payment: Payment shall be made at the contract unit price per cubic yard

c. 2.3 - Dam Embankment - Sta 13+50-35+00

1) This item is for sourcing, screening, loading, hauling, spreading, grading, placing, moisture control and compacting of Dam Fill (STA 13+50 to 35+00) from stockpiles, and/or borrow area in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved Dam Fill volume, based on survey before fill placement and to the neat lines on the drawings showing the subgrade of the Riprap Bedding, Topsoil and crest road Base-course. Slurry wall bench construction/removal is considered incidental to construction and will not be measured for payment
3) Payment: Payment shall be made at the contract unit price per cubic yard

d. 2.4 - Dam Embankment - Downstream Buttress & West Access Rd Fills

1) This item is for sourcing, screening, loading, hauling, spreading, grading, placing, moisture control and compacting of Road Fill from stockpiles, and/or borrow area in compliance with the Drawings and Specifications for the dam embankment downstream buttress and the western access road in compliance with the Drawings (see Drawings C-01) and Specifications
2) Measurement: Measurement for payment will be based on the approved volume, based on survey before fill placement and the neat lines on the drawings showing the subgrade of the Riprap Bedding, Topsoil and access road Base-course.
3) Payment: Payment shall be made at the contract unit price per cubic yard

e. 2.5 - Connection of New Dam Embankment to Existing Dam Embankment

1) This item is for the removal, stockpiling of excavation material and reinstatement of embankment material associated with the connection of the existing and new dam embankment in compliance with the Drawings and Specifications. This item includes screening, loading, hauling, spreading, grading, placing, moisture control and compacting
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

f. 2.6 - Unclassified Dam Excavation (Buttress, Swales, Channels and Road)

1) This item is for the removal and stockpiling of unclassified excavation material associated with the downstream buttress, drainage swale, western access road and overburden pile for reuse or waste
2) Measurement: Measurement for payment will be based on the approved foundation and excavation volume, based on survey before and after excavation and less the topsoil that has been stripped/removed
3) Payment: Payment shall be made at the contract unit price per cubic yard

g. 2.7 - West Swale

1) This item is for swale construction including furnishing and installation of riprap and bedding but excluding excavation for swale construction
2) Measurement: Measurement for payment will be based on the approved length, calculated by survey or approved field measurements, of swale construction
3) Payment: Payment shall be made at the contract unit price per lineal foot

h. 2.8 - Slurry Wall

1) This item is for Slurry Wall construction in compliance with the Drawings and Specifications. This Item is inclusive of elements, such as providing water, slurry wall excavation, importation of fines material, supply of Bentonite material, slurry mixing/production, slurry installation and slurry disposal are included in this item
2) Measurement: Measurement for payment will be based on the approved area of completed Slurry Wall measured in a vertical plane through the centerline of the slurry trench from the top of the slurry wall shown on the Drawings (EL 7837) to the bottom of the excavated trench as measured by depth soundings documented by the Contractor and approved by the Engineer. The lineal feet of completed Slurry Wall will be measured by survey. Lead-in and lead-out Slurry Wall portions are considered incidental to Slurry

Wall construction and will not be measured for payment. The full depth slurry wall is defined as from STA 12+60 to 32+75 as shown on the Drawings. Slurry wall bench construction/removal is considered incidental and will not be measured for payment

3) Payment: Payment shall be made at the contract unit price per square foot

i. 2.9 - Articulated Concrete Blocks -Tri-Lock Type 4015

1) This item is for Articulated Concrete Blocks furnishing and installation in accordance with the Drawings and Specifications (STA 38+38 to 44+10)
2) Measurement: Measurement for payment will be based on the approved three-dimensional surface area, calculated by survey, of Articulated Concrete Block construction
3) Payment: Payment shall be made at the contract unit price per square foot

j. 2.10 - ACB termination detail - Structural Concrete

1) This item is for Articulated Concrete Blocks termination with structural concrete construction in accordance with the Drawings and Specifications (STA 38+38 to 44+10)
2) Measurement: Measurement for payment will be based on the approved volume, calculated by cross sectional area (neat lines on the Drawings) and lineal feet measured by survey or approved field measurement, of structural concrete construction
3) Payment: Payment shall be made at the contract unit price per cubic yard

k. 2.11 - ACB termination detail - Riprap

1) This item is for Articulated Concrete Blocks termination with riprap construction in accordance with the Drawings and Specifications (STA 38+38 to 44+10)
2) Measurement: Measurement for payment will be based on the approved volume, calculated by cross sectional area (neat lines on the Drawings) and lineal feet measured by survey, of riprap termination construction
3) Payment: Payment shall be made at the contract unit price per cubic yard

l. 2.12 - Geotextile

1) This item is for Geotextile including furnishing and installation in accordance with the Drawings and Specifications for Articulated Concrete Blocks construction (STA 38+38 to 44+10)
2) Measurement: Measurement for payment will be based on the approved area, calculated by the neat lines on the drawings, of Geotextile installation. Lapping areas will not be paid
3) Payment: Payment shall be made at the contract unit price per square yard

m. 2.13 - Base-coarse Dam Crest & West Access Road

1) This item is for Road Base (Base Course) including furnishing and installation on the western access road, dam embankment and overflow spillway (areas outside of the ACB) in accordance with the Drawings and Specifications. This item includes procuring from offsite sources, transporting, placing, spreading, grading, moisture conditioning, and compaction
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed length or approved field measurement length and width/depth shown on the Drawings, of road base construction
3) Payment: Payment shall be made at the contract unit price per cubic yard

n. 2.14 - Riprap - dam embankment (D50-12")

1) This item is for Riprap (D50-12") including furnishing and installation on the upstream dam embankment slope in compliance with the Drawings and Specifications. Riprap is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed area and depth shown on the Drawings, of installed riprap
3) Payment: Payment shall be made at the contract unit price per cubic yard

o. 2.15 - Riprap - dam embankment (D50 - 6")

1) This item is for Riprap (D50 - 6") including furnishing and installation on the downstream dam embankment slope, the western access road, and the downstream buttress in compliance with the Drawings and Specifications. Riprap is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed area and depth shown on the Drawings, of installed riprap
3) Payment: Payment shall be made at the contract unit price per cubic yard

p. 2.16 - Launching Riprap and Launching Riprap at Sheetpiles

1) This item is for Launching Riprap (D50 - 12") including excavation and furnishing, installation of launching riprap in compliance with the Drawings (see Drawing C-01 and C-30 for extent) and Specifications
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed length and the neat line cross sectional area shown on the Drawings, of installed launching riprap
3) Payment: Payment shall be made at the contract unit price per cubic yard

q. 2.17 - Bedding below Riprap (below slope riprap only)

1) This item is for Riprap Bedding including furnishing and installation below riprap on the dam embankment slopes, the western access road and the downstream buttress in compliance with the Drawings and Specifications. Bedding is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment will be based on approved volume, calculated by surveyed area and depth shown on the Drawings, of installed bedding
3) Payment: Payment shall be made at the contract unit price per cubic yard

r. 2.18 - Sheetpile South Toe of New Dam

1) This item is for Sheetpile construction at south toe of new Dam Embankment including furnishing, installation, splicing and sheet cutting in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved cross-sectional area of installed sheet pile. Cross section area will be measured in a vertical plane through the centerline of the wall. Installation depth to be documented by the Contractor and installed sheetpile wall length measured by survey. Each approved sheetpile splice will be measured as an additional 3 square feet of sheet pile. Sheet Pile cut-offs 10 square feet or less in area will be paid at the contract unit price less 20 percent
3) Payment: Payment shall be made at the contract unit price per square foot

s. 2.19 - Sheetpile Concrete Cap

1) This item is for sheetpile concrete cap at the toe of the new Dam Embankment including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved length, calculated by survey, of sheetpile cap construction
3) Payment: Payment shall be made at the contract unit price per lineal foot

t. 2.20 - Dam Monitoring

1) This item is for Dam Monitoring and is included as an allowance
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract unit price per lump sum

u. 2.21 - Decommissioning of Existing Piezometers

1) This item includes all work associated with abandoning piezometers designated on the Drawings for abandonment

2) Measurement: Measurement for payment shall be based on the approved number of piezometers abandoned
3) Payment: Payment shall be made at the contract unit price per item

v. 2.22 - New Instrumentation

1) This item is for new Piezometers, new Movement Monuments and Station Markers furnishing and installation. For piezometers this item includes all work associated with furnishing and installing new piezometers (including drilling bore holes, backfilling boreholes, protective steel pipe casings, locks, and concrete backfill) at the locations and in accordance with the details shown on the Drawings and as Specified. This Item also includes obtaining required permits, completion survey, and required regulatory construction documentation
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

w. 2.23 - Reclaim Borrow Area

1) This item is for the Reclamation of the Borrow Area. This item includes grading to enable free draining, spreading of topsoil and seeding
2) Measurement: Measurement for payment will be based on approved area, calculated by survey, of reclaimed borrow area
3) Payment: Payment shall be made at the contract unit price per acre

x. 2.24 - Credit for re-use of salvage riprap

1) This item is a Credit for re-use of salvaged riprap
2) Measurement: Measurement for payment will be based on approved volume, calculated by surveyed area and depth shown on the Record Drawings or approved field measurement depth, of existing riprap
3) Payment: Payment shall be made at the contract unit price per cubic yard

3. Diversion Structure and Grade Control Structure

a. 3.1 - Foundation Excavation

1) This item is for the removal and stockpiling of foundation excavation material associated with the diversion structure for reuse or waste
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

b. 3.2 - Spillway and Haul Road Fills (Sta 35+00 to SH40)

1) This item is for sourcing, screening, loading, hauling, spreading, grading, placing, moisture control and compacting of Road Fill (STA 35+00 to Highway 40) from stockpiles, and/or borrow area in compliance with the Drawings and Specification
2) Measurement: Measurement for payment will be based on the approved volume, based on survey before fill placement and to the neat lines on the drawings showing the subgrade of the Riprap Bedding, crest road Base-course and ACBs.
3) Payment: Payment shall be made at the contract unit price per cubic yard

c. 3.3 - Sheetpile PZ-22 Structure & Grade Control

1) This item is for Sheetpile construction at the Diversion Structure, Grade Control Structure and Fish Passage Channel including furnishing, installation, splicing and sheet cutting in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved cross-sectional area of installed sheet pile. Cross section area will be measured in a vertical plane through the centerline of the wall. Installation depth to be documented by the Contractor and installed sheetpile wall length measured by survey or approved field measurement. Each approved sheetpile splice will be measured as an additional 3 square feet of sheet pile. Sheet Pile cut-offs 10 square feet or less in area will be paid at the contract unit price less 20 percent
3) Payment: Payment shall be made at the contract unit price per square foot

d. 3.4 - Sheetpile Concrete Cap

1) This item is for sheetpile concrete cap at the Grade Control Structure and the Fish Passage Channel including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved length, calculated by survey, of sheetpile cap construction
3) Payment: Payment shall be made at the contract unit price per lineal foot

e. 3.5 - Grade Control Boulders & Riprap

1) This item is for Boulders and Riprap including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed area and depth shown on the Drawings, of boulder and riprap construction
3) Payment: Payment shall be made at the contract unit price per cubic yard

f. 3.6 - Reinforced Concrete - Slabs

1) This item includes procuring, batching, transporting, forming, placing, vibrating, finishing, and curing reinforced structural concrete for the diversion structure floor and cutoffs. This item also includes procuring transporting, and installing reinforcing steel, accessories (such as waterstop), and joint preparation
2) Measurement: Measurement for payment will be based on approved volume (cubic yards) of concrete placed to the neat lines and grades shown on the Drawings.
3) Payment: Payment shall be made at the contract unit price per cubic yard

g. 3.7 - Reinforced Concrete - Walls

1) This item includes procuring, batching, transporting, forming, placing, vibrating, finishing, and curing reinforced structural concrete for the diversion walls. This item also includes procuring transporting, and installing reinforcing steel, accessories (such as waterstop), and joint preparation
2) Measurement: Measurement for payment will be based on approved volume (cubic yards) of concrete placed to the neat lines and grades shown on the Drawings.
3) Payment: Payment shall be made at the contract unit price per cubic yard

h. 3.8 - Vehicle Bridge - Contech

1) This item is for Prefabricated Vehicle Bridge indicated on the diversion structure including furnishing and installation. This item includes a reinforced concrete deck and guard rails
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

i. 3.9 - Hinged Crest Gate

1) This item is for the Hinged Crest Gate (including associated controls and instruments) furnishing, installation, testing and commissioning
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

j. 3.10 - Control Building - Prefabrication structure

1) This item is for Control Building including furnishing and installation of the building, electrical features, electrical supply from new transformer (furnished and installed by the Owner), controls, instruments (excludes Hinged Crest Gate and associated controls and instruments)
2) Measurement: Measurement for payment based on the approved schedule of values

3) Payment: Payment shall be made at the contract price per lump sum

k. 3.11 - Miscellaneous Metal Work

1) This item is for Miscellaneous Metal Work including furnishing and installation of 5'Wx4'H slide gate (including controls), grating, hand railing allowance, structural survey points and staff gage
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

l. 3.12 - Rip Rap (D50-6") Adjacent to HWY 40 Access Road

1) This item is for Riprap (D50 - 6") including furnishing and installation on the Highway 40 access road embankment slopes and culvert ditch in compliance with the Drawings and Specifications. Riprap is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed area and depth shown on the Drawings, of installed riprap
3) Payment: Payment shall be made at the contract unit price per cubic yard

m. 3.13 - Bedding below Riprap (below slope riprap only) Adjacent to HWY 40 Access Road

1) This item is for Riprap Bedding including furnishing and installation below riprap on the Highway 40 access road slopes and culvert ditch in compliance with the Drawings and Specifications. Bedding is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed area and depth shown on the Drawings, of installed riprap bedding
3) Payment: Payment shall be made at the contract unit price per cubic yard

n. 3.14 - Base-coarse US 40 Entrance drive & parking

1) This item is for Road Base (Base Course) including furnishing and installation on the Highway 40 access road and parking area adjacent to the diversion structure in accordance with the Drawings and Specifications. This item includes procuring from offsite sources, transporting, placing, spreading, grading, moisture conditioning, and compaction
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed length or approved field

measurement length and width/depth shown on the Drawings, of road base construction

3) Payment: Payment shall be made at the contract unit price per cubic yard

o. 3.15 - Asphalt Apron off US 40

1) This item is for Asphalt Apron including furnishing and installation
2) Measurement: Measurement for payment shall be based on the approved tons of installed asphalt
3) Payment: Payment shall be made at the contract unit price per ton

p. 3.16 - US 40 Entrance Swing Gate

1) This item is for a ranch style gate including furnishing and installation
2) Measurement: Measurement for payment shall be based on the approved number of gates installed
3) Payment: Payment shall be made at the contract unit price per item

4. Connectivity Channel

a. 4.1 - CRCC Excavation - Channel

1) This item is for the removal and stockpiling of excavated material associated with the CRCC for waste or reuse
2) Measurement: Measurement for payment will be based on the approved foundation and excavation volume, based on survey before excavation (less the topsoil that has been stripped/removed) to the neat lines on the Drawings
3) Payment: Payment shall be made at the contract unit price per cubic yard

b. 4.2 - CRCC & Floodplain Fill

1) This item is for loading, hauling, placing, compacting fill associated with the Floodplain and CRCC Fill from stockpiles, and/or borrow area in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved volume, based on survey before fill placement and the neat lines on the drawings
3) Payment: Payment shall be made at the contract unit price per cubic yard

c. 4.3 - Riffle Structure CRCC

1) This item is for CRCC Riffle Structures using onsite materials and including screening, stockpiling, reloading and placement/installation
2) Measurement: Measurement for payment will be based on the approved number of CRCC Riffle Structures installed
3) Payment: Payment shall be made at the contract unit price per item

d. 4.4 - Riffle Structure Side Channel

1) This item is for Side Channel Riffle Structures using onsite materials and including screening, stockpiling, reloading and placement/installation
2) Measurement: Measurement for payment will be based on the approved number of Side Channel Riffle Structures installed
3) Payment: Payment shall be made at the contract unit price per item

e. 4.5 - Downstream Diversion Channel w/ Fish Passage Channel

1) This item is for earthworks associated with the Diversion Channel and Fish Passage Channel
2) Measurement: Measurement for payment will be based on the approved excavation volume, based on survey before excavation and to the finished surface neat lines on the Drawings
3) Payment: Payment shall be made at the contract unit price per cubic yard

f. 4.6 - Topsoil Placing from Stockpile

1) This item is for Topsoil including furnishing and installation in compliance with the Drawings and Specifications. This item includes loading and hauling topsoil from stockpiles, spreading, and grading topsoil evenly over the areas to be reclaimed/seeded/planted
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed or approved field measured surface area by the topsoil depth shown on the Drawings, of installed topsoil
3) Payment: Payment shall be made at the contract unit price per cubic yard

g. 4.7 - On-Site Spoiling of Surplus Fills

1) This item is for On-Site Spoiling of Surplus Fills in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved volume, calculated by survey to the neat lines shown on the Drawings for Spoils or Surplus Fills
3) Payment: Payment shall be made at the contract unit price per cubic yard

h. 4.8 - Soil Prep (Disk/Harrowing)

1) This item is for Soil Preparation (Disk/Harrowing) in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved area, calculated by survey or approved field measurements, of Soil Preparation areas
3) Payment: Payment shall be made at the contract unit price per acre

i. 4.9 - Soil Amendments and Hydro mulch

1) This item is for Soil Amendments and Hydro mulch including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved area, calculated by survey or approved field measurements, of Soil Amendment and Hydromulch
3) Payment: Payment shall be made at the contract unit price per acre

j. 4.10 - Type A Stabilization

1) This item is for Type A Stabilization including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved length, by survey or approved field measurements, of Type A Stabilization
3) Payment: Payment shall be made at the contract unit price per lineal foot

k. 4.11 - Type B Stabilization

1) This item is for Type B Stabilization including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved length, by survey or approved field measurements, of Type B Stabilization
3) Payment: Payment shall be made at the contract unit price per lineal foot

l. 4.12 - Type C Stabilization

1) This item is for Type C Stabilization including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved length, by survey or approved field measurements, of Type C Stabilization
3) Payment: Payment shall be made at the contract unit price per lineal foot

m. 4.13 - Type D Stabilization

1) This item is for Type D Stabilization including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved length, by survey or approved field measurements, of Type D Stabilization
3) Payment: Payment shall be made at the contract unit price per lineal foot

n. 4.14 - Type E Stabilization

1) This item is for Type E Stabilization including furnishing and installation in compliance with the Drawings and Specifications

2) Measurement: Measurement for payment will be based on the approved length, by survey or approved field measurements, of Type E Stabilization
3) Payment: Payment shall be made at the contract unit price per lineal foot

o. 4.15 - Reservoir Fish Passage Channel

1) This item is for the Reservoir Fish Passage Channel installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract unit price per lump sum

p. 4.16 - Planting Pockets

1) This item is for Planting Pocket installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment based on the number of Planting Pockets installed
3) Payment: Payment shall be made at the contract unit price per item

q. 4.17 - Boulder Habitat Clusters

1) This item is for Boulder Habitat Cluster Boulders including furnishing and installation in compliance with the Drawings and Specifications. Boulders to be sourced from Northern's Quarry
2) Measurement: Measurement for payment will be based on approved number of Boulders installed
3) Payment: Payment shall be made at the contract unit price per item

r. 4.18 - Spillway Channel Narrowing

1) This item is for the Spillway Channel Narrowing installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract unit price per lump sum

s. 4.19 - Zone 1 Seed Mix

1) This item is for Zone 1 Seed Mix including procuring, transporting, and placing in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on approved area, calculated by survey or approved field measurement, of Zone 1 Seed Mix
3) Payment: Payment shall be made at the contract unit price per acre

t. 4.20 - Zone 2 Seed Mix

1) This item is for Zone 2 Seed Mix including procuring, transporting, and placing in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on approved area, calculated by survey or approved field measurement, of Zone 2 Seed Mix
3) Payment: Payment shall be made at the contract unit price per acre

u. 4.21 - Zone 3 Seed Mix

1) This item is for Zone 3 Seed Mix including procuring, transporting, and placing in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on approved area, calculated by survey or approved field measurement, of Zone 3 Seed Mix
3) Payment: Payment shall be made at the contract unit price per acre

v. 4.22 - Zone 4 Seed Mix

1) This item is for Zone 4 Seed Mix including procuring, transporting, and placing in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on approved area, calculated by survey or approved field measurement, of Zone 4 Seed Mix
3) Payment: Payment shall be made at the contract unit price per acre

w. 4.23 - Zone 5 Seed Mix

1) This item is for Zone 5 Seed Mix including procuring, transporting, and placing in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on approved area, calculated by survey or approved field measurement, of Zone 5 Seed Mix
3) Payment: Payment shall be made at the contract unit price per acre

x. 4.24 - Zone 6 Seed Mix

1) This item is for Zone 6 Seed Mix including procuring, transporting, and placing in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on approved area, calculated by survey or approved field measurement, of Zone 6 Seed Mix
3) Payment: Payment shall be made at the contract unit price per acre

y. 4.25 - Shrubs D40

1) This item is for Shrubs D40 including transportation, installation in compliance with the Drawings and Specifications, and return of reusable items to the Nursery. Shrubs for Nursery pick up will be furnished by the Owner

2) Measurement: Measurement for payment shall be based on number of approved D40 shrubs installed
3) Payment: Payment shall be made at the contract unit price per item

z. 4.26 - Shrubs D60

1) This item is for Shrubs D60 including transportation, installation in compliance with the Drawings and Specifications, and return of reusable items to the Nursery. Shrubs for Nursery pick up will be furnished by the Owner
2) Measurement: Measurement for payment shall be based on number of approved D60 shrubs installed
3) Payment: Payment shall be made at the contract unit price per item

aa. 4.27 - Shrubs No 5

1) This item is for Shrubs No 5 including transportation, installation in compliance with the Drawings and Specifications, and return of reusable items to the Nursery. Shrubs for Nursery pick up will be furnished by the Owner
2) Measurement: Measurement for payment shall be based on number of approved No 5 shrubs installed
3) Payment: Payment shall be made at the contract unit price per item

~~bb. 4.28 - Large Woody Debris Type A Stabilization~~

~~1) This item is for Large Woody Debris (12 inch diameter) furnishing and installation in compliance with the Drawings and Specifications. Item includes the use of onsite trees removed as part of Item 26, tree preparation, hauling, excavation for installation, placement and backfilling.~~
~~2) Measurement: Measurement for payment shall be based on number of approved Large Woody Debris' installed~~
~~3) Payment: Payment shall be made at the contract unit price per item~~

cc. 4.29 - Erosion Control Blanket

1) This item is for Geotextile beyond channel limits including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved area, calculated by survey or approved field measurement, of Geotextile. Lapping areas will not be paid
3) Payment: Payment shall be made at the contract unit price per square yard

~~dd. 4.30 - Establishment Watering System~~

~~1) This item is for Watering System including furnishing and installation in compliance with the Drawings and Specifications~~
~~2) Measurement: Measurement for payment based on the approved schedule of values~~
~~3) Payment: Payment shall be made at the contract unit price per lump sum~~

ee. 4.31 - Establishment Watering

1) This item is for Establishment Watering and is included as an allowance
2) Measurement: Measurement for payment will be based on the approved instances of watering
3) Payment: Payment shall be made at the contract unit price per item

ff. 4.32 - Weed Management – During Construction

1) This item is for Weed Management during construction and is included as an allowance
2) Measurement: Measurement for payment will be based on the approved number of treatments
3) Payment: Payment shall be made at the contract unit price per item

gg. 4.33 - Weed Management – Post Construction

1) This item is for Weed Management post construction and is included as an allowance
2) Measurement: Measurement for payment will be based on the approved number of treatments
3) Payment: Payment shall be made at the contract unit price per item

~~hh. 4.34 - Planting & Seeding Warranty~~

~~1) This item is for Plantings and Seeding Warranty and is based on 1 year 10% replacement and includes materials for replanting/reseeding~~
~~2) Measurement: Measurement for payment based on the approved schedule of values~~
~~3) Payment: Payment shall be made at the contract unit price per lump sum~~

ii. 4.35 - Adjustments or Modifications after Construction

1) This item is for adjustments and modifications following construction and is included as an allowance
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract unit price per hour

~~jj. 4.36 - Lodgepole Pines~~

~~1) This item is for 12" diameter 20' long lodgepole pines including furnishing and installation~~
~~2) Measurement: Measurement for payment shall be based on the approved number of imported lodgepole pines installed~~
~~3) Payment: Payment shall be made at the contract unit price per item~~

5. Fraser Gauge Modifications

a. 5.1 - Existing Concrete Weir Modifications

1) This item is for modifications to existing concrete weir in compliance with the Drawings and Specifications. This item includes disposal or waste material off site
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

b. 5.2 - Channel Riverbed Fill

1) This item is for Riverbed Fill including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

c. 5.3 - Channel Regrading Excavation

1) This item is for Channel Regrading Excavation and Stockpiling in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

d. 5.4 - Grade Control Weir

1) This item is for Grade Control Weir boulders & riprap including furnishing and installation in compliance with the Drawings and Specifications. Riprap is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

e. 5.5 - Riprap - Bank Stabilization D50-18"

1) This item is for Riprap (D50-18") including furnishing and installation in compliance with the Drawings and Specifications. Riprap is to be sourced from Northern's quarry and may require blasting, crushing, screening and will require hauling to the Project site
2) Measurement: Measurement for payment will be based on the approved volume, calculated by surveyed area and depth shown on the Drawings, of installed riprap
3) Payment: Payment shall be made at the contract unit price per cubic yard

f. 5.6 - 18"-24" Habitat Boulders

1) This item is for Habitat Boulders including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the number of approved Habitat Boulders installed
3) Payment: Payment shall be made at the contract unit price per item

g. 5.7 - Geotextile Fabric

1) This item is for Geotextile below the riprap including furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

h. 5.8 - Boat & River Crossing

1) This item is for Articulated Concrete Blocks furnishing and installation in compliance with the Drawings and Specifications
2) Measurement: Measurement for payment will be based on the approved area, calculated by survey, of Articulated Concrete Block construction
3) Payment: Payment shall be made at the contract unit price per square foot

i. 5.9 - Access Road

1) This item is for Road Base (Base Course) including furnishing and installation in compliance with the Drawings and Specifications. This item includes procuring from offsite sources, transporting, placing, spreading, grading, moisture conditioning, and compaction
2) Measurement: Measurement for payment based on the approved schedule of values
3) Payment: Payment shall be made at the contract price per lump sum

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 31 30
PROJECT COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 WORK INCLUDED IN THIS SECTION

A. The work of this section includes coordination; preconstruction meeting; progress meetings; and task startup meetings.

1.2 COORDINATION

A. Coordinate scheduling, submittals, and work of the various sections of the Specifications to assure efficient and orderly sequence of installation of interdependent construction elements.

B. Coordinate all work with progress meetings to explain unique features of the Work to the work forces. The Engineer may attend such meetings. Meet daily with the Engineer to explain work progress, quality control, and any issues affecting successful completion of the Work.

C. Coordinate completion and clean up of work of separate sections in preparation for Substantial Completion.

D. After Owner occupancy of premises, coordinate access to site for correction of defective work and the work not in accordance with Contract Documents, to minimize disruption of the Owner's activities.

1.3 PRECONSTRUCTION MEETING

A. Within 10 days after Notice to Proceed and prior to starting the Work (except mobilization), the Contractor, accompanied by a representative from each principal subcontractor, shall meet with the Owner and the Engineer for a Preconstruction Meeting. The Preconstruction Meeting will be scheduled by the Owner. The principal features of the Work will be reviewed and any questions regarding the Contract and work Site will be addressed.

B. Attendance Required: the Owner, the Engineer, the Colorado State Engineers Office (SEO) Representative, the Contractor's Superintendent, the Contractor's Safety and Health Officer, principal subcontractors, and other key personnel as requested by the Contractor, Owner, or Engineer.

C. Bring the following schedules to the Preconstruction Meeting:

1. Preliminary Construction Schedule.
2. Procurement Schedule.
3. Shop Drawings and other submittal schedules.
4. Schedule of Values.

D. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda will include the following:

1. Distribution of Contract Documents, including Contractor's executed bond, certificate of insurance, and Contract.
2. Submission of list of subcontractors, list of Products, schedule of values, and preliminary progress schedule.
3. Designation of personnel representing the parties in the Contract, and the Engineer.
4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
5. Contractor's schedules.
6. Critical Work sequencing.
7. Procedures for processing Applications for Payment.
8. Field decisions and Change Orders.
9. Use of premises by the Owner, Engineer and Contractor.
10. Owner's requirements.
11. Construction facilities and controls provided by the Owner.
12. Use of premises, office and storage areas, security, housekeeping, and the Owner's needs.
13. Survey and layout.
14. Security and housekeeping procedures.
15. Contractor's assignments for safety and first aid.
16. Quality Control and Inspection Program.
17. Procedures for maintaining record documents.
18. Major equipment deliveries and priorities.
19. Requirements for startup of equipment.
20. Inspection and acceptance of equipment put into service during construction period.
21. Office of the State Engineer requirements.
22. Record drawings.

E. The Engineer will preside at the conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

1.4 PROGRESS MEETINGS

A. The Engineer will schedule and hold regular progress meetings at least weekly and at other times, as requested by the Owner or required by progress of the Work. The purpose of the meetings will be to review the progress of the Work, review the three-week (3-week) look ahead schedule, maintain coordination of efforts, discuss changes in scheduling, and resolve other issues which may develop.

B. Additional meetings may be called by the Owner, Engineer, or Contractor during any stage of the project when it is deemed necessary to raise any significant questions, establish new guidelines, introduce a new aspect to the project, or any other items that will affect the progress of the Work.

C. Meetings may take place at the project Site or some other location that is satisfactory to the Owner, Engineer, and Contractor.

D. The Engineer will make arrangements for meetings, preside at meetings, and prepare agendas with copies for participants.

E. Attendance Required: The Contractor and all Subcontractors active on the site shall be represented. The Contractor may, at its discretion, request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.

F. All expenses associated with attending the meetings that are incurred by those other than the Owner and the Engineer shall be borne by the Contractor.

G. Proposed Agenda:

1. Review and approval of minutes of previous meetings.
2. Review of the Work progress and minutes of previous meeting.
3. Field observations, problems, conflicts, and decisions.
4. Identification of problems which impede the schedule and proposed corrective actions.
5. Review of submittals schedule and status of submittals; expedite as required.
6. Requests for information status.
7. Review of offsite fabrication and delivery schedules.
8. Revisions to project schedule.
9. Maintenance of progress schedule.
10. Corrective measures and procedures to regain projected schedules.
11. Planned progress during succeeding Work period.
12. Coordination of project schedules and projected progress. Review of three week look-ahead schedule provided by the Contractor to ensure proper coordination with the Owner, Engineer, and subcontractors.
13. Maintenance of quality, and Safety and Work standards.
14. Pending changes and substitutions.
15. Effect of proposed changes on progress schedule and coordination, and effect on other contracts of the project.
16. Other business relating to the Work.

H. The Engineer will document the meeting; include significant proceedings and decisions and distribute copies after the meeting to participants.

1.5 TASK START-UP MEETING

A. Before the start of any significant site activity, as determined by the Engineer, conduct a startup meeting to discuss procedures, quality control, inspections, and related activities. Attendance at the meeting should include the Contractor Project Manager, Site Supervisor, representatives of key Subcontractors, and the Engineer and his designated representatives. Notify the Engineer at least 72 hours in advance of meeting to allow the Engineer to invite necessary offsite personnel.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.1 SUMMARY

A. Construction Progress Schedule developed in accordance with this Section and the General Conditions.

B. The Contractor is required to provide all information and input for development of the Construction Progress Schedule in accordance with this Section and the General Conditions.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. With each Progress Schedule submission provide the following:

1. Contractor certification that Progress Schedule submission is the actual Schedule being utilized for execution of the Work and certification by all Subcontractors with 10 percent or more of Work that they concur with Contractors progress schedule submission.
2. Three legible copies of the Progress Schedule.

C. Preliminary Construction Schedule:

1. Unless otherwise provide in the Contract Documents, within 10 days following the effective date of the Agreement, prepare and submit a preliminary Critical Path Method (CPM) Gantt construction schedule covering all Work to be done on the Project. Include the major construction activities, their durations and start/finish dates.
2. The Gantt schedule and subsequent revisions shall be submitted to the Owner and shall reflect the actual progress of the Project to within 5 days prior to submittal.
3. If the Schedule or any subsequent revision is not acceptable to the Owner, the Schedule shall be revised and resubmitted as many times as necessary until the Schedule is acceptable. Acceptance of the Schedule will not be unreasonably withheld.
4. The initial Progress Schedule, when accepted by the Owner, will be the Project Baseline Schedule.

D. Monthly Progress Schedule: Submit adjusted schedule or confirm validity of current schedule with each monthly Application for Payment in accordance with this Section and the General Conditions, and at such other times as necessary to reflect the following:

1. Progress of Work to within 5 days prior to submission.
2. Changes in Work scope and activities modified since submission.
3. Delays in Submittals or resubmittals, deliveries, or Work.
4. Adjusted or modified sequences of Work.
5. Other identifiable changes.
6. Revised projections of progress and completion.

E. Submittals, Shop Drawings and Engineering Data Schedule.

1. At the time the preliminary Gantt progress schedule is submitted, submit a schedule for materials, equipment, qualifications, plans, and data for which Shop Drawings and/or engineering data required by the Specifications. For each required submittal item, the date shall be given for intended submission of the item to Engineer for review and the date required for its return to avoid delay in any activity beyond the scheduled start date. Sufficient time shall be allowed for initial review, correction and resubmission, and final review of all submittals.

F. Narrative Progress Report: Submit with each monthly submission of Progress Schedule.

1.3 PROGRESS OF THE WORK

A. If the Contractor fails to complete an activity by its latest scheduled completion date and this failure may extend Contract Times (and/or Milestones), within 7 days of such failure, submit a written statement as to how the Contractor intends to correct nonperformance and return to the acceptable current Progress Schedule. Actions by the Contractor to complete the Work within Contract Times (or Milestones) will not be justification for adjustment to the Contract Price or Contract Times.

B. The Engineer may request a schedule recovery or mitigation plan if the Contractor fails to: (i) complete a critical scheduled activity by its latest Milestone completion date, or (ii) satisfactorily execute Work as necessary to prevent delay to the overall completion of the Work.

1.4 PRELIMINARY CONSTRUCTION SCHEDULE

A. As a minimum, submit two computer generated Critical Path Method (CPM) schedules as follows:

1. Project Overview Plan: Show major components of the Work and the sequence relations between major components and subdivisions of major components. The chart shall indicate the relationship and time frames in which the various facilities will be made substantially complete and placed into service in accordance with the Project Milestones. Sufficient detail shall be included for the identification of subdivisions within major components such as:

a. Mobilization
b. Submittals
c. Clearing, Grubbing, and Stripping
d. Water management infrastructure.
e. Sediment and erosion control, and environmental compliance measures.
f. Site access roads
g. Demolition
h. Dam
i. Diversion Structure
j. Connectivity Channel
k. Fraser Gauge
l. Reclamation of Disturbed Areas
m. Start-up and Testing
n. Substantial Completion
o. Final Completion
p. Demobilization

B. Planned durations and start dates shall be indicated for each Work item subdivision. Work item durations for any activity shall not exceed 30 working days. Each major component and subdivision component shall be accurately plotted on time scale sheets 11 inches by 17 inches or 24 inches by 36 inches in size. Not more than four sheets shall be employed to represent this overview information.

C. Submit in accordance with Section 01 33 00: Submittals.

D. The Preliminary Construction schedule, when accepted by the Engineer, will be the Project Baseline Schedule.

1.5 PROGRESS SCHEDULE

A. General:

1. Schedule(s) shall reflect Work logic sequences, restraints, delivery windows, review times, Contract Times, and Milestones set forth in the Agreement, and shall begin with the date of Notice to Proceed and conclude with the date of Final Completion.
2. The schedule requirement herein is the minimum required. The Contractor may prepare a more detailed schedule if such will aid the Contractor in execution and timely completion of the Work.
3. Submit assumptions for base schedule describing work week duration, numbers of shifts, hours per shift, holidays, assumed weather days, assumed productivity, crew size, etc.
4. Adjust or confirm schedules in accordance with this Section and the General Conditions on a monthly basis.
5. The update of the Project Schedule shall be an integral part of the estimate upon which progress payments will be made. If, in the judgment of the Owner, the Contractor fails or refuses to provide information required to accomplish a complete Project Schedule Update or revision as specified hereafter, the Contractor shall be deemed to have not provided the required estimate upon which progress payments may be made, and shall not be entitled to progress payments until it has furnished the information necessary for a complete schedule update to the satisfaction of the Owner.
6. Float time is a Project resource available to both parties to meet contract Milestones and Contract Times.
7. Use of float suppression techniques such as preferential sequencing or logic, special lead/lag logic restraints, and extended activity times are prohibited, and use of float time disclosed or implied by use of alternate float-suppression techniques shall be shared to proportionate benefit of the Owner and Contractor.
8. Pursuant to above float-sharing requirement, no time extensions will be granted nor delay damages paid until a delay occurs which (i) impacts Project's critical path; (ii) consumes available float or contingency time; and (iii) extends Work beyond contract completion date.
9. If the Contractor provides an accepted schedule with an early completion date, The Owner reserves the right to reduce Contract Times to match the early completion date by issuing a deductive Change Order at no change in the Contract Price.

B. Format:

1. Computer generated baseline schedule, on maximum 11-inch by 17-inch or 24-inch by 36-inch sheet size to include at least:

    a. Identification and listing in chronological order of those activities reasonably required to complete the Work, including, but not limited to, subcontract work, fabrication, and delivery dates including required lead times, move-in and other preliminary activities, Project closeout and cleanup, specified Work sequences, constraints, and Milestones, including Substantial Completion date(s). Listings to be identified by Specification section number.
    b. Identify: (i) horizontal time frame by year, month, and week; (ii) duration, early-start, and completion for each activity and subactivity; (iii) critical activities and Project float; (iv) assumed weather allowances; (v) planned holidays; (vi) production rates; and (vii) assumed work hours per day and number of work days per week.
    c. Subschedules to further define critical portions of the Work.
    d. Monthly Schedule Submissions: Show overall percent complete, projected and actual, and completion progress by listed activity and subactivity.

1.6 NARRATIVE PROGRESS REPORT

A. Include, as a minimum:

1. Summary of Work completed during the past period between Narrative Progress Reports.
2. Work planned during the next period.
3. Explanation of differences between summary of Work completed and Work planned in previously submitted Narrative Progress Report.
4. Current and anticipated delaying factors and their estimated impact on other activities and completion Milestones.
5. Corrective actions taken or proposed.

1.7 REPORTS

A. Submit a status report signed by the Contractor weekly to the Engineer at the weekly progress meeting. Delinquency in submitting weekly status reports may result in delay of progress payments. The weekly status report shall include a summary of completed work, and a 3-week "Look Ahead" bar chart schedule.

B. Submit a monthly progress report, listing all construction activities and their scheduled completion dates. Activities shall show the percent completion and the days required for completion and shall be forwarded to the Engineer no later than the fifth (5^{th}) working day after the last working day of the month the report is based on. Requests for progress payments shall be accompanied by the latest pertinent report.

1.8 CLAIMS FOR ADJUSTMENT OF CONTRACT TIMES

A. Reference the General Conditions.

B. Where the Engineer and Owner have not yet rendered formal decision on the Contractor's claim for adjustment of Contract Times, and parties are unable to agree as to amount of adjustment to be reflected in progress schedule, reflect that amount of time adjustment in progress schedule as the Engineer and Owner may accept as appropriate for

the interim. It is understood and agreed that such interim acceptance by the Engineer and Owner will not be binding and will be made only for purpose of continuing to schedule Work, until such time as formal decision as to an adjustment, if any, of the Contract Times acceptable to the Engineer and Owner has been rendered. Revise the progress schedule prepared thereafter in accordance with the Engineer's and Owner's formal decision.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 33 00
SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal requirements. Submittals shall be in accordance with this Section and the General Conditions.

1.2 CONFLICTS

A. In the event of conflict between this Section and the General Conditions, the more restrictive requirements shall apply.

1.3 DEFINITIONS

A. Work-related submittals of this Section are categorized for convenience as follows:

1. Product Data: Product Data includes standard printed information on materials, products, and systems not specifically prepared for the Work, other than designation of selections from among available choices printed therein.
2. Shop Drawings: Shop Drawings include specially prepared technical data for the Work, including drawings, diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, instructions, measurements, and similar information not in standard printed form for general application to other contracts.
3. Samples: Samples include both fabricated and unfabricated physical examples of materials, products, and units of Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or, where indicated, for more detailed testing and analysis.
4. Miscellaneous Submittals: Miscellaneous Submittals include construction permits, reports, Stormwater Management Plan, Spillway Prevention Control and Countermeasure Plan, Health and Safety Plan, work plans required for various parts of the Work, Project photographs, survey data and reports, physical Work records, quality testing and certifying reports, copies of industry standards, record drawings, field measurement data and similar information, devices and materials applicable to the Work and not processed as Product Data, and Shop Drawings or Samples.

1.4 QUALITY ASSURANCE

A. Submittals shall verify compliance with the Contract Documents and shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and operation of component materials and devices; the external connections, anchorages, and supports required; performance characteristics; and dimensions needed for installation and correlation with other materials and equipment. When an item consists of components from several sources, submit a complete initial submittal including all components.

B. The Engineer will review submittals only for general conformance with the design intent. Such review by the Engineer shall not relieve the Contractor or any subcontractor of responsibility for full compliance with Contract requirements; for correctness of dimensions, clearances, and material quantities; for proper designing of details; for

proper fabrication and construction techniques; for proper coordination with other trades; or for providing all devices required for safe and satisfactory construction and operation.

1.5 SUBMITTAL SEQUENCING AND SCHEDULING

A. Coordinate preparation and processing of submittals with performance of the Work so that Work will not be delayed by submittal preparation, review and acceptance.

B. Coordinate and sequence different categories of submittals for the same Work, and for interfacing units of Work, so that one will not be delayed for coordination with another.

C. Make all submittals far enough in advance of scheduled installation/construction dates to provide all time required for reviews, for possible revisions and resubmittals, and for placing orders and securing delivery. Submittals shall be received at least 21 calendar days prior to any scheduled work for the activity covered by the submittal, unless otherwise noted in individual Specification Sections or agreed to in writing by the Engineer.

D. Timing of submittals shall allow for review time by the Engineer. The Engineer's submittal review period will be 14 consecutive calendar days commencing on the first calendar day following receipt of the submittal or resubmittal in the Engineer's office. The time required to mail the submittal or resubmittal back to the Contractor is not considered a part of the submittal review period

E. Contractor scheduling shall include preparation of a Submittal Schedule to be coordinated with the Contractor’s construction sequencing and scheduling, including allowance for the Engineer’s review time.

1.6 SUBMITTALS

A. Submit a log of all submittals required by the Specifications with planned submittal dates coordinated with the Contractor’s construction sequencing and scheduling including allowance for the Engineer’s review time and organized by Section and Paragraph.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.1 SUBMITTAL PROCEDURES

A. Process submittals in accordance with this section.

B. Resubmissions will be handled in the same manner as first submissions. Direct specific attention, in writing or on the resubmittal, to revisions other than the corrections requested by the Engineer on previous submittals using the notation specified in this Section. All requirements specified for initial submittals also apply to resubmittals. Resubmittals shall be made within 7 days of the date of the letter returning the material to be modified or corrected.

C. Transmit submittals with a pre-printed letter of transmittal form of Contractor's choosing, dated and signed, with the job title and Section(s) of the Specification requiring the submittal clearly indicated. The forms shall be sequentially numbered based on Section

(e.g., 03 33 00-1, 03 33 00-2 etc.) Resubmittals shall have the original number together with an alphabetic suffix (A, B, C….) indicating the number of resubmittals.

D. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. Indicate the current revision, issue number, and date on all drawings and other descriptive data. Identify specific variations from the Contract Documents and Product or system limitations which conflict or may be detrimental to successful performance of the completed Work.

E. By signing the submittal, the Contractor certifies that review, verification of products required, field dimensions, and coordination of information is in accordance with the Work, as specified in the Contract Documents.

F. Submittal shall contain Contractor's executed review and approval marking. Provide space for the Contractor's stamp and the Engineer's review stamp (approximately 3½ inches by 2½ inches).

G. Submittals which are received from sources other than through the Contractor's office will be returned "without action."

H. Revise and submit resubmittal as required and identify all changes made since the previous submittal.

I. Distribution:

1. Distribute copies of reviewed submittals to all Subcontractors whose Work will interface with the subject of the submittal.
2. Provide additional distribution of submittals (not included in other copy submittal requirements specified in this Section) to Subcontractors, suppliers, fabricators, installers, governing authorities and others as necessary for performance of the Work.
3. Submit hard copies as follows:

    a. One copy to the Owner.
    b. Three copies to the Engineer.

4. The Engineer will return one electronic copy to the Contractor marked with review comments. The Engineer will not accept submittals from anyone but the Contractor.

J. Electronic Submittals:

1. Furnish submittals including shop drawings in legible electronic format. At the Engineer’s request, provide hard copies of complicated or oversized submittals in addition to providing them electronically. For electronic submittals, submit to the Engineer as specified below.
2. Electronic submittal documents may be in black and white unless color is required for the review of the submittal. All electronic files shall be in Portable Document Format (PDF) as generated by Adobe Acrobat Professional Version 7.0 or later.
3. PDF document properties shall include the submittal number for the document title and the Contractor's name for the author. Electronic submittal file sizes shall

be limited to 10 MB. When multiple files are required for a submittal, the least number of files possible shall be created.

4. Electronic submittal requirements also apply to proprietary project documentation management systems if used. Include access to such system to specific individuals or entities as directed by the Engineer.

3.2 PROPOSED PRODUCT LIST

A. Within 30 days from execution of the Agreement between the Owner and Contractor, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product, and the lead time for procurement, fabrication and delivery of all products with a lead time of more than 30 days.

B. For products specified only by reference standards, give manufacturer, trade names, model or catalog number, and reference standard.

3.3 PRODUCT DATA, SHOP DRAWINGS, AND SAMPLES

A. Product Data:

1. Collect required data into one submittal for each unit of Work or system; and mark each copy to show which choices and options are applicable to the Work. Include manufacturer's standard printed recommendations for application of labels and seals, notation of field measurements, which have been checked, and special coordination requirements.
2. Maintain one set of Product Data (for each submittal) at project site, available for reference by the Engineer/Owner and others.
3. Submit number of copies required by the Contractor plus 2 copies which will be retained by Engineer.
4. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide all information unique to this Project.

B. Shop Drawings:

1. Submit number of copies required by the Contractor plus 2 copies which will be retained by the Engineer.

C. Samples:

1. Provide units identical with final condition of proposed materials or products for the Work.
2. Include "range" samples (not less than 3 units) where unavoidable variations must be expected, describe or identify variations that must be expected, and describe or identify variations between units of each set.
3. Provide a full set of optional samples where the Engineer's/Owner's selection is required. Prepare samples to match the Engineer's sample, where so indicated.
4. Include information with each sample, where so indicated. Include information with each sample to show generic description, source or product name and manufacturer, limitations, and compliance with standards. Samples are submitted for review and confirmation of color, pattern, texture, and "kind" by the Engineer.

5. The Engineer will not "test" samples (except as otherwise indicated), for compliance with other requirements, which are therefore the exclusive responsibility of the Contractor.

3.4 MISCELLANEOUS SUBMITTALS

A. Construction Permits:

1. Acquire, maintain, and submit 3 copies of all construction permits (except Owner's acquired permits) that are required by the agencies to execute the Work.

B. Manufacturers' Instructions:

1. When specified in individual Specification Sections, submit 3 copies of manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing.
2. Identify conflicts between manufacturers' instructions and the Contract Documents.

C. Manufacturers' Certificates:

1. When specified in individual Specification Sections, submit 3 copies of manufacturers' certificates to the Engineer.
2. Indicate that a material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
3. Certificates may be recent or previous test results (within one year), on material or Product; but must be applicable to the Product and acceptable to the Engineer.

D. Tests and Test Reports:

1. Classify each as either "project related" or Product Data, depending upon whether the report is uniquely prepared for the Project, or a standard publication of workmanship control testing at point of production, and process accordingly.
2. All test equipment used shall be verified to be in calibration at the time of each test and test reports shall so indicate. No test shall be made without such verification.

E. Substitution Request:

1. When the Contractor desires to use a product, procedure, or other item not detailed in the Drawings or Specification, a substitution request must be submitted including the following:

   a. Reason for substitution
   b. Schedule of costs

2. The Substitution request must be submitted at least 14 calendar days prior to the planned procurement.

3.5 SUBMITTALS PROCESSING

A. Submittals reviewed by the Engineer and returned to the Contractor will be marked with one of the following designations:

1. No Exceptions Taken

2. Furnish As Noted
3. Revise and Resubmit
4. For Information Only

B. Revise and Resubmit

1. Do not proceed with manufacture.
2. Make corrections and resubmit.

C. Furnish As Noted

1. The Contractor may proceed with manufacture at its own risk on the basis of incorporating all comments noted on the returned drawings and data.
2. Make corrections and resubmit.

D. No Exceptions Taken

1. Construction may be carried out in accordance therewith and no further changes made therein except upon written instructions from the Engineer. Final drawings (paper, Mylar, or electronic) and/or microfilms shall be submitted to the Engineer.

E. For Information Only

1. Submittals returned with For Information Only indicate they do not require action, and the response is to acknowledge receipt.

END OF SECTION

SECTION 01 33 40
CONTRACTOR WORK PLAN

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the Contractor Work Plan.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Prepare and submit a project-specific Work Plan to the Engineer for approval 30 days before starting work at the site. Include the following topics in the Work Plan:

1. Construction implementation plan to include work approach, equipment to be used for each item of construction, methods, and management.
2. Key personnel names and qualifications, list of subcontractors, including an organizational chart and project directory with contact information.
3. Health and Safety Plan. See Section 01 35 29: Health, Safety, and Emergency Response Procedures.
4. Environmental Protection. See Section 01 35 43: Environmental Protection.
5. Waste Handling and Disposal Procedures. See Section 01 74 19: Disposal of Waste Materials.
6. Spill Prevention and Control Procedures. See Section 01 35 43: Environmental Protection.
7. Fire prevention and protection. See Section 01 35 43: Environmental Protection.
8. Dust control. See Section 01 35 43: Environmental Protection (BMPs to be used).
9. Construction sequence and schedule. See Section 01 32 16: Construction Progress Schedule.
10. Construction Quality Control Plan (CQCP). See Section 01 45 00 Quality Control.
11. Construction Water Plan. See Section 01 50 00: Construction Facilities & Temp Controls
12. Access Road and Traffic Control Plan. See Section 01 50 00: Construction Facilities & Temp Controls
13. Parking Plan. See Section 01 50 00: Construction Facilities & Temp Controls
14. Other applicable items to describe work approach.

1.3 WORK PLAN REQUIREMENTS

A. Develop the Work Plan in accordance with the requirements of the individual Sections listed above and any additional requirements in this Section and other Contract Documents. The Work Plan shall be carefully thought out, prepared in accordance with all applicable Federal, state, and local laws and regulations, these specifications, and good engineering and construction practices. Include in the Work Plan a complete discussion of conformance with applicable laws, regulations, guidelines, and other applicable procedures.

B. Incomplete Plans or Plans without sufficient detail will be rejected and revisions required until the Plan is acceptable. The Plan must be approved by the Engineer before beginning field activities.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 35 29
HEALTH, SAFETY, AND EMERGENCY RESPONSE PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. This section covers the requirements for health, safety, and emergency response for the Project including submitting a written Site Health and Safety Plan (HSP) which at a minimum meets the General Conditions and the requirements of this Section, and complies with applicable Federal, state, and local laws and regulations.

B. It is the Contractor's responsibility to provide all facilities, equipment, materials, and personnel necessary to protect the Contractor and other project personnel from physical injury and potential adverse health effects due to exposure to chemical, physical, weather, and other hazardous exposures while performing the Work.

1.2 REFERENCES

A. Occupational Safety and Health Administration (OSHA), 29 Code of Federal Regulations (CFR) 1910, General Industry Safety and Health Standards.

B. OSHA, 29 CFR 1926, Construction Industry Safety and Health Standards.

1.3 SUBMITTALS

A. Submit HSP in accordance with Section 01 33 00: Submittals.

B. Submit the HSP to the Engineer for information only before any construction is initiated.

1.4 HEALTH AND SAFETY PLAN REQUIREMENTS

A. Develop the HSP to identify the sequence of work, the specific hazards anticipated, and the control measures to be implemented to minimize or eliminate each hazard. Develop a job specific activity hazard analysis (AHA) to address the activity being performed, sequence of work, and hazards to be controlled in each activity.

B. Specifically address in the HSP activities that have the potential for personnel being exposed to chemical, dust, and noise hazards. Establish specific requirements and procedures activities that identify and monitor employee exposures, describe personal protective equipment used necessary to eliminate potential exposures, describe additional training on specific chemical hazards, and identify record keeping requirements for personnel monitoring data.

C. HSP Administrative Section:

1. Administrative responsibilities for implementing the HSP (project organization identifying the Contractor personnel responsible for accident prevention).
2. Local requirements, if any (e.g., noise control, traffic ordinances, etc.).
3. Methods the Contractor proposes to use to control and coordinate subcontractor work.
4. Safety Meetings.
5. Plans for initial indoctrination, continued safety education, and training.
6. Safety Inspections.
7. Health and safety monitoring requirements.

8. Emergency response procedures and contingency plans, including fire protection, ambulance service, first aid, communication, etc.
9. Incident reporting and investigations.
10. Record keeping.
11. Other applicable/required health and safety procedures.

D. HSP Activity Hazard Analysis Section:

1. At a minimum address the following:

a. Mobilizing
b. Transporting tools, heavy equipment, and materials to the site.
c. Clearing and grubbing.
d. Dewatering and diversion.
e. Excavation, including shoring and earthwork.
f. Specialty work not otherwise listed here.
g. Industrial Hygiene monitoring
h. Cold and Heat Stress
i. Working in or near water
j. Confined Space procedures if applicable.
k. Heavy equipment operation and refueling procedures.
l. Project feature construction including structures, vaults, pipes, and mechanical equipment.
m. Electrical power connections and hook-ups.
n. Disposal of waste materials.
o. Traffic control.
p. Site reclamation.
q. Demobilization from site.

E. Incident Reporting Section:

1. Include an Incident Reporting section that includes procedures for notifying appropriate parties with the Owner and Engineer immediately following an incident, and procedures and requirements for providing the Owner and Engineer with at least a preliminary written report within 24 hours.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 35 43
ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Landscape preservation, prevention of water pollution, abatement of air pollution, abatement of noise, and temporary drainage provisions.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Complete Environmental Plan. Detail in the Environmental Plan the equipment, materials, and methods that will be used to comply with the requirements in this Section and other applicable regulatory requirements not specifically listed in this Section. This plan shall include a Noxious Weed Management Plan and Wildlife Management Plan.

1.3 LANDSCAPE PRESERVATION

A. Exercise care to preserve the existing landscape outside of specified limits of areas of site disturbance. Conduct construction operations to prevent any unnecessary destruction, scarring, or defacing of natural or man-made surroundings in the vicinity of the Work.

B. Irregularly shape edges of clearings and cuts through trees, shrubbery, and vegetation to soften the visual impact of straight lines. Perform movement of crews and equipment within the right-of-way, within easements, and over routes provided for access to the Work in a manner to prevent damage to vegetation and property.

C. Repair, replant, reseed, or otherwise correct destruction, scarring, damage, or defacing of the landscape resulting from the Contractor's operations as determined by the Owner.

D. The locations, alignments, and grades of construction roads are subject to approval of the Owner. Site clearing shall be conducted in accordance with Section 31 11 00: Clearing and Grubbing. When no longer required by the Contractor, restore areas of construction roads and staging, stockpiling/disposal, and storage areas to the original topographic contours except as otherwise specified for excess excavation materials. Reclaim and reseed all areas disturbed by construction in accordance with Section 32 96 10: Native Planting or 32 92 19: Native Seeding as applicable. Conduct contouring and reclamation work in disturbed areas in such a manner as to provide for proper drainage and to prevent erosion.

E. Except where clearing is required for permanent works, excavation operations, or otherwise allowed for wetland disturbance identified on the Drawings, preserve and protect all trees, shrubbery, vegetation, and wetlands from damage by the Contractor's construction operations and equipment.

F. Exercise special care where trees or shrubs to remain are exposed to injuries by construction equipment, excavating, dumping, chemical damage, or other operations. Adequately protect such trees by use of protective barriers or other methods approved by the Owner. Removal of trees and shrubs shall be permitted only after approval by the Owner.

G. Plan the layout of the Contractor's construction facilities such as shops, trailers, storage areas, and parking areas; location of access and haul routes; and operations in the stockpile areas in such a manner that all trees and shrubbery not approved for removal by the Owner are preserved and adequately protected from either direct or indirect damage by the Contractor's operations.

H. Do not operate equipment within the dripline of any tree to be protected.

I. Do not use trees for anchorages.

J. The Contractor is responsible for injuries to trees and shrubs caused by their operations. The term injury includes bruising, scarring, tearing, and breaking of roots, trunks, or branches. Repair or treat all injured trees and shrubs without delay, at the Contractor's expense. If injury occurs, the Owner will determine the repair method or treatment to be used for injured trees and shrubs as recommended by an experienced horticulturist or vegetation specialist provided by the Contractor.

K. Replace injured trees or shrubs that, in the opinion of the Owner, are beyond saving early in the next planting season. Replace with the same species, or other approved species, and of the maximum size that is practicable to plant and sustain growth in the particular environment. Guy, water, and maintain replacement trees and shrubs for a period of at least one month. Remove and replace any replacement tree or shrub that dies, as directed by the Owner, and maintain for a period of one month from the replacement date. Replacement of injured trees and shrubs not required to be cleared or removed for construction shall be at the Contractor's expense.

1.4 SPILL PREVENTION AND CONTROL

A. Prepare and submit spill prevention and control procedures in the Work Plan. See Section 01 33 40: Contractor Work Plan. Implement spill prevention and control procedures and appropriate containment and diversionary structures, materials, and equipment to prevent and control the maximum spillage of any specific item within the scope of work. This includes the materials and equipment used in connection with this project. The procedures must include sufficient inspections and tests performed on a continuing basis. Furnish qualified personnel, appropriate facilities, instruments, equipment, and testing devices necessary for quality spill prevention and control. The spill prevention and control procedures shall be carefully thought out and prepared in accordance with all applicable Federal, State, and local laws and regulations, and good engineering practices, and address the necessary resources for procedures, methods, and equipment operations.

B. Identify spill prevention and control procedures in the Work Plan as appropriate for the material being handled and hauled by the Contractor. Design, construct, maintain, and operate preparedness and prevention facilities to minimize the possibility of a fire, explosion, or any unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to the air or surface water which could threaten human health or the environment.

C. Implement special measures to prevent chemicals, fuels, oils, greases, bituminous materials, waste washings, herbicides, insecticides, harmful materials, biological materials, and concrete materials from entering the air, waters of the State, utilities, and storage areas.

D. Laws and Regulations: Do not pollute any area with any manmade or natural harmful materials. It is the sole responsibility of the Contractor to investigate and comply with all

applicable Federal, State, county, and municipal laws and regulations concerning spill prevention and control procedures.

E. Communications: Provide internal communications or an alarm system to provide immediate emergency instruction to facility personnel if necessary. Provide a device, such as a telephone immediately available at the scene of operations, capable of summoning emergency assistance from local police departments, fire departments, State or local emergency response teams. Include a project telephone directory in the Work Plan.

F. Dispose of materials required to be disposed of offsite in accordance with applicable Federal, State, and local laws and regulations. See Section 01 74 19: Construction Waste Management and Disposal for additional requirements.

G. Required inspections and documentation shall be in accordance with written procedures developed by the Contractor. These written procedures shall be part of the Work Plan. Maintain a record of the inspections, signed by the appropriate supervisor or inspector, during the project and submit to the Engineer for final close-out.

H. If materials are released, provide a written description of the event, corrective action taken, and plans for preventing recurrence, as well as a written document of manpower, equipment, and materials required to expedite control and removal of any harmful quantity of materials released.

I. The Contractor is responsible for properly instructing Contractor personnel regarding applicable pollution control laws, rules, and regulations and in the operation and maintenance of equipment and BMPs to prevent the discharge of materials. Schedule and conduct spill prevention briefings for its operating personnel at intervals frequent enough to assure adequate understanding of spill prevention and control procedures for this project. Such briefings shall highlight and describe known spill events or failures, malfunctioning components, and recently developed precautionary measures.

J. Designate a person who is responsible for environmental protection to include spill prevention, BMPs maintenance, recordkeeping, permit condition compliance, and who reports to management.

K. Maintain all facility communication systems and spill control equipment as necessary to assure proper operation in time of emergency.

1.5 PREVENTION OF WATER POLLUTION

A. Comply with all project permit requirements, and all other applicable federal, state, and local laws, orders, regulations, permits, and water quality standards concerning the control and abatement of water pollution.

B. Conduct construction activities by means and methods that shall prevent entrance or accidental spillage of solid matter, contaminants, debris, and other pollutants and wastes into streams, flowing or dry water courses, rivers, lakes, and underground water sources.

C. Such pollutants and wastes include refuse, garbage, sediment from erosion of construction areas, concrete wash-out, sanitary waste, industrial waste, radioactive substances, oil and other petroleum products, aggregate processing tailings, mineral salts, and thermal pollution.

D. Do not allow wastewater from construction operations to enter streams, water courses, wetlands, or lakes without passing through suitable sedimentation ponds or treatment facilities approved by the Engineer.

E. Do not use chemicals within 50 feet of, or on slopes leading to waters of the U.S.

F. Except as specifically authorized and necessary for construction, do not stage or store equipment or materials within 50 feet of, or on slopes leading to waters of the U.S.

G. Where the location of a construction site is such that oil or gas from an accidental spillage could reasonably be expected to enter into or upon the waters of the U. S. or adjoining shorelines, and the aggregate storage of oil or gas at the site is over 1,320 gallons, or a single container has a capacity in excess of 660 gallons, prepare a Spill Prevention Control and Counter Measure Plan (SPCC) reviewed and certified by a registered professional engineer in accordance with 40 CFR, Par 112, as required by Public Law 92-500, as amended by Public Law 95-217 and Public Law 95-576.

H. Submit to the Engineer, a certified statement that the SPCC was reviewed and certified by a registered professional engineer.

I. Comply with notification and response requirements required by regulatory agencies or Owner.

1.6 ABATEMENT OF AIR POLLUTION

A. Comply with applicable Federal and State laws and County ordinances and regulations concerning the prevention and control of air pollution.

B. In conducting construction activities and operation of equipment, utilize such practicable methods and devices as are reasonably available to control, prevent, and otherwise minimize atmospheric emissions or discharges of air contaminants.

C. Minimize dust emission into the atmosphere during handling and storage of construction materials, and use such methods and equipment as are necessary to minimize or prevent dust during these operations. Keep earth surfaces subject to dusting moist with water or by application of a chemical dust suppressant if approved and allowed. When practicable, cover dusty materials in piles or in transit to prevent blowing dust.

D. Do not operate equipment and vehicles that are found to have emissions of exhaust gases or particulates that exceed applicable limits established by Federal, State, or local laws or authorities until corrective repairs or adjustments are made. If requested by the Engineer, provide acceptable evidence that equipment and vehicles have been tested for exhaust emissions and have been found to be in compliance with applicable limits.

E. Carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance, and to prevent dust from damaging crops, orchards, cultivated fields, and dwellings, or causing a nuisance to persons or adjacent properties. The Contractor will be held liable for any damage resulting from dust originating from their operations.

1.7 ABATEMENT OF NOISE

A. Comply with applicable Federal and State laws and County ordinances, orders, and regulations concerning the prevention, control, and abatement of excessive noise.

B. Take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. Equip all construction machinery and vehicles with practical sound-muffling devices, and operate in a manner to cause the least noise consistent with efficient performance of the Work.

1.8 TEMPORARY DRAINAGE PROVISIONS

A. Provide for the drainage of storm water, and such water as may be applied or discharged on the site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the site, and adjacent property.

B. Clean, enlarge, or supplement existing drainage channels and conduits as necessary to carry all increased runoff attributable to the Contractor's operations. Construct dikes as necessary to protect the Owner's facilities and the Work, and to direct water to drainage channels or conduits.

C. See also Section 01 57 13: Temporary Sediment and Erosion Control.

1.9 NOXIOUS WEED CONTROL

A. Comply with the site Noxious Weed Program as applicable and the following unless otherwise required by the Noxious Weed Program.

B. Clean and inspect all construction vehicles and equipment before, and anytime they enter the site to ensure that they are free of soil and debris capable of transporting noxious weed seeds or roots, or invasive species of terrestrial or aquatic species. Notify the Owner when construction vehicles and equipment are ready for Owner inspection. No equipment will be allowed on site without Owner approval.

C. Staging areas will not be allowed in weed-infested areas unless the staging area is pre-treated using integrated management. Weed-infested staging areas shall be mowed and cleared of noxious weeds and sprayed with an appropriate and approved herbicide.

D. Areas of planned topsoil stripping shall be assessed for presence and abundance of noxious weeds prior to stripping. Treat areas of topsoil stripping infested with noxious weeds prior to salvage, using methods and products acceptable to the Engineer.

E. Stockpiles of topsoil that remain unmoved for greater than 30 days must be assessed for the presence and abundance of noxious weeds and treated appropriately prior to placement.

F. If construction is completed and permanent seeding cannot occur due to the time of year, a temporary cover crop or other temporary erosion control, if approved by the Engineer, may be used for temporary erosion control until seeding can occur.

G. If offsite borrow material is used for any part of the Project, provide acceptable certification that the material is free of noxious weeds. If any borrow is stockpiled it shall be stabilized and remain weed-free for the duration.

1.10 WILDLIFE MANANGEMENT PLAN

A. Comply with applicable Federal and State laws and County ordinances and regulations concerning interaction with wildlife.

1. Develop a wildlife management plan in conjunction with the owner and engineer that details implementation and compliance with Federal and State laws and County ordinances and regulations concerning interaction with wildlife

B. In conducting construction activities and operation of equipment, utilize such practicable methods and devices as are reasonably available to control, prevent, and otherwise minimize impacts to wildlife.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 41 00
REGULATORY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Responsibilities for obtaining permits in accordance with Federal, State, and local agencies.

1.2 GENERAL PERMIT REQUIREMENTS

A. Comply with the conditions and requirements of all permits required by Federal, State, County, and local governing agencies in the performance of this Contract. If the Contractor fails to comply with the conditions and requirements of any permit and such failure to comply results in fines, penalties, and/or suspension of Work by a regulatory agency, all liability for such fines, penalties and delays are the sole responsibility of the Contractor.

B. The Contractor is responsible for obtaining all permits necessary to complete the Work. The Contractor is also responsible for all monitoring, testing, and corrective measures necessary to maintain the permits throughout the duration of the Project, including modification of or renewal of the permits as necessary. Applicable permits include the following at a minimum:

1. Stormwater Permit – Colorado Department of Public Health and Environment (CDPHE) Construction Stormwater Discharge Permit (COR400000). Includes preparation of a Stormwater Management Plan [SWMP] and a Storm Water Pollution Prevention Plan [SWPPP].
2. Dewatering Permit – Colorado Department of Public Health and Environment (CDPHE) Discharges from Short-term or Long-term Construction Dewatering Activities (COG080000 or COG603000) depending on project schedule.
3. CDOT Special Use and Haul permits.
4. Fugitive Dust.
5. Grand County building or grading permits.

1.3 OWNER OBTAINED PERMITS

A. The Owner is responsible for obtaining certain permits that pertain to the Work. These permits may include the following:

1. United States Army Corps of Engineers' (USACE) Clean Water Act Section 404 Nationwide Permit 27
2. CDOT Region 3 Access Permit, Form No.137
3. NRCS Watershed Plan and Environmental Assessment with signed Finding of No Significant Impact (National Environmental Policy Act (NEPA) compliance)

    a. Includes applicable Section 7 Endangered Species Act, Section 106 National Historic Preservation Act and Migratory Bird Treaty Act compliance measures.

4. Grand County Floodplain Development Permit
5. Colorado Division of Reclamation Mining and Safety Permits

    a. Permits M-1981-085 (Miller Hereford Quarry) and M-1981-086 (Miller Hereford Gravel Barrow)

6. Colorado Department of Public Health and Environment Stormwater Discharge Permits for Sand and Gravel Mining

   a. Permits COG501782 (Miller Herford Quarry) and COG501781 (Miller Hereford Gravel Borrow*)*

7. Tri-State Crossing agreement

B. The Contractor is responsible for implementing and coordinating the terms and requirements of all permits obtained by the Owner.

C. A copy of the permits obtained by the Owner will be provided.

1.4 RESPONSIBILITY AND COORDINATION

A. Accept full responsibility for contacting all Federal, State, and local agencies to obtain permitting requirements for construction related activities on lands under jurisdiction by those agencies and be fully responsible to research and become familiar with regulatory requirements that must be met for the performance of the Work.

B. Perform all coordination and documentation, and engineering to obtain the Contractor-required permits including providing a registered professional engineer for engineering to obtain permits where required.

C. Be fully responsible and solely accountable for meeting the requirements of all permits.

D. Unless otherwise specified by an agency, the Contractor is the sole permittee for all contractor-obtained permits.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Contractor-Obtained Permits: Copies of permits obtained by the Contractor.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 41 30
STATE ENGINEER REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Authority of the State of Colorado Office of the State Engineer.

1.2 REFERENCES

A. Rules and Regulations for Dam Safety and Dam Construction, January 2020, Division of Water Resources, Office of the State Engineer, Department of Natural Resources.

1.3 STATE ENGINEERS OFFICE AUTHORITY AND REQUIREMENTS

A. Plans and Specifications

1. Approved plans and specifications shall not be materially changed without the prior written approval of the State Engineer. Construct the work in accordance with the approved plans and specifications.

B. Quality of Work

1. The State Engineer has the authority to require the material used and the work of construction to be accomplished according to rules and regulations and that construction shall not be considered complete until the State Engineer has accepted the same in writing. The State Engineer may also conduct periodic inspections of the Work. Provide State Engineer access to the work at all reasonable times.
2. The Owner's Engineer will monitor the quality of construction as specified in Rules and Regulations for Dam Safety and Dam Construction Rule 9.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 45 00
QUALITY CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Contractor quality requirements.

1.2 DEFINITIONS

A. Specific quality control requirements for the Work are indicated throughout the Contract Documents. The term "Quality Control" includes inspection, sampling and testing, and associated requirements furnished by the Contractor.

B. The term "Quality Assurance" includes inspection, sampling, and testing which may be performed by the Engineer.

C. Registered Engineer: Wherever references are made in these Specifications to a registered or professional engineer, it means a professional engineer (P.E.) registered with the State of Colorado.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1.	ASTM C 1077	Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
2.	ASTM D 3740	Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
3.	ASTM E 329	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

B. U.S Army Corps of Engineers: Handbook for Concrete and Cement

C. American Welding Society

D. American Water Works Association

E. American Concrete Institute

1.4 SAMPLING AND TESTING

A. Except as otherwise required, conduct all sampling and testing in accordance with the methods prescribed in the standards of the ASTM, ACI, AWWA, AWS, and other specified standards in place at time of Notice to Proceed, as applicable to the class and nature of the article or materials considered. The Engineer may use any generally accepted system of inspection that, in the opinion of the Engineer, will ensure the Engineer that the quality of the workmanship is in full accord with the Contract Documents.

B. The Engineer may waive tests or quality assurance measures. Waiver of any specific testing or other quality assurance measure are not to be construed as a waiver of any technical or qualitative requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the Engineer may make independent investigations and tests. Failure of any portion of the Work to meet any of the qualitative requirements of the Contract Documents, are considered reasonable cause for the Engineer to require the removal, or correction, and reconstruction of any such work.

D. The Engineer may independently select, test, and analyze additional test specimens of any or all of the materials to be used. Results of such tests and analyses shall be considered along with the tests or analyses made by the Contractor to determine compliance with the applicable specifications for the materials. If any portion of the work fails to meet the requirements of the Contract Documents, all costs of such independent inspection and investigation and all costs of removal, correction, reconstruction, or repair of any such work shall be borne by the Contractor.

1.5 QUALITY ASSURANCE/CONTROL

A. Provide a quality control system to perform inspections, tests, and retesting in the event of failure of items of Work, including that of subcontractors, to ensure compliance with the Contract provisions. Establish quality control/quality assurance for all work.

B. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.

C. Comply fully with manufacturers' instructions, including each step in sequence.

D. Should manufacturers' instructions conflict with the Contract Documents, request clarification from the Engineer before proceeding with the Work.

E. Comply with specified standards as a minimum quality for the Work except when more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

F. Perform the Work by persons qualified to produce workmanship of specified quality.

G. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. For Products or workmanship specified by association, trades, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

I. Obtain copies of standards when required by the Contract Documents.

J. Should specified reference standards conflict with the Contract Documents, request clarification from the Engineer before proceeding.

K. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

L. Provide a Construction Quality Control Plan for all of the requirements of this section and these specifications.

1.6 INSPECTION PROCEDURES

A. Perform preparatory inspection before beginning any work, and, in addition, before beginning each segment of work. Preparatory inspection must include a review of the Contract Document requirements, the review of Shop Drawings and other submittal data, a check to ensure that required control testing will be provided, a physical examination to ensure that materials and equipment conform to approved Shop Drawings and submittal data, and a check to ensure that required Preliminary Work has been completed.

B. Perform an initial inspection as soon as a representative segment of the particular item of Work has been accomplished. Initial inspection to include performance of scheduled tests, examination of the quality of workmanship, a review for omissions or dimensional errors, and approval or rejection of the initial segment of the Work.

C. Perform follow-up inspections as necessary that include continued testing and examinations to ensure continued compliance with the Contract Document requirements.

D. Provide test results citing the Contract Document requirements, the test or analysis procedures used, and the actual test results, and include a statement that the item tested or analyzed conforms or fails to conform to the specification requirements. Each report shall be conspicuously noted in large letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements as the case may be. Test reports are to be signed by a professional engineer licensed in the State of Colorado. Arrange for immediate delivery of the signed original of all test reports, certifications, and other documentation to the Engineer.

1.7 INDEPENDENT INSPECTION AND TESTING LABORATORY SERVICES

A. Perform all tests that require independent testing to determine compliance with the Contract Documents by an independent commercial testing firm retained by the Contractor and acceptable to the Engineer. Staff testing firm with experienced technicians, supervised by an engineer, and properly equipped and fully qualified to perform the tests in accordance with the specified standards.

B. Independent Testing Firm Requirements:

1. At least 10 years of experience in soil and concrete inspection and testing.
2. Meet the requirements of ASTM D 3740 and ASTM E 329.
3. Approved for testing by Colorado Department of Transportation (CDOT).
4. Accredited in accordance with the requirements of ASTM C 1077.
5. Equipped to perform all field and laboratory tests specified.

C. Submit the name of the independent testing firm and laboratory and a statement of its qualifications. Obtain the Engineer’s acceptance of the testing firm before having services performed and pay all costs for these testing services.

D. Submit names and resumes of the laboratory's key personnel and field testing personnel. Requirements:

1. Field Technicians: At least 3 years of experience in soil and/or concrete testing as applicable and cannot be changed without prior written approval of the Engineer. Concrete testing technicians shall possess a current American Concrete Institute field-testing grade one certification.

2. Laboratory technician — Technicians conducting concrete laboratory testing shall be certified as ACI Concrete Laboratory Testing Technician – Level 1 or ACI Concrete Strength Testing Technician, unless otherwise specified.

E. The Engineer may inspect work performed by the independent testing firm, both at the project site and at the laboratory. This shall include inspection of the independent testing laboratory's internal quality assurance records, including quality assurance manual, equipment calibrations, and proficiency sample performance.

F. Conduct quality control testing for each item of Work to confirm work is in accordance with the contract documents.

G. Written results of all completed tests and inspections performed by the Contractor's independent commercial testing firm shall be available to the Engineer by the end of the next working day following completion of the tests. Verbal results shall be provided to the Engineer upon test completion. Results of all completed tests shall be submitted to the Engineer.

H. Reports will indicate observations and results of tests and indicate compliance or non-compliance with Contract Documents.

I. Retesting required because of non-conformance to specified requirements is the Contractor's responsibility and shall be performed by the Contractor's approved independent commercial testing firm.

1.8 ENGINEER TESTING

A. The Engineer may perform and pay for quality assurance inspection and testing at their discretion, independent of testing and inspections performed by the Contractor or their hired independent commercial testing firm.

B. Cooperate with the Engineer; furnish samples of materials, equipment, tools, storage, access, and assistance as requested.

C. Notify the Engineer 24 hours prior to QC testing or sampling.

D. The Engineer may obtain samples of material for testing. Provide the Engineer access and assistance in obtaining samples.

E. The Engineer may inspect the Contractors offsite producers of materials and products. Provide access to these offsite facilities to the Engineer at all times during the Work.

F. Testing services performed by the Engineer are for the sole benefit of the Owner. Test results will be made available to the Contractor. Testing necessary to satisfy the Contractor's internal quality control procedures are the sole responsibility of the Contractor.

G. The Engineer will furnish the Contractor with one courtesy copy of each field and laboratory quality assurance test conducted by the Engineer.

1.9 QC PLAN REQUIREMENTS

A. Provide personnel with assigned QC functions reporting to a qualified and experienced, full-time Field QC Representative. Assign the Field QC Representative exclusively to this Project with their sole duty monitoring and reporting the QC functions of this Project.

The Field QC Representative must be assigned to report to a Senior Manager of the Contractor and shall have no supervisory or managerial responsibility over the work force. Persons performing QA/QC functions shall have qualifications, authority, and organizational freedom to identify quality problems and to initiate and recommend solutions. Make available evidence of QC personnel qualifications upon request by the Engineer. The Field QC Representative must be onsite not less than the Contractor's daily working hours daily work hours to remedy and demonstrate that work is being performed properly and to make multiple observations of all work in progress. The Field QC Representative shall prepare a daily and weekly status report and present it at the weekly progress meeting.

B. The QC Plan shall include a statement by the Senior Manager designating the Field QC Representative and specifying authorities delegated to the Field QC Representative to direct cessation or removal and replacement of defective work.

C. The QC Plan shall ensure the achievement of acceptable quality throughout all applicable areas of the Contract Documents. Describe in the QC Plan the QC program and include procedures, work instructions, and records for each section within the Contract Documents. In addition, the QC Plan describe methods relating to each section which require special testing and procedures as noted in the Contract Documents.

D. Identification and Control of Items and Materials: Include procedures to ensure that items or materials that have been accepted at the site are properly used and installed, for proper identification and storage, and to prevent the use of incorrect or defective materials.

E. Inspection and Tests: Have written procedures defining a program for control of inspections performed.

1. Perform and document inspections and tests by qualified individuals. At a minimum, "qualified" means having performed similar QC functions on similar type projects. Maintain and submit records of personnel experience, training, and qualifications for review by the Engineer.
2. Maintain and provide to the Engineer, within one working days, acceptable records following completion of each inspection and test. Document and evaluate inspection and test results sufficient to ensure that requirements have been satisfied.
3. Procedures shall include:

    a. Specific instructions, organized by Specification Sections, defining procedures for observing all work in progress and comparing this work with the Contract Documents.
    b. Specific instructions for noting deficiencies and steps to be taken to have the deficiency corrected, repaired, or replaced.
    c. Specific instructions for recording all 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 QC Representatives and the foreman, or site superintendent.

4. The QC Plan shall identify all contractual hold/inspection points, as well as any Contractor imposed hold/inspections points.

5. The QC Plan shall include procedures to provide verification and control of all testing provided by the Contractor, including:

    a. Verifying and noting on the Daily Report all required testing was performed and documenting results if available, including a sample of the Contractor's Daily Report.
    b. Providing for location maps for all tests performed or location of work covered by the tests.
    c. Maintaining copies of all test results.
    d. Ensuring the Engineer receives an independent copy of all tests.
    e. Ensuring testing labs are functioning independently and in accordance with the Contract Documents.
    f. Ensuring re-tests are properly taken and documented.

F. Control of Measuring and Test Equipment: Measuring and/or testing instruments shall be maintained, calibrated, and adjusted to maintain accuracy within prescribed limits. Perform and document calibration at specified periods against valid standards traceable to nationally recognized standards.

G. Supplier Quality Assurance: The QC Plan shall include procedures to ensure that procured products and services conform to the requirements of the specifications. Requirements of these procedures shall be applied to lower-tier suppliers and/or subcontractors.

H. Nonconformance and Corrective Action: The QC Plan shall include procedures for handling of nonconformances. Nonconformances are defined as documentation, plans, material, equipment, or work not conforming to the specified requirements. The procedure shall prevent nonconformances by identification, documentation, evaluation, separation, disposition, and corrective action to prevent recurrence. Conditions having adverse effects on quality shall be promptly identified and reported to the senior level management. The cause of conditions adverse to quality shall be determined and documented and measures implemented to prevent recurrence.

I. Special Processes and Personnel Qualifications: The QC Plan shall include detailed procedures for the performance and control of special process such as, topsoil management, welding, soldering, heat treating, cleaning, plating, and nondestructive examination.

J. Personnel performing special process tasks shall have the experience, training and certifications commensurate with the scope, complexity, or nature of the activity. They shall be approved in writing by the Engineer before the start of Work on the Project.

K. Audits: The QC Plan shall provide for documented audits to verify that QC procedures are being fully implemented by the Contractor, as well as its Subcontractors. Audit records shall be made available to the Engineer upon request.

L. Documented Control/Quality Records: Establish methods for control of subcontract documents which describe how plans and specifications are received and distributed to assure the correct issue of the document being used. The methods shall also describe how record data are documented and furnished to the Engineer.

1. Maintain evidence of activities affecting quality, including operating logs, records of inspections and tests, audit reports, material analyses, personnel qualification and certification records, procedures, and document review records.

2. Maintain quality records in a manner that provides for timely retrieval, and traceability. Protect quality records from deterioration, damage, or destruction.
3. Provide a list with specific records, as specified in the Contract Documents, which will be furnished to the Engineer at the completion of activities.

M. Acceptance of QC Plan: The Engineer's review and acceptance of the QC Plan shall not relieve the Contractor from any of its obligations for the performance of the Work. The Contractor's QC staffing is subject to the Engineer's review and continued acceptance. The Owner, at its sole option, without cause, may direct the Contractor to remove and replace the QC Representative. No work covered by the QC Plan shall start until the Engineer's written acceptance of the Contractor's QC Plan has been obtained.

N. The Engineer may perform independent quality assurance audits to verify that actions specified in QC Plans have been implemented. No Engineer audit finding, or report shall in any way relieve the Contractor from any requirements of this Contract.

1.10 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Quality Control Plan. Prepare and submit a Construction Quality Control Plan (CQCP) within 30 calendar days after receipt of the Notice of Award. The CQCP shall identify personnel, procedures, controls, instructions, tests, records, reports, and forms to be used. Describe quality control for each work element. Submit as part of the Work Plan specified in Section 01 33 40: Contractor Work Plan. Unless specifically authorized by the Engineer in writing, construction shall not be started and no requests for payment will be processed until the CQCP is approved. In addition to meeting the QC Plan requirements, the plan shall include:

1. Names and qualifications of personnel responsible for quality control on the Contract.
2. Area of responsibility and authority of each individual in the quality control system.
3. A description of the services the Contractor will have provided by outside organizations such as testing laboratories, manufacture representatives' architects, and consulting engineers.
4. Procedures for reviewing shop drawings, samples, certificates, or other submittals for contract compliance, including the name of the person(s) authorized to sign the submittals for the Contractor, as complying with the Contract Documents.
5. A test and inspection schedule, keyed to the construction schedule and following the order of the specification technical sections, indicating inspections and tests, the names of persons responsible for the inspection and testing for each segment of Work, and the time schedule for each inspection and test.
6. The procedures for documenting quality control operation, inspection, and testing, with a copy of forms and reports to be used for this purpose.
7. A submittal status log listing the submittals required by the specifications and drawings and stating the action required by the Contractor or the Engineer.

C. Independent Laboratory Qualifications. Name of the independent laboratory, a statement of qualifications (SOQ), the most recent certification by State/Federal or other appropriate independent commercial testing services, names, resumes, and experience of

the laboratory and field key personnel. Include a statement indicating the laboratory and field key personnel meet the requirements of this Specification.

D. Daily and Weekly Quality Control Reports.

E. Quality Test Reports: Submit written test reports, engineering data and other documentation.

1. The independent testing firm retained by the Contractor for material testing shall submit 3 copies of each test report directly to the Engineer in a sealed envelope within 2 working days after each test is completed.
2. Consecutively number each report for each type of test. Summarize the report by material and/or operation type. Identify the tolerances as defined in the Contract Documents and indicate if the results meet or do not meet the Contract Document requirements.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 50 00
CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Temporary Utilities: Electricity, lighting, heating ventilation and air conditioning (HVAC), telephone service, water, and sanitary facilities.

B. Temporary Controls: Barriers, enclosures and fencing, protection of the Work, project signage, and water control.

C. Construction Facilities: Access roads, parking, field offices.

1.2 TEMPORARY ELECTRICITY

A. General

1. Provide all power for HVAC, lighting, operation of the Contractor's plant or equipment, or for any other use by the Contractor, and provide and maintain all temporary power lines required to perform the Work in a safe and satisfactory manner.
2. Provide temporary electric feeder and electrical service as required. Temporary connections for electricity are subject to approval of the Engineer and the power company representative.
3. Securely fasten in place and maintain all wiring for temporary electric power. All electrical facilities shall conform to the requirements of Subpart K of the OSHA Safety and Health Standards for Construction and applicable local codes.
4. Pay for power service from utility sources and provide separate metering for cost of energy used as required.
5. Remove temporary electrical connections before final acceptance of the Work.

B. Qualification and Installation Requirements:

1. Install all materials and equipment in accordance with printed recommendations of the manufacturer.
2. Accomplish all work, including installation, connections, calibration, testing, and adjustments by qualified, experienced personnel working under continuous, competent supervision, reflecting adherence to prevailing codes, standards and methods. Coordinate installation in the field with other trades so that interferences are avoided.
3. Furnish adequate means for and fully protect all finished parts of the materials and equipment against damage from any cause during the progress of the Work. All materials and equipment, both in storage and during construction, shall be covered in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint. All moving parts shall be kept clean and dry.
4. Replace or have refinished by the manufacturer all damaged materials or equipment, including face plates of panels and switchboard sections.
5. Perform testing and checkout work by qualified personnel skilled in the particular tests being conducted. Personnel are to have at least 5 years of experience with tests of the same type and size as specified. Submit

qualifications for all individuals that will perform testing to the Engineer at least 30 days before testing. Qualification statements shall clearly identify the individual's qualifications, and the specific tests that each individual is qualified to perform.

C. Jobsite Condition:

1. The site is supplied with commercial electrical power from Tri-State and Mountain Parks Electric.
2. The commercial power sources are located as shown on the Drawings.
3. The commercial power supply may be interrupted due to impacts from others, such as brownouts or delays upgrading the commercial power;
4. If commercial power is used for the Work:

a. Coordinate directly with owner to verify the power supplier, the available capacity and the location where power may be accessed.
b. Do not interrupt or delay the Work if commercial power is not available.
c. Provide an Emergency Power Supply Plan defining the alternate power source if commercial power is interrupted.

1.3 TEMPORARY LIGHTING

A. Provide and maintain lighting for construction operations.

B. Provide suitable light for work conducted at night or under conditions of deficient daylight to ensure proper work and to afford adequate facilities for inspection and safe working conditions.

C. Securely fasten in place and maintain all wiring for temporary electric lighting. All electrical facilities shall conform to the requirements of Subpart K of the OSHA Safety and Health Standards for Construction and local codes.

1.4 INTERNET SERVICE

A. Owner to provide Internet Service at the Windy Gap Pump Plant.

1.5 WATER SUPPLY

A. Provide an adequate supply of water of a quality suitable for its use, either domestic or construction. Untreated water sources may be available by pumping directly from the river or reservoir at approved location(s) within the project limits of disturbance. Provide a totalizing meter(s) and report water volumes to the Owner on a daily basis using approved forms.

B. Submit a Construction Water Plan with the Contractor Work Plan in Section 01 33 40: Contractor Work Plan. This plan shall indicate all piping, meters, valves, and other materials necessary for obtaining water from Owner sources. Do not install piping, valves, or meters until the Engineer has approved the Construction Water Plan.

C. The Contractor is solely responsible for the adequate functioning of its water supply system and shall be solely liable for any claims, delays or damages resulting from the use of same.

D. Furnish all drinking water on the site during construction. Post notices conspicuously throughout the site warning the Contractor's personnel that piped construction water is non-potable.

1.6 TEMPORARY SANITARY FACILITIES

A. Furnish temporary sanitary facilities at the site, as provided herein, for the needs of all construction workers and others performing Work or furnishing services on the Project, including Engineer and Owner personnel.

B. Provide sanitary facilities of reasonable capacity. The facilities shall be properly maintained throughout the construction period and obscured from public view to the greatest practical extent. If toilets of the chemically treated type are used, unless otherwise required, furnish at least one toilet for each 20 persons.

1.7 CONSTRUCTION AIDS

A. Furnish, install, maintain, and operate all construction aids required by the Contractor and its Subcontractors in the performance of the Work. Such construction aids shall include the following:

1. Cranes and hoists
2. Temporary enclosures
3. Scaffolding
4. Temporary stairs
5. Drainage provisions

1.8 PROTECTION OF PUBLIC AND PRIVATE PROPERTY

A. See Section 01 74 30: Protection of Existing Facilities for additional requirements.

B. Protect, shore, brace, support, and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by construction operations.

C. Damage to Existing Property

1. The Contractor is responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or workers to or from the Work or any part or Site thereof, whether by the Contractor or Subcontractors. Make satisfactory and acceptable arrangements with the owner of, agency, or authority having jurisdiction over, the damaged property concerning its repair or replacement, or for payment of costs incurred in connection with the damage.
2. The Contractor is responsible for any damage to existing structures, Work, materials, or equipment because of operations and shall repair or replace any damaged structures, Work, materials, or equipment to the satisfaction of the Owner.
3. Protect all existing structures and property from damage and provide bracing, shoring, or other Work necessary for such protection.

1.9 BARRIERS AND FENCING

A. Provide barriers or fencing to protect adjacent properties from damage from construction operations and demolition.

B. Provide barriers around all excavations or obstructions to prevent accidents and protect Work, apparatus, equipment, and material from theft and accidental or other damages, and make good any damages thus occurring at no cost to the Owner.

C. Protect non-owned vehicular traffic, stored materials, Site and structures from damage.

D. Provide measures to protect the Owner's personnel and public from Work activities including safety fence surrounding the Work and staging, storage and stockpile areas.

1.10 WATER CONTROL

A. Grade site to drain.

B. Maintain excavations free of water.

C. Provide, operate, and maintain pumping equipment.

D. Protect site from ponded or running water.

E. Provide water barriers, as required, to protect site from soil erosion or damage.

F. See also Sections 01 57 13: Temporary Sediment and Erosion Control, 31 23 19: Dewatering, and 31 52 00: Cofferdams and Stream Diversion,

1.11 DUST CONTROL

A. Provide all labor, equipment, machinery and other means to control dust emissions throughout the site for the duration of the project.

B. Abate dust nuisance by cleaning, sprinkling with water, or other means as necessary.

C. The use of water, in amounts which result in ponding, is not acceptable as a substitute for other methods.

D. See also Section 01 35 43: Environmental Protection

1.12 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual Specification Sections.

B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.

1.13 SECURITY

A. Provide security and facilities to protect Work and Owner's operations from unauthorized entry, vandalism, or theft.

B. The Contractor is responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

C. No claim shall be made against the Owner by reason of any act of an employee or trespasser, and the Contractor is responsible for damage to the Owner's property resulting from failure to provide security measures as specified.

D. Security measures shall be at least equal to those usually provided by the Owner to protect the existing facilities during normal operation, but shall also include such additional security fencing, barricades, lighting, and other measures as required to protect the Site and the public.

E. Keep all Owner-identified access gates locked except during the time when they are attended. Key privileges will be defined in the Preconstruction meeting.

1.14 ACCESS ROADS

A. Conduct Work so as to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walkways, whether public or private, provide and maintain suitable and safe detours, or other temporary expedients for the accommodation of public and private travel.

B. Coordinate traffic control and any temporary road closures directly with the Colorado Department of Transportation.

C. As approved, and based on the site location, construct and maintain temporary roads accessing public thoroughfares to serve the construction area.

D. Submit an Access Road and Traffic Control Plan for approval with the Contractor's Work Plan in Section 01 33 40: Contractor Work Plan showing locations and methods of construction proposed, and methods to maintain and control traffic on public roads impacted by site access roads. Traffic control plan to describe possible road restrictions or closures, show locations of flaggers, signage, signals, or any other means proposed to control and maintain traffic flow.

E. Extend and relocate access roads as Work progress requires. Provide detours necessary for unimpeded traffic flow unless otherwise approved.

F. Provide means of removing mud from vehicle before entering streets, roads, or highways.

1.15 PARKING

A. Provide and maintain suitable parking areas for the use of all construction workers and others performing Work or furnishing services in connection with the Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic, Owner's operations, or construction activities. The location of the Contractor's parking areas shall be acceptable to, and must approved by, the Owner. Submit for approval with the Contractor's Work Plan in Section 01 33 40: Contractor Work Plan.

1.16 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition. Brush clean or wash roadway near construction entrance(s) regularly.

B. Broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust.

C. Remove waste materials, debris, and rubbish from the Site and dispose offsite.

D. Maintain all construction areas and adjacent sites in a dust free condition.

E. Do not allow any condition to exist during construction which creates a nuisance; a fire hazard; an environment injurious to water quality, air quality, or health or safety; or an attraction for children, animals, birds, rodents, etc.

F. Failure to comply with this provision after due and proper notice has been given by the Owner or Representative will be sufficient grounds for the Owner to proceed to clean up such material and debris, make repairs and charge same to the Contractor.

1.17 PROJECT SIGNAGE AND CONTROLS

A. PROJECT IDENTITFICATION SIGNAGE

1. Provide a project sign, 6-foot wide by 4-foot high constructed of exterior grade plywood and wood frame construction, painted, with exhibit lettering by professional sign maker.
2. List title of Project, names of the Owner, the Engineer, and Contractor in a layout approved by Owner:
3. The Owner and Engineer will provide their logo graphic for the sign.
4. Submit Project identification sign layout for approval before fabrication.
5. Erect the Project identification sign in locations identified by the Owner.
6. No other project identification signs are allowed without Owner permission, with the exception of those required by law or this Section, unless otherwise approved by the Owner.

B. Provide signs to direct subcontractors, vendors, etc. to the construction Site and office trailers.

1.18 CONTRACTOR'S FIELD OFFICE

A. During the performance of this Contract, maintain a suitable office at or near the Site of the Work as the headquarters of the Contractor's Representative authorized to receive drawings, instructions, or other communication or articles. Any communication given to the Contractor's Representative or delivered to the Contractor's office at the Site of the Work, in its absence, shall be deemed to have been delivered to the Contractor. Areas within the Windy Gap Pump Plant will be made available for use by the Contractor as a construction field office.

B. Keep Record Documents at the Contractor's office at the Site of the Work and available for use at all times.

1.19 ENGINEER FIELD OFFICE

A. Areas within the Windy Gap Pump Plant will be made available for use by the Engineer and Owner as a construction filed office.

B. Set up, equip, and make Engineer's field office ready for use prior to the beginning of other Work on the Project until all field records pertinent to the Project have been completed.

C. Provide Engineer's Field Office meeting the following requirements unless otherwise approved:

1. Cooled bottled, drinking water (with adequate supplies maintained during the construction period).
2. Office furnishings:

a. 1 30-inch by 60-inch desk with drawers and chair
b. 1 36-inch by 72-inch table
c. 1 2-drawer file cabinet with lock and 2 sets of keys. Cabinets shall be fire resistant, meeting the requirements for "Filing Devices, Insulated (36E9) Class D Label" of UL Specifications.
d. 2 office chairs
1 7-foot 3-inch by 3-foot steel utility shelving assembled.
e. 1 4-foot by 6-foot bulletin board, mounted
f. 2 clothes rack
g. 2 first aid kit
1 color printer/scanner/copier/fax with multi sheet feeder, 11-inch by 17-inch capability, and operating software.

D. Maintain the office in good condition and appearance for the duration of the Project, including weekly cleaning.

E. Clean office and leave area in a neat and acceptable condition within 15 days after final use.

1.20 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities, materials, when no longer required, and prior to Final Application for Payment inspection.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing facilities used during construction including all temporary connections and piping, and all affected improvements to their original condition, or better, to the satisfaction of the Engineer, Owner, and any other agency owning the affected utility

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 57 13
TEMPORARY SEDIMENT AND EROSION CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Erosion and sedimentation control work as specified and as required by local, State and Federal regulations and permits to prevent erosion and/or transport of sediment outside the limits of disturbance.

B. The work includes installing sediment barriers, sediment removal and disposal, device maintenance, removal of temporary devices, temporary stabilization, best management practices (BMPs), and final cleanup.

C. This section is intended to supplement erosion and sediment control measures specified and required by local, State and Federal regulations and permits. Comply with the more stringent measures in the Section or as required by local, state and federal regulations and permits.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Technical product literature for all commercial products to be used for sedimentation and erosion control.

C. Shop drawings for constructed temporary erosion control measures, and supporting calculations, stamped and sealed by a professional engineer as required.

D. Contractor's Stormwater Management Plan (SWMP). The SWMP shall comply with the most recent SWMP guidance prepared by the Colorado Department of Public Health and Environment (CDPHE), follow regional stormwater guidelines, and describe the (BMPs) that will be used to control contamination, erosion and sedimentation in accordance with local, State and Federal regulations and permits and this Section. The SWMP must include drawings showing locations for all features and be stamped and sealed by a professional engineer as required.

1.3 QUALITY ASSURANCE

A. The Contractor is responsible for the timely installation, maintenance, and removal of all erosion and sedimentation control devices necessary to prevent the movement of slurry or sediment from the construction Site to offsite areas such as into the stream or wetland system, into preservation/conservation areas via surface runoff or into underground drainage systems. Measures, in addition to any shown on the Drawings, necessary to prevent the movement of sediment outside the limits of construction shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the Owner will be considered for the Work under this Section.

B. Conduct and sequence excavations and soil disturbing activities to minimize the risk of sediment transport downstream.

PART 2 PRODUCTS

2.1 GENERAL

A. Provide sedimentation and erosion control products suitable for the intended application meeting the requirements of the Drawings, this Section, local, state and federal regulations and permits requirements as applicable. Submit product data for review and approval.

2.2 MATERIALS

A. Silt Fence:

1. Consisting of geotextile and posts suitable for sedimentation control application, with or without wire mesh reinforcement as required for the application.
2. Fabric: Woven, polypropylene, ultraviolet resistant material.
3. Wire Mesh: minimum 14 gauge with a maximum mesh opening of 6 inches.
4. Posts:

    a. Wooden: 2-inch by 2-inch; 4-feet 6-inches long, wood stakes, suitably durable for driving without cracking.
    b. Metal: Studded tee or U type with a minimum weight of 1.34 pound per feet.

B. Hay or Straw Bales:

1. Certified weed free hay or straw identified with appropriate tagging and twine as required.
2. Erosion control bales shall be inspected for and Regionally Certified by the Colorado Department of Agriculture as weed free based on the Regionally Designated Noxious Weed and Undesirable Plant List.
3. Do not unload certified weed free erosion bales or remove their identifying twine, wire or tags until the Engineer has inspected and accepted them. Provide a certificate of compliance showing the transit certificate number or a copy of the transit certificate as supplied from the forage producer.
4. Provide either wire-bound or string-tied bales with the bindings oriented around the sides rather than over and under the bales.

C. Wattles/Erosion Logs:

1. Weed free straw or curled aspen wood excelsior with a consistent width of fibers evenly distributed throughout and a seamless casing comprised of photodegradable tube netting.
2. Diameter 8 to 12 inches, length 20 to 25 feet.
3. Fungus free, resin free and free of growth or germination inhibiting substances.

D. Turbidity Barriers.

1. May be floating or staked, based on the conditions at the location for installation.
2. Capable of functioning properly for flow conditions.
3. Constructed of ultraviolet resistant PVC or polypropylene material.
4. All components corrosion resistant.

E. Tracking Pads: Crushed stone or manufactured products suitable to prevent tracking mud onto paved roads.

PART 3 EXECUTION

3.1 GENERAL SEDIMENT/EROSION CONTROLS

A. Install in accordance with the approved Sedimentation and Erosion Control Plan along the limits of disturbance, where shown on the Drawings and where necessary to control erosion on slopes or protect waterways.

B. Provide additional sediment/erosion control barriers as needed to control the transport of silt and sediments outside of the limits of construction.

C. Install around the base of all soil stockpile areas.

D. Unless otherwise approved by the Engineer and allowed by local authorities, stabilize nonworking faces of soil stockpiles in place longer than 3 months, by seeding and mulching or other stabilization method acceptable to the Engineer.

3.2 MANUFACTURED CONTROL INSTALLATION

A. Silt Fence:

1. Position as necessary to prevent movement of sediment produced by construction activities outside of the limits of construction or as approved.
2. Install pre-fabricated silt fence according to Manufacturer's instructions and approved Erosion and Sediment Control Plan details.

B. Hay Bale Barriers:

1. Place bales lengthwise in a single row with the ends of adjacent bales tightly abutting one another.
2. Entrench and backfill bale barriers. Excavate trench the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After bales are staked and chinked, backfill excavated soil against the barrier. Match backfill to the ground level on the downhill side and about 2 inches above the ground level against the uphill side.
3. Securely anchor each bale with at least 2 stakes or rebars driven through the bale deep enough into the ground to securely anchor the bales. Drive the first stake toward the previously laid bale to force the bales together.
4. Chink gaps between each bale (filled by wedging) with weed free straw as necessary to prevent water from flowing between the bales.

C. Inlet Protection:

1. Install inlet protection for all catch basins, drop inlets, drop structures, inlets to drainage pipes, or other structures.

D. Wattles:

1. Install and securely stake with 1x2 or 2x2 wooden stakes at maximum 4’ spacing as recommended by the manufacturer and in a depression or with upslope backfill such that water will not run under the wattle

3.3 CONSTRUCTED CONTROLS

A. Install constructed features such as rock check dams and sedimentation ponds in accordance with approved designs and details in the submitted Sediment and Erosion Control Plan.

3.4 MAINTENANCE AND INSPECTIONS

A. Inspections:

1. Make a visual inspection of all devices at least once every 14 days and promptly after every rainstorm. If such inspection reveals that additional control measures or repairs are needed, promptly install necessary additional devices, or make repairs to prevent erosion and/or movement of sediment to areas outside the limits of construction.
2. Keep a log of all inspections indicating the following:

    a. Date and time of inspection
    b. Construction Project Inspector
    c. Amount of rainfall
    d. Erosion and sediment control devices inspected
    e. Condition of sediment and erosion control devices
    f. Repairs needed
    g. Date repair is completed

B. Minimum Maintenance :

1. Silt Fence:

    a. Remove accumulated sediment once it builds up to one-half of the height of the fabric.
    b. Replace damaged fabric, or patch with a 2-foot minimum overlap.
    c. Make other repairs as necessary to ensure that the fence is filtering all runoff directed to the fence.

2. Hay Bales:

    a. Remove accumulated sediment once it builds up to one-half of the height of the hay bales.
    b. Replace damaged hay bales.
    c. Make other repairs as necessary to ensure that the hay bales are filtering all runoff directed to the barrier.

3. Wattles:

    a. Ensure position is maintained and flow is directed through, not around or under wattles.

4. Inlet Protection:

    a. Remove accumulated sediment once it builds up to one-half of the height of the barrier.
    b. Remove all sediment accumulated within the barriers.
    c. Make repairs as necessary to ensure that the inlet protection device is operating properly.

5. Turbidity Barriers:

   a. Inspect on a daily basis.
   b. Replace damaged fabric, or patch with a 2-ft minimum overlap.
   c. Make other repairs as necessary to ensure barriers are effectively maintaining turbidity levels outside of the barrier within limits prescribed by permit.

6. Check Dams:

   a. Inspect on a daily basis.
   b. Add material or make repairs as necessary to ensure the dam is effectively maintaining turbidity levels outside of the barrier within limits prescribed by permit.

7. Sediment Ponds:

   a. Confirm continued function od pond, inlets, and outlets.
   b. Remove sediment as necessary to maintain design capacity.

3.5 TEMPORARY STABILIZATION

A. The duration of the exposure of uncompleted construction to the elements shall be as short as practicable. Unless otherwise approved, permanently stabilize completed areas by seeding and mulching in accordance with Section 32 92 19 Native Seeding within 7 calendar days after completion.

B. Temporarily stabilize disturbed areas where work is temporarily halted within 7 days after the activity ceased unless work is to be resumed within 30 calendar days after the activity ceased. Temporary stabilization required by the Contractor's negligence, or lack of proper scheduling, or for the convenience of the Contractor shall be at no cost to the Owner.

C. Temporary stabilization is defined as the covering of disturbed areas with seed, mulch, mulch with a tackifier, or a combination thereof. Temporary soil stabilization techniques shall be proposed by the Contractor and approved by the Engineer. Furnish temporary seed, if required, in accordance with Section 32 92 19 Native Seeding.

3.6 REMOVAL AND FINAL CLEANUP

A. Once the Site has been fully stabilized against erosion, and as acceptable to the Engineer, remove sediment control devices and all accumulated sediment. Dispose of sediment and waste materials in proper manner.

B. Regrade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings or specified herein.

END OF SECTION

SECTION 01 57 19
RESERVOIR CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Owner control of Windy Gap Dam and Reservoir before construction. Contractor responsibility for water management during construction

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 RESERVOIR CONTROL AND DRAWDOWN

A. Under existing conditions, the reservoir is primarily supplied from inflows from the Colorado and Fraser Rivers.

B. The Owner will begin to lower the reservoir to the lowest extent possible using the existing Auxiliary Outlet (Invert Level: 7820.5 ft) and/or Bypass Outlet (Invert Level: 7818.0 ft). Lowering of the reservoir is restricted by inflow rates and outlet capacity, historically reservoir drawdown has begun in early July. Drawings, including discharge tables, are provided in the 1985 Windy Gap Record Drawings. These outlets will remain open during the 2022 construction season, but the Owner reserves the right to close these outlets during the 2023 construction season to allow filling of the reservoir and for the potential operation of the Windy Gap pump station. The Auxiliary Outlet and the Bypass Outlet can be included in the Contractors 2022 diversion and dewatering plans.

C. Contractor is responsible for dewatering any remaining reservoir pools necessary for construction in accordance with Section 31 23 19: Dewatering.

D. The Owner reserves the right to pump from the reservoir using the Windy Gap pump station when water is available and stream flow requirements are met. The Contractor shall plan and execute the work in a manner that does not inhibit the ability of the Owner to operate the pumping system in 2023.

E. The Contractor will be required to construct all facilities necessary to divert inflows into as specified in Section 31 52 00: Cofferdams and Stream Diversion.

END OF SECTION

SECTION 01 64 00
OWNER-FURNISHED MATERIALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements for Owner-Furnished Materials.

1.2 OWNER-FURNISHED MATERIALS

A. The Owner has elected to furnish the following materials:

1. Containerized plants in accordance with Section 32 96 10: Native Planting.

B. New electrical transformer located approximately adjacent to the new Control Building connected to mains electricity. Notwithstanding the transfer of Owner-furnished Materials by the Owner to the Contractor's possession, the Owner retains legal and equitable title to any and all Owner-furnished Materials.

C. General responsibilities for the Owner and Contractor regarding Owner-furnished Materials are specified below. Additional responsibilities may be identified in other Sections. Any specific requirements in other Sections take precedence over this Section.

D. Wood chip mulch

E. Logs to be utilized as Large Woody Debris (LWD) or logs associated with bank stabilization types

1.3 CONTRACTOR RESPONSIBILITIES

A. Coordination: Coordinate Owner-furnished Material delivery schedules with the Owner, including but not limited to material receipt witness and documentation, delivery sequence, timing, and laydown areas.

B. The Contractor is responsible to evaluate the completeness of Owner-furnished Materials provided, identify addition items or quantities of items necessary for the Contractor to construct complete and operational systems, and to furnish the additional materials.

C. Unloading, Handling and Documenting: Provide all labor and equipment required for the delivery (when required), unloading, handling, and documenting Owner-furnished materials. Receive Owner-furnished Materials in the presence of Owner’s authorized representative. Record delivery and acceptance in writing and acknowledge receipt by signing forms satisfactory to Owner.

D. Inspection and Notification: Completely inspect all Owner-furnished Material deliveries on delivery. Carefully note any visible shortage or damage to Owner-furnished materials prior to acceptance of delivery and assume full responsibility for any loss or damage of such items thereafter. Promptly notify Owner if any items supplied to Contractor are surplus and, without additional compensation, cooperate in the disposition of such surplus. Inspect items for conformance with the Specifications, completeness compared to Bill of Lading or other documentation provided, and the completeness of all parts required for assembly and installation. If upon inspection Owner-furnished Materials are found to be defective, in insufficient quantities as represented by delivery documentation,

or non-conforming, immediately notify the Owner of the defective, incomplete, or nonconforming condition so that repair, replacement or obtaining missing materials can occur without undue delay or interruption to the Project. Do not incorporate nonconforming or defective materials in the Work.

E. Delays: If the Contractor fails to perform the specified inspections and otherwise incorporates into the Contractor's Work defective or nonconforming Owner-furnished Materials, the condition of which it either knew or should have known by performance of an inspection, Contractor is responsible for all damages to the Owner resulting from Contractor's incorporation of such materials into the Project, including liquidating or delay damages. Additionally, if Contractor fails to identify during the specified inspection the completeness of equipment or material quantities resulting in the inability to install the equipment or materials as planned, Contractor is responsible for all damages to the Owner resulting from such delay, including liquidating or delay damages

F. Documentation: Confirm that each delivery of Owner-furnished Materials is either accompanied by documentation adequate to verify compliance with the Specifications, or such documentation is provided by the Owner.

G. Acceptance: Provide to the Owner a listing and signed documentation indicating the acceptance of the Owner-furnished Materials within 1 day after inspection.

H. Records: Maintain records of all Owner-furnished Materials incorporated into Contractor's Work from the stock of Owner-furnished Materials in the Contractor's possession. Account monthly with Pay Applications to the Owner for any Owner-furnished Materials delivered into the Contractor's possession, indicating portions of all such materials which have been incorporated in the Contractor's Work.

I. Transfer of Risk: Except for damages that cannot be ascertained by visual inspection of deliveries, Contractor assumes the risk of damage or loss from the time that the materials are physically delivered to the job site and accepted by the Contractor, prior to their installation or incorporation into the project.

1.4 OWNER RESPONSIBILITIES

A. Purchase and deliver materials to the site or make available materials for Contractor pickup as agreed in the Contract.

B. Obtaining material and equipment warranties and guarantees for Owner-furnished Materials if applicable.

C. Obtaining and providing to the Contractor installation instructions for Owner-furnished Materials if applicable.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 71 10
MOBILIZATION, PREPARATORY WORK, AND DEMOBILIZATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Mobilization, preparatory work, and demobilization requirements.

B. Mobilization and Preparatory Work includes, but is not limited to:

1. Obtaining all permits, SWPPP, licenses, bonds and insurance.
2. Moving all equipment, plant(s), material, incidentals, and personnel and to the site.
3. Furnishing, erecting, and removing temporary facilities including temporary construction power, lighting, and construction water supply.
4. Erection of buildings, plants, and other temporary facilities at the Project Site.
5. Preparing and submitting Work Plans.
6. Providing and maintaining field offices for the Contractor.
7. Providing and maintaining field offices for the Engineer.
8. Security measures including any installing and maintaining temporary fence, security gate(s) and signs.
9. Providing onsite sanitary facilities and potable water facilities.
10. Arranging and erecting Work and storage yard.
11. Posting all OSHA required notices and establishing safety programs.
12. Employing Project superintendent full time and locating superintendent at the Work site.
13. Preparing and submitting CPM Construction Schedule.
14. Preparing and submitting Schedule of Values.
15. Installing temporary erosion and sediment control measures.
16. Providing diversion, and all surface/runoff water control.
17. Environmental protection and regulatory requirements.
18. Contractor quality control program.
19. Safety program.
20. Documenting the site and access conditions with photographs before starting and after completing the Work.
21. Demobilizing and contract closeout requirements.
22. Any other Work and operations that must be performed, or incidental to the initiation of meaningful Work at the Site and for which payment is not otherwise provided for, under this contract.

C. All facilities, plant, and equipment that are established at, or brought to, the Work Site shall be deemed to be subject to the provisions of this Section, unless the Engineer specifically provides otherwise in writing for a particular item or items. The Contractor is solely responsible for the adequacy, efficiency, use, protection, maintenance, repair, and preservation of all facilities, plant, and equipment. Do not dismantle or remove from the Work Site facilities, plant, or equipment before completion of the Work under the Contract without the written permission of the Owner.

D. All facilities, plant, and equipment on the Work Site are subject to the Owner's right to take possession of and utilize the same for the purposes of completion of the Work, should the Contractor's right to proceed be terminated. In addition, any encumbrance,

lien, or other security interest on any such facilities, plant, or equipment shall be subordinated to the Owner's rights.

E. Payment for mobilization will be based on the Contractor's lump sum Schedule of Values breakdown submitted in accordance with Section 01 20 00: Price and Payment Procedures. Mobilization will be an ongoing item throughout the duration of the Contract.

1.2 SUBMITTAL

A. Submit in accordance with Section 01 33 00: Submittals.

B. Complete list of equipment proposed for the Work to include type, number of units, and any other data necessary to permit the Engineer to judge that adequate equipment will be provided to complete the Work in a timely manner.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 01 71 23
LAYOUT OF WORK AND SURVEYING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section covers surveying requirements.

1.2 GENERAL

A. The Engineer will identify existing Site reference points and baselines.

B. Provide all materials, items, operations or methods specified, listed or scheduled in specifications and drawings, including all materials, labor, equipment, and incidentals necessary, and required to conduct proper surveys to stake and layout the Work.

C. Conduct all surveys for the Work including checking existing survey control reference point locations and elevations; establishing or reestablishing construction control, resetting of stakes and monuments, measurement for payment of completed work, and performing surveys needed for restoration of public and private improvements that have been damaged, destroyed, or relocated by the Contractor.

D. Conduct all surveys and staking under the responsible charge of a Professional Land Surveyor (PLS) licensed in the State of Colorado.

E. The surveyor performing the onsite construction staking shall have a minimum of 5 years of construction staking experience.

F. Make all field books, notes, and other data developed by Contractor in performing surveys required as part of the Work throughout the construction period available to the Engineer for examination. Submit such data to the Engineer on request, and with the other documentation required for final acceptance of the Work.

G. Keep neat and legible notes of measurements and calculations made in connection with the layout of the Work and measurement and payment. Submit copies of such data to the Engineer for use in checking Contractor's layout and measurement for payment.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Qualifications:

1. Resume detailing the experience level of the PLS for review 10 days prior to the start of any surveying activities. Include Telephone Number, Address, Qualifications, and License.
2. Resume of staking surveyor if different than PLS above.

C. Survey Control Plan: Surveyor plan to conduct surveys using the control points established and shown on the Drawings. As the Work progresses, submit all subsequent changes to the Survey Control Plan.

D. Submit a certificate signed by the PLS, stating that the elevations and locations of the Work are in conformance with the Contract Documents at Contract closeout.

E. Survey Records: After a survey is conducted, submit survey data and field notes to the Engineer. Additionally, submit electronic data (drawings in AutoCAD-compatible .DWG format and data in ASCII format).

1.4 PROJECT PRIMARY SURVEY CONTROL

A. Horizontal and vertical primary survey control for the project consists of existing benchmark reference points shown on the Drawings.

B. Check the position of the reference points comprising the primary control prior to starting Site Work and notify Engineer of discrepancies found between actual and record measurements.

C. Do not disturb existing reference points without prior written approval from the Engineer. If existing reference points are disturbed during construction, install and establish new replacement reference points as an equal replacement for survey control as approved by the Engineer. Submit the locations of the new or replacement reference points for Engineer approval before establishing as reference points.

D. Protect reference points. Replace damaged reference points.

1.5 SECONDARY CONTROL

A. From the primary reference control provided by the Engineer, establish secondary control points as necessary for the construction of the Work. Secondary control shall consist of sufficient permanent points to establish the lines and grades for the various Work either directly or by offset. Establish layout lines for use in construction of the Work taken directly from either the primary or secondary controls.

B. Tie to and close secondary controls with the primary controls.

1.6 ACCURACY OF SURVEYS

A. Locate points for cross sections to the nearest 0.05 feet horizontally and vertically.

B. Close vertical elevation surveys within 0.05 feet times the square root of the length of the circuit in miles.

C. Set grade stakes to nearest 0.02 feet.

D. Alignment of tangents and curves: Within 0.01 feet.

E. Set points for structures to the nearest 0.02 feet, except where the operational function of special features require closer tolerances.

F. Survey any movement monuments with First Order, Class 1 survey within an accuracy of 0.001-foot vertical and 0.001-foot horizontal.

G. Tolerances for all other Work: As shown or specified in the Contract Documents.

H. Furnish accurate survey instruments. Survey instruments are subject to inspection by Engineer for proper operation.

1. Check calibration of electronic distance measuring (EDM) instruments a minimum of once per month on an established baseline approved by the Engineer. Keep calibration results in a log book, available for the Engineer's

review, showing the date and distances measured on the baseline. Do not use an EDM if it does not meet the minimum advertised accuracy published by the manufacturer of the EDM.

2. Conduct a zero baseline test on Global Positioning System (GPS) equipment. A zero baseline test is a test on two or more receivers simultaneously gathering data from one antenna with data post-processed to give a resulting vector between the receivers that is equal to zero.
3. Promptly replace, repair, or adjust defective survey instruments to operate within the tolerances of the instrument manufacturer.

I. Remove and replace all work not surveyed with the methods and equipment as submitted by the Contractor and accepted by the Engineer at no additional cost to the Owner.

1.7 PROTECTION OF MONUMENTS, STAKES, AND MARKS

A. Preserve and protect all survey monuments and related marks. When removal is necessary, accurately reference the monuments or related marks, subject to the approval of the Engineer.

1. Replace and reset all survey stakes, control points, monuments, benchmark, or reference stakes disturbed or destroyed during the work to the satisfaction of the Engineer at no additional cost to the Owner.
2. Reset primary or secondary control monuments removed as soon as the Work requiring the removal is complete. Alternatively, set other control points so as to reestablish the control network.
3. Recheck the position of monuments, control points, or other marks that are subject to movement due to the passage of equipment or other forces at regular intervals, but not less than monthly.

1.8 QUANTITY SURVEYS

A. Following the completion of all the clearing and grubbing operations in an area, and before commencing topsoil or other stripping, prepare a baseline survey consisting of, at a minimum, cross-sections at 50-foot intervals, and additional points as necessary to represent the surface accurately in all areas of disturbance as a basis for determining excavation quantities.

B. Conduct a cross section survey meeting the same requirements as the baseline survey after excavation is complete and any time before fill placement. Calculate and submit excavation and fill quantities by either the average end area method or by using digital terrain models.

C. If a material is specified to be measured in a stockpile, conduct the baseline survey on the ground surface before stockpiling the material, and a survey of stockpiled material.

D. Each month, determine the volume of excavation and fill using the established baseline survey cross-sections or digital terrain models.

E. At the point where the Work performed under a bid item is completed, perform a final cross section survey meeting the same requirements as the baseline survey to calculate quantities (as described above).

F. Submit a copy of cross-section survey data and quantity calculations to Engineer with each monthly payment.

G. The Engineer or Owner may perform check surveys in selected locations to verify measurements and quantities. Provide the Engineer and Owner access to the Work areas for survey measurements, as required.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 REQUIRED SURVEYS

A. Surveys listed below are the minimum survey requirements. Whether listed or not the Contractor is responsible to provide all surveys necessary for control, construction, and to provide complete as-constructed information for record documents and record drawings.

B. Quantity surveys.

C. Surveys required for establishing and maintaining survey control.

D. Surveys required for construction to plan elevation and locations, including staking.

E. Surveys for project boundaries, including easements, right of ways, and disturbance limits.

F. Surveys of existing structures, including structure and pipe inverts and elevations required to confirm, coordinate and attach existing work to new construction. Complete surveys as soon as features previously submerged, buried, or covered become accessible.

G. As-constructed surveys of new construction, including, but not limited to:

1. New structures including all vertical and horizontal corners.
2. Pipe inverts, alignments, and connection points.
3. Regraded and disturbed areas including existing, excavation, and foundation surfaces, and final grades.
4. New and relocated roads.
5. Wetlands mitigation areas.
6. Planting areas.
7. Embankment Dam, including material zones and finished surfaces.
8. Relocated and new utilities.
9. New instrumentation, including piezometers, monuments, staff gages, measurement devices.

END OF SECTION

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Classification of waste materials and disposal of waste materials.

1.2 CLASSIFICATION OF WASTE MATERIALS

A. Waste materials to be disposed of are classified in three categories: Excess excavated materials, cleared vegetation, other waste materials, including hazardous, controlled, or regulated waste materials.

1. Excess excavated soil, rock or unclassified materials include only those materials which are excavated from the designated excavations at the site which are not suitable for use in construction with or without processing, or in excess of that needed for construction as approved by the Engineer. Sediment from sediment and erosion control devices will also be considered excess excavated materials.
2. Cleared vegetation includes vegetation cleared from within the limits of site disturbance, from the staging and stockpile areas, borrow areas, and from temporary and permanent construction roads that is not used at the Site, as determined by the Engineer, to create wildlife habitat or natural features.
3. Other waste materials include, but are not limited to miscellaneous materials including, concrete, reinforcing steel, pipe, miscellaneous metalwork, wood, etc.; and contractor generated waste materials including: petroleum products, solvents, paints and stains, refuse, garbage, debris, sanitary waste, crank case oil, grease, paint thinner, cleaning solvents, or any other materials used by the Contractor for maintenance or operation of construction equipment that can be classified as controlled, regulated, or hazardous waste, and require special handling, storage, and disposal.

1.3 DISPOSAL OF MATERIALS

A. Dispose of the following materials offsite:

1. Excess excavated soil, rock or unclassified materials.
2. Excess cleared vegetation. Burning of cleared vegetation and other waste materials is not permitted.
3. Other waste materials.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Load receipts for materials disposed of at an offsite facility and other documentation as required by the Owner.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

3.1 DISPOSING OF WASTE MATERIALS OFFSITE

A. Remove waste materials from the construction area prior to the completion of the Work. Dispose of excess cleared vegetation and other waste materials in an approved solid-waste facility or other approved facilities.

B. It is the responsibility of the Contractor to make any necessary arrangements with private parties and landfill operators pertinent to locations and regulations of area landfills, and to pay any fees or charges required for offsite disposal of materials.

END OF SECTION

SECTION 01 74 30
PROTECTION OF EXISTING FACILITIES

PART 1 GENERAL

1.1 DESCRIPTION

A. This Section describes the procedures for photo and video documenting, locating, protecting, and relocating existing underground utilities and surface improvements.

B. The Drawings show underground utilities identified by a search of records, but other utilities may exist which were not identified and are not shown on the Drawings. Actual utility locations may differ from the locations shown on the Drawings. Notwithstanding the identification by the Engineer of any underground or above-ground utility or improvement, the Contractor is solely responsible for identifying and protecting all existing underground or above-ground utilities or improvements within the limits of construction, whether shown on the Drawings or not.

C. Do not perform work that would affect any oil, gas, sewer, water pipeline, or other water treatment plant piping; any telephone, cable, fiber optic, or electric transmission line; any fence; or any other structure, until authorization has been obtained from the owner of the improvement. Provide the owner of the improvement due notice of the beginning of Work, and remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace same.

1.2 UNDERGROUND SERVICE ALERTS AND NOTIFICATIONS

A. Except in an emergency, contact the facility operators and One Call (811) at least 2 working days, but not more than 5 working days before beginning any excavation. Comply with all applicable laws and regulations in locating subsurface installations and in excavating.

B. An emergency is defined as a sudden, unexpected occurrence, involving a clear and imminent danger, demanding immediate action to prevent or mitigate loss of, or damage to, life, health, property, or essential public services. An emergency includes such occurrences as fire, flood, earthquake, or other soil or geologic movements, as well as such occurrences as riot, accident, or sabotage.

C. Subsurface installations means any underground pipeline, conduit, duct, wire, or other structure.

D. Before beginning any excavation in the vicinity of any existing underground facilities, notify the respective authorities representing the owners or agencies responsible for such facilities not less than two days nor more than 14 days before excavation so that a representative of said owners or agencies can be present during such work if they so desire.

1.3 EXISTING UTILITIES AND IMPROVEMENTS

A. Before submittal of shop drawings, and before beginning any excavations, conduct investigations, including exploratory excavations, drill holes, and potholing to determine the location and type of underground utilities and services connections that could result in damage to such utilities.

B. Pothole utilities to accurately identify the utility locations. The positions of utilities shown on the drawings were obtained from various utility records and shall all be verified by the Contractor.

C. Before submittal of shop drawings, and before beginning any excavations for new pipelines or structures, conduct investigations, including exploratory excavations and borings, to determine the locations and type of underground utilities and service connections which could result in damage to such utilities. Prepare a report (i.e., Potholing Report) identifying each utility by its size, elevation, station, or coordinates and material of construction. Immediately notify the Engineer and the Utility in writing as to any utility discovered in a different position than as marked in the field or shown in the Contract Documents, or any utility which is not marked in the field or shown in the Contract Documents, or any utility which is in direct conflict with the proposed utilities.

D. Prepare a support plan for each utility crossing detailing the intended support method. Obtain approval from the owner of the utility before excavation of the utility.

E. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the utility. Conform to local agency requirements for backfill and pavement repair subsequent to performing exploratory excavations.

F. Protect all underground utilities and other improvements which may be impaired during construction operations. 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. Obtain prior written approval from utility owners for any work which may result in interruption of utility service.

G. Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing utility or other improvement which is at the location shown on the Drawings, remove and temporarily replace or relocate such utility or improvement in a manner satisfactory to the Engineer and the owner of the facility. Restore or replace the utility or improvement as nearly as possible to its former locations and to as good or better condition than found before removal.

1. Other Utilities

    a. When it is necessary to remove, relocate, or temporarily maintain an existing utility, the cost of which is not required to be borne by the owner thereof, the Contractor shall bear all expenses incidental to the work on the existing utility. The work on the existing utility shall be done in a manner satisfactory to the owner thereof; it being understood that the owner of the utility has the option of doing such work with its own forces or permitting the work to be done by the Contractor.

    b. When it is necessary to remove, relocate, or temporarily maintain a utility which is not shown on the Drawings or is in a position different from that shown on the Drawings and were it in the position shown on the Drawings would not need to be removed, relocated, or temporarily maintained, and the cost of which is not required to be borne by the owner thereof, the Engineer will make arrangements with the owner of the utility for such work to be done at no cost to the Contractor, or will require the Contractor to do such work in accordance with the provisions of the General Conditions or will make changes in the alignment and grade of the Work to eliminate the necessity to remove, relocate, or

temporarily maintain the utility. Changes in alignment and grade will be ordered in accordance with the provisions of the General Conditions.

H. Take precautions to prevent damage to all pavement and other surfaces outside the limits of necessary excavation, whether on public streets, utility or Owner rights-of-way, or private property and roads. The Engineer will conduct regular inspections of the road conditions used to access the site during construction. Make temporary repairs to roads damaged by trucks or the Contractor's or Subcontractor equipment during the construction period. Temporary repairs shall consist of patching the roads by placing a minimum of a 2-inch thick layer of asphalt concrete paving on native material or existing base, unless the jurisdictional agency has more stringent requirements. Replace all temporary repairs and damaged pavement in accordance with accepted standards of the jurisdictional agency. Where the foregoing standards are silent, replace pavement to the existing thickness plus one inch. A final road inspection will be conducted, and permanent repairs shall be completed at the Contractor's cost before the Notice of Completion is issued. For the purposes of this Section, the terms "pavement" and "surfaces" shall be deemed to include base materials.

I. Take precautions to prevent damage to all property outside the limits of construction.

J. Install temporary fencing to delineate the entire length and width of all designated and Contractor-elected material storage and crossing locations over the existing pipelines.

1.4 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. Do not perform any pavement breaking or excavation until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced for restoration. Accurately restore all survey benchmarks, markers or points disturbed by Contractor activities after all surface restoration has been completed.

1.5 APPROVAL OF REPAIRS

A. All repairs to a damaged improvement are subject to inspection and written approval by an authorized representative of the improvement owner before being concealed by backfill or other work.

1.6 MAINTAINING IN SERVICE

A. All utilities including plant process piping, oil and gasoline pipelines, power, and telephone or 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 Engineer are made with the owner of said utility. Repair all damage due to operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 77 00
CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SUMMARY

A. This section covers contract closeout items including closeout procedures, final cleaning, equipment start up, project record documents, and operation and maintenance procedures.

1.2 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that the Work is complete in accordance with the Contract Documents and ready for the Engineer's and Owner's review.

B. Provide submittals to the Engineer that are required by the Contract Documents and by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

1.3 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean debris from the site.

C. Sweep paved areas and rake clean landscaped surfaces.

D. Disconnect all temporary utilities to the Site and temporary Site facilities and utilities.

E. Remove all Contractor-constructed access roads and parking areas.

F. Clear, grade, and seed as required.

G. Remove waste and surplus construction materials, rubbish, wood, bituminous concrete, concrete debris, demolished materials, other foreign material, and construction facilities from the Site.

1.4 ADJUSTING

A. Adjust operating Products and equipment to ensure smooth and unhindered operation.

1.5 PROJECT RECORD DOCUMENTS

A. Maintain on Site, one set of the following record documents; record actual revisions to the Work:

1. Contract Drawings.
2. Specifications.
3. Addenda.
4. Change Orders and other Modifications to the Contract.
5. Reviewed submittals including Shop Drawings, product data, and samples.
6. Requests for information, field directives and project correspondence.

B. Store Record Documents separate from documents used for construction.

C. Record information concurrent with construction progress.

D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:

1. Manufacturer's name and product model and number.
2. Product substitutions or alternates utilized.
3. Changes made by Addenda and Modifications.

E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured depths of foundations in relation to completed construction and the project datum.
2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements or benchmarks.
3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
4. Field changes of dimension and detail.
5. Details not on original Contract Drawings.

F. Submit closeout documents to Engineer with request for final Application for Payment.

1.6 OPERATION AND MAINTENANCE INSTRUCTIONS

A. Submit two hard copies of the O&M Instructions 21 days prior to final inspection, bound in 8-1/2 x 11-inch text pages, ring binders with durable plastic covers, and an additional copy submitted electronically.

B. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," with title of project.

C. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tabs clearly printed under reinforced laminated plastic.

D. Contents:

1. Prepare a Table of Contents for each volume, with each Product or system description identified.
2. Part 1: Directory, listing names, addresses, and telephone numbers of the Engineer, Contractor, Subcontractors, and major equipment and material suppliers.
3. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

a. Significant design criteria
b. List of equipment
c. Parts list for each component
d. Operating instructions

e. Maintenance instructions for equipment and systems
f. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents

4. Part 3: Project documents and certificates, including the following:

a. Shop drawings and product data
b. Certificates
c. Warranties

E. This preliminary submittal will be returned to the Contractor, with Engineer and Owner's comments. Resubmit O&M instructions, with revisions based on Engineer and Owner comments. Submit four hard copies as described above and an electronic copy within ten days after final inspection.

1.7 WARRANTIES/GUARANTEES

A. Provide two notarized copies.

B. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.

C. Provide Table of Contents and assemble in ring binders with durable plastic cover.

D. Submit 10 days prior to final Application for Payment.

E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

1.8 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.

B. Deliver to Project Site and place in location as directed by the Owner; obtain receipt prior to final payment.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 02 32 00
GEOTECHNICAL INVESTIGATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Geotechnical investigation data.

B. Groundwater level information.

1.2 GEOTECHNICAL INVESTIGATION DATA

A. The technical data contained in the following reports upon which the Contractor may rely on is reliable factual information, such as field logs of drill holes and excavated test pits and laboratory test results.

1. Report dated June 1977 prepared by International Engineering Company, Inc. (IECO) titled: Windy Gap Project, Grand County, Design Report No. 2, Diversion Dam Embankment.
2. Report dated February 1981 prepared by IECO titled: Windy Gap Project, Grand County, Colorado; Project General Construction; Contract Documents No. 2040-C Volume V; Information for Bidders.
3. Report dated September 1982 prepared by IECO titled: Windy Gap Project, Report on Pumping Plant Excavation and Re-examination of Pumping Plant and Dam Stability.
4. Report dated February 2015 prepared by Tetra Tech titled: Windy Gap Reservoir Modification Study.
5. Report dated May 2017 prepared by Tetra Tech titled: Windy Gap Reservoir Modification Study – Supplemental Report.
6. Memorandum dated December 2018 prepared by Northern Colorado Water Conservation District (Northern) titled: Low Permeability Borrow for Windy Gap Connectivity Channel.
7. Report dated March 10, 2021 prepared by AECOM titled: Colorado River Connectivity Channel (CRCC) and Windy Gap Dam Geotechnical Data Report.

1.3 GROUNDWATER LEVEL INFORMATION

A. Up to date data for groundwater levels in the piezometers installed at the site can be obtained from Northern Water.

1.4 LIMITATIONS

A. Refer to General Conditions regarding use of the information included in Appendices.

B. Exploratory investigations are not sufficiently complete to disclose all defects or material types that may be encountered during construction.

C. The subsurface conditions, and groundwater levels provided apply only to the locations and conditions at the time of the explorations and measurements. The subsurface conditions and reservoir levels at the site may be different at the time of construction as compared to when observations were made and recorded, and Bidder should expect this data to vary.

PART 2 PRODUCTS

NOT USED.

PART 3 EXECUTION

NOT USED.

END OF SECTION

SECTION 02 41 19
SELECTIVE DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Selective demolition of existing project features indicated on the Drawings. The term selective demolition in this section may be used to define Work that may include protection of features to remain, demolition, disposal, salvage, and relocation, of items.

1.2 DEFINITIONS

A. Abandonment: Treating features no longer required as indicated on the Drawings to allow them to remain in place without impacting other functional features.

B. Demolish: Remove and dispose of designated existing equipment, materials, and ancillary features and components.

C. Dispose: Transport and dispose removed items at a permitted landfill or licensed recycling facility.

D. Hydrodemolition: Concrete removal technique using high-pressure water jets to remove concrete at pressures high enough for removal, but not high enough to damage concrete beyond the removal lines and grades shown on the Drawings or otherwise approved.

E. Protect: Leave designated existing equipment, materials, and ancillary features and components in place and protect from damage until all work is complete and accepted.

F. Reinstall: Make service connections and provide functional equipment and features designated new location.

G. Relocate: Remove equipment, materials, and ancillary features and components, store, protect, and reinstall at designated new location.

H. Salvage: Remove existing equipment, materials, and ancillary features and components without damage, and deliver to the Owner designated location.

I. Wire Sawing or Wire Cutting: Using a wire saw consisting of a multi-strand cable with diamond segments threaded through a system of pulleys used to remove large sections of concrete.

1.3 COORDINATION AND PRE-INSTALLATION MEETINGS

A. Coordinate demolition with the Owner and the Engineer.

B. Arrange for a meeting before demolition starts to review the demolition limits and the methods and equipment to be used in certain areas.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Selective Demolition Plan:

1. Proposed procedures for demolition, salvage, relocation, protection, and disposal of the items listed in this section and shown on the Drawings.
2. Identify procedures for safe conduct of the Work, dust control, careful removal and disposition of materials specified to be salvaged or relocated, protection of property that is to remain undisturbed, coordination with other Work in progress, and timely disconnection of utility services. Include:

    a. Sequence and schedule, including removal, salvage, and relocation.

3. Proposed methods of demolition and equipment to be used and qualifications:

    a. Mechanical tools.
    b. Hydrodemolition:

        1) Qualifications of operators.
        2) Proposed water pressure and flow rate, and weight, type, and location of each component.

    c. Wire Sawing:

        1) Qualifications of operators.
        2) Proposed type, and location of each component.

    d. Water supply, containment and discharge:

        1) Water supply source.
        2) Equipment and procedures for collecting, treating, and disposing of hydrodemolition and wirecutting water.

C. Permits: Copies of current valid permits and licenses for work in this section where required by local, state, or federal agencies.

D. Preconstruction Video Documentation: Complete video documentation with sufficient detail and viewpoints to record the existing condition.

E. After demolition is complete, if requested by the Engineer, submit reports describing quantities and type of demolition materials, and the locations, quantity, and method of disposal and recycling.

F. Report with list and photos of salvaged materials delivered to the designated Owner facility.

1.5 SITE CONDITIONS

A. Information contained in the Contract Documents showing the scope of demolition is based on available record documents:

1. Inspect facilities and verify the nature and location of the Work.
2. Differences between the Contract Documents and actual facilities does not constitute grounds for a time extension or Contract modifications.

1.6 QUALITY ASSURANCE

A. Qualifications

1. Personnel operating hydrodemolition or wire sawing equipment shall have at least 3 years' experience operating the type of equipment used.

PART 2 PRODUCTS

2.1 MATERIALS

A. Equipment:

1. Hydrodemolition:

a. Capable of concrete removal to the required depths without damage to concrete that will remain.
b. Hydrodemolition equipment to include a pumping unit providing high-pressure water through hosing or tubing to a device capable of safely and effectively positioning the high-pressure jet for concrete removal.
c. The equipment must have the ability to control the concrete removal depth to one-half the size of one aggregate, plus or minus, in competent concrete.
d. Maintain on the job site an inventory of common wear parts and replacement accessories for the equipment adequate to assure that routine maintenance tasks can be performed readily without undue project delay.
e. In areas designated on the drawings for hydrodemolition that are inaccessible to hydrodemolition equipment use specified mechanical demolition tools.

2. Wire Sawing:

a. Capable of concrete removal to the required depths without damage to concrete that will remain.

3. Mechanical Demolition Tools:

a. In areas that require preservation of concrete beyond the limit of demolition use power-driven hand tools (such as jack hammers, mechanical chipping tools, or chipping hammers). Do not use jack hammers heavier than 30 lbs and chipping hammers heavier than 15 lbs. Operate mechanically driven tools at a maximum angle of 45-degree angle from the concrete surface to the centerline of the tool.

PART 3 EXECUTION

3.1 PREPARATION

A. Videotape all features identified for selective demolition after the Notice to Proceed and before beginning the Work of this Section. Coordinate with the Engineer to fully document and record the condition of features and materials prior to removal.

B. Notify the Owner and Engineer a minimum of 7 days prior to beginning demolition Work.

C. The extent of selective demolition work shown on the Drawings is based on historical drawings and site observations.

D. Not all details may be shown on the Drawings, and the Contractor is required to field verify existing features.

E. The specific extent of selective demolition for the various items will be determined by the Engineer in the field. Do not remove without Engineer approval.

F. Protect existing facilities, equipment, and components to remain with temporary barricades and other protective measures and procedures as required to prevent damage.

G. Remove concrete, material, and structures in a manner that prevents interference with the Owner's operation and maintenance of the Project and prevents damage or structural instability/weakness to adjacent structures and equipment.

H. Provide shoring, bracing, and supports as required.

3.2 GENERAL DEMOLITION

A. Conduct demolition operations and debris removal in a manner ensuring minimum interference with roads, structures, and other adjacent features and facilities.

B. Immediately notify the Engineer of damage to structures and features not identified for demolition or beyond the limits of demolition shown on the Drawings or as identified by the Engineer.

C. Repair or replace damage to existing features beyond the limits of demolition using materials and methods appropriate for the particular location, as approved by the Engineer, at no additional cost to the Owner.

D. Remove materials to conform to new elevations, profiles, and sizes. Comply with specified tolerances and finishes.

E. Saw cut or otherwise isolate materials to be removed to minimize damage to adjacent surfaces.

F. Remove concrete in small sections.

G. Use water sprinkling, temporary enclosures, and other methods to limit dust. Indiscriminate production or blowing of dust will not be allowed. Submit a plan for dust control, as part of the demolition plan indicated herein, before starting the Work.

H. Cut rectangular openings in concrete structures with full depth saw cut edges with core drill corners to prevent over-cutting. Cut round openings with full depth coring methods.

I. Assume all concrete to be demolished contains steel reinforcement.

J. Comply with provisions of Section: 01 74 19 – Construction Waste Management and Disposal for disposal of demolished and removed materials and debris.

K. Blasting is not allowed for demolition.

3.3 HYDRODEMOLITION

A. Calibrate equipment to project conditions and the material being removed before beginning hydrodemolition work. If hydrodemolition equipment cannot be calibrated to the satisfaction of the ENGINEER, remove equipment and provide another hydrodemolition system.

B. Conduct a test of hydrodemolition equipment before production work starts in an area of concrete designated for demolition proposed by the Contractor and approved by the

Engineer. The test section must demonstrate effectiveness of equipment to remove concrete without damage to concrete beyond the demolition limit and prepare the remaining concrete surface to a suitable condition for a construction joint with an amplitude of about ¼ to 3/8-inch, and no undercutting of aggregates.

C. Adjust equipment at the beginning of each shift on an area of representative concrete approved by the Engineer before commencing operations.

D. Adjust settings as necessary to achieve the desired removal of concrete.

E. Recalibrate during the work if parameters change (such as degree of concrete deterioration or the concrete strength changes).

3.4 WIRE SAWING

A. Operate equipment to preserve concrete beyond removal limits.

B. Promptly replace worn cutting devices.

3.5 SALVAGE AND RELOCATE

A. Remove equipment and materials designated for salvage and relocation in a manner that prevents damage and preserves the items including mechanical and electric connections for future use.

B. Remove and transport items identified for salvage to a location acceptable to Owner.

C. Store items identified for relocation in a location protected from weather and other adverse conditions.

3.6 SCHEDULE

A. Provide a schedule of items for selection demolition to include all components, attached or associated appurtenances, or miscellaneous items, requiring selective demolition shown on the Drawings. Organize in the following categories as applicable:

1. Demolish and Remove
2. Salvage
3. Relocate

3.7 QUALITY CONTROL

A. After completion of demolition and prior to final cleaning, observe the surface and sound remaining concrete to determine completeness of concrete removal, verify depth and vertical edge of cut, uniformity of excavation, and evaluate damage to concrete beyond the limit of demolition.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMWORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Formwork for cast-in place concrete with shoring, bracing, and anchorage.

B. Form accessories.

C. Form stripping.

1.2 REFERENCES

A. American Concrete Institute (ACI)

1. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
2. ACI 301 - Structural Concrete for Buildings.
3. ACI 347 - Recommended Practice For Concrete Formwork.

B. APA – The Engineered Wood Association

1. PS-1 - Structural Plywood.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. At least 14 calendar days prior to forming, submit forming plans, procedures, support system, and product data for forming concrete structures.

C. Information on formwork design and construction when specified in other Specification Sections.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with ACI 301 and the recommendations of ACI 347.

B. Tolerance shall be as necessary to provide completed concrete structure within the tolerance specified in ACI 117.

C. Design Requirements

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

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Plywood: Concrete form plywood, exterior grade, mill-oiled and edge-sealed as specified herein and in accordance with APA PS-1. High-density overlaid, or provided with an

equivalent smooth form liner as the minimum form material for surfaces indicated to receive smooth form finish or any rubbed finish.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished concrete surface.

C. Lumber: Fir species; No. 2 grade or better; with grade stamp clearly visible.

D. Steel: Minimum 16 gauge sheet, well matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to structural tolerances and appearance of finished surfaces.

2.2 FORMWORK ACCESSORIES

A. Form Ties: Removable snap-off type, galvanized metal, fixed length, cone type, with waterproofing washer, free of defects that could leave holes larger than 1-¼ inch (32 mm) in concrete surface.

B. Form Release Agent: Colorless, material which will not stain concrete, absorb moisture, or impair natural bonding or color characteristics of coating intended for use on concrete.

C. Corners: Chamfered, rigid plastic or wood strip, ¾ by ¾ inch size, maximum practical lengths.

D. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

E. Joint Filler: A dense, closed-cell, foam rubber approved by the Engineer.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions match the Drawings.

B. Obtain Engineer approval for formwork.

3.2 EARTH FORMS

A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.3 FORMWORK ERECTION

A. Erect formwork, shoring, and bracing to achieve design requirements in accordance with requirements of ACI 301.

B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.

C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.

D. Align joints and make watertight to prevent leakage of mortar. Keep form joints to a minimum.

E. Provide chamfer strips on all external corners, unless indicated otherwise.

3.4 FORM RELEASE AGENT APPLICATION

A. Apply form release agent on formwork in accordance with manufacturer's recommendations.

B. Apply form release agent prior to placement of reinforcing steel, anchoring devices and embedded items.

C. After form release agent is applied to forms, place concrete within 14 calendar days. If concrete is not placed within 14 calendar days, remove forms and reapply form release agent.

D. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes which may be affected by the agent such as crystal forming waterproofing. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

3.5 INSERTS, EMBEDDED PARTS AND OPENINGS

A. Provide formed openings where required for items to be embedded in or pass through concrete work.

B. Locate and set in place items which will be cast directly into concrete.

C. Coordinate Work of other Sections in forming and placing openings, sleeves, bolts, anchors and other inserts.

D. Install accessories and embedded items in accordance with manufacturer's instructions, straight, level, and plumb. Secure all embedded items before placing concrete. Ensure that items are not disturbed during concrete placement. Fill voids with readily removable material to prevent entry of concrete, placed so that no voids are created in surrounding concrete.

E. Install waterstops continuous without displacing reinforcement.

F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

G. Close temporary openings with tight fitting panels, flush with inside face of forms and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.6 FORM CLEANING

A. Clean and remove foreign matter within forms as erection proceeds.

B. Clean formed cavities of debris prior to placing concrete.

C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

D. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure.

3.7 FORMWORK TOLERANCES

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

3.8 FIELD QUALITY CONTROL

A. Inspect erected formwork, shoring, and bracing to ensure that Work is in accordance with formwork design and that supports, fastenings, wedges, ties, and items are secure.

3.9 FORM REMOVAL

A. Notify Engineer at least 48 hours prior to removal of forms.

B. Remove forms in a manner which will not damage concrete.

C. Do not wedge pry bars, hammers or tools against finish concrete surfaces scheduled for exposure to view.

D. It is the Contractor's responsibility to limit construction loads at all times to those which can be carried safely by the developed strength of the structure at time of loading, and by formwork and shoring in-place at time of loading.

E. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND PVC WATERSTOPS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Definitions and requirements for construction, expansion, contraction, and control joints in concrete structures.

B. Tooling exposed edges of concrete.

C. Furnishing and installing PVC waterstop materials in joints.

1.2 REFERENCES

A. American Society of Testing and Materials International (ASTM)

1.	ASTM D638	Standard Test Method for Tensile Properties of Plastic
2.	ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
3.	ASTM D747	Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
4.	ASTM D1203	Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
5.	ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
6.	ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction

B. U.S. Army Corps of Engineers (USACE)

1.	EM 1110-2-2102	Water Stops and Other Preformed Joint Materials for Civil Works Structures
2.	COE CRD-C-572-74	Polyvinylchloride Waterstop

C. American Concrete Institute (ACI)

1.	ACI 224.3R	Joints in Concrete Construction
2.	ACI 318	Building Code Requirements for Structural Concrete

D. International Concrete Repair Institute (ICRI)

1.	ICRI 0372	Selecting and Specifying Concreter Surface Preparation for Sealing, Coatings, and Polymer Overlays

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Approval Samples of Waterstops:

1. 2-foot long sample of each size and type of waterstop to be used in work.

C. Certifications of Waterstops:

1. Manufacturer's certification for PVC compound used to fabricate PVC waterstop. Include physical property test data on compound from tests performed by manufacturer or other laboratory within eighteen (18) months before submittal.

2. Sampling certification that samples are representative of waterstop to be used in the Work.

D. Instructions for Waterstops:

1. Manufacturer's recommendations for installing and splicing waterstop.

E. Material Approval Data for Joint Filler:

1. Name and manufacturer of joint filler. The Engineer reserves the right to require submission of manufacturer's test data and certification of compliance with specifications.

F. Waterstop Layout Drawings

1. Detailed waterstop layout drawings for approval at least 14 calendar days prior to installation. Indicate field and shop welded connections and all changes in direction or areas requiring special placement.

1.4 CONTRACTOR QUALITY CONTROL

A. Perform concrete work in accordance with ACI 318 and ACI 224.

1.5 DEFINITIONS

A. The following language regarding concrete joints takes precedence over the language in ACI 224.3R.

B. Construction Joints (CJ):

1. Construction joints are joints which are purposely placed in concrete to facilitate construction; to reduce initial shrinkage stresses and cracks; to allow time for the installation of embedded metalwork; or to allow for subsequent placing of other concrete.

2. Bond is required at construction joints regardless of whether or not reinforcement is continuous across the joint.

C. Contraction Joints (CR.J):

1. Contraction joints are joints placed in concrete to provide for volumetric shrinkage of a monolithic unit or movement between monolithic units.

2. Contraction joints are constructed so no bond exists between concrete surfaces forming the joint.

3. Except as provided for dowels, reinforcement is never continuous across a contraction joint.

D. Control Joints (CT.J):

1. Control joints are joints placed in concrete to provide for control of initial shrinkage stresses and cracks of monolithic units.

2. Control joints are constructed the same as contraction joints, with the exception that reinforcement is continuous across control joints.

E. Expansion Joints (EJ):

1. Expansion joints are joints provided to allow for expansion and contraction between two adjacent concrete members.

2. Joints are filled with sponge rubber joint filler.

F. Tooled Edges: Unless otherwise shown or specified, tool permanently exposed edges of slabs to a radius of ¼ inch.

PART 2 PRODUCTS

2.1 SPONGE RUBBER JOINT FILLER

A. ASTM D1752, Type I, except as specified.

B. Test Specimen Compression Load: 50 to 1500 lb./in^2.

C. Joint filler adhesive: Non-bituminous adhesive recommended by filler manufacturer.

D. Pre-molded sponge rubber fully compressible with recovery rate of minimum 95 percent.

2.2 PVC WATERSTOPS

A. Polyvinyl Chloride (PVC) Waterstop:

1. Provide flexible PVC (polyvinyl chloride) waterstop as shown on the Drawings, as manufactured by Greenstreak, Va. 3400 Tree Court Industrial Boulevard, St. Louis, MO 63122, telephone (800) 352-9504, or equal in the following styles:

a. Style 705 (6-inch ribbed with centerbulb)

b. Style 709 (9-inch ribbed with centerbulb)

B. PVC Compound:

1. Domestic virgin PVC with additional resins, plasticizers, stabilizers, or other materials required to meet specified requirements.

2. Do not use reclaimed PVC or manufacturer's scrap.

C. Meet physical characteristic requirements specified in Table 03150-1 PVC Waterstop Physical Characteristics.

Table 03 15 00-1
PVC Waterstop Physical Characteristics

Property	Test Method	Requirement
Tensile test, minimum	ASTM D 638, speed D, specimen type IV	2,000 lbs/in^2
Ultimate elongation, minimum	ASTM D 638, speed D, specimen type IV	300 percent
Stiffness in flexure, minimum	ASTM D 747	600 lbs/in^2
Low temperature brittleness at –35 degrees F	ASTM D 746	No cracking or chipping
Volatile loss, change in weight, maximum	ASTM D 1203, method A, 0.08-inch thick specimen	0.50 percent
Tensile strength after accelerated extraction test, percent of tensile strength before extraction test, minimum	COE CRD-C-572	80 percent
Ultimate elongation after accelerated extraction test, percent of ultimate elongation before extraction test, minimum	COE CRD-C-572	80 percent
Change in weight after effect of alkalies test	COE CRD-C-572	+0.25 percent -0.10 percent
Change in Shore durometer hardness after effect of alkalies test	COE CRD-C-572	+/- 5

D. Prepare test specimens in accordance with COE CRD-C-572.

E. Ties for PVC Waterstop: “Hog Rings” or grommets for each edge at 12-inches maximum spacing.

PART 3 EXECUTION

3.1 INSTALLING PVC WATERSTOPS

A. Before starting installation of waterstops, furnish the Engineer with the manufacturer’s recommendations for installing and making splices in the waterstops.

B. Install waterstops at locations shown on the Drawings.

C. Install waterstops in accordance with these Specifications and manufacturer’s recommendations.

D. Install waterstops so as to form a continuous watertight diaphragm in the joint unless otherwise shown on the Drawings. Extend vertical waterstops 6-inches below the top of walls or floors, unless otherwise shown on the Drawings.

E. Provide additional vibration to concrete surrounding waterstops, over and above that used for adjacent concrete placement, to ensure complete and void-free embedment of waterstops in the concrete.

F. Install waterstops with approximately one-half of the width of the waterstop embedded in the concrete on each side of the joint.

G. To eliminate faulty installation that may result in joint leakage, take special care to correctly position and secure waterstops during installation.

H. Take adequate precautions to protect waterstops from any damage during progress of the Work.

I. Provide pre-molded waterstop of maximum practicable length to minimize the number of joints.

J. Remove curing compound and other foreign material from waterstops in all joints before placing concrete.

3.2 SPLICING PVC WATERSTOP

A. Splice waterstops at joints in waterstop sections and at intersections of waterstops.

B. Use only factory made waterstop fabrications for intersections, changes of direction, and transitions.

C. Fabricate field splices of waterstops with workers who have demonstrated to the satisfaction of the Engineer that they are sufficiently skilled to fabricate the required splices.

D. Only straight butt splices using heat welding are permitted for field splicing of waterstops unless otherwise approved in writing by the Engineer. Lapping of waterstop, use of adhesives, or solvents is not allowed.

E. Reform waterstops at splices with a remolding iron to match the waterstop pattern, including ribs or other features.

F. Allow minimum of ten (10) minutes before new splice is pulled or strained in any way.

G. After allowing joint to cool, bend completed joints at a sharp angle to test weld integrity. Cut out and reweld joints that separate under this test.

H. Finished Splices: Provide cross-section dense and free of porosity with tensile strength of not less than 80% of un-spliced materials.

3.3 CONCRETE JOINTS

A. Construction Joints:

1. Locate construction joints where shown on Drawings or approved by the Engineer in writing. Show proposed locations of construction joints on the placement Drawings submitted under Section 03 30 00: Cast-In-Place Concrete. Relocation, addition, or elimination of construction joints is subject to approval by the Engineer.

2. Waterstops shall be installed in construction joints where shown on the Drawings.

3. Locate horizontal joints in walls at the tops of footings or grade slabs. Place haunches at the same time as slabs.

4. Prepare construction joint surfaces for bonding by sandblasting, steel shot blasting, or high-pressure water jetting (6,000 psi minimum), or other method approved by the Engineer to thoroughly clean the surface. Remove all laitance, loose, or defective concrete, coatings, sand, curing compound, and other foreign material to expose coarse aggregate uniformly, free of laitance, loose aggregate, or damaged concrete. Roughen concrete to produce minimum roughness profile of 1/4 inch. Conduct surface preparation using methods that do not cause undercutting at the edges of the larger particles of aggregate.

5. Thoroughly moisten surfaces of construction joints to be covered with fresh concrete to surface saturated dry condition and remove standing water leaving the surface damp just before concrete placement.

B. Contraction Joints:

1. Construct contraction joints so that there is no bond created between the concrete surfaces forming the joint.

2. Install waterstop in contraction joints where shown on the Drawings.

3. Construct contraction joints by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. Coat the surface of the concrete first placed at the contraction joint with curing compound, or other approved bond breaker, before the concrete on the other side of the joint is placed. Protect reinforcement and waterstop from application of curing compound so that reinforcement and waterstop does not become coated with curing compound. Furnish curing compound that conforms to the requirements of Section 03 30 00: Cast-In-Place Concrete.

C. Control joints:

1. Construct control joints using the same procedures specified for contraction joints. Coat the surface of the concrete first placed at the control joint with curing compound, or other approved bond breaker, before the concrete on the other side of the joint is placed. Protect reinforcement and waterstop from application of curing compound so that reinforcement and waterstop does not become coated with curing compound. Furnish curing compound that conforms to the requirements of Section 03 30 00: Cast-In-Place Concrete.

2. Waterstop shall be installed in control joints where shown on the Drawings.

3. The language in these specifications regarding control joints takes precedence over the language in the referenced American Concrete Institute Document entitled “Joints in Concrete Construction”.

D. Expansion Joints:

1. Structural reinforcement shall not be continuous across any expansion joint.

2. Install expansion joint filler between adjacent concrete members where an expansion joint is required in accordance with manufacturer's instructions, or shown on the Drawings.

3. Construct expansion joints by forming the concrete on one side of the joint and allowing it to set before concrete is placed on the other side of the joint. Coat the surface of the concrete first placed at the expansion joint with curing compound, or other approved bond breaker, before the joint filler is installed and the concrete on the other side of the joint is placed. Furnish curing compound that conforms to the requirements of Section 03 30 00: Cast-In-Place Concrete.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and placing deformed reinforcing steel bars, dowels, welded wire fabric, and associated accessories for cast-in-place concrete.

1.2 REFERENCES

A. American Society of Testing and Materials International (ASTM)

1.	ASTM A82	Standard Specifications for Steel Wire, Plain, for Concrete Reinforcement.
2.	ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3.	ASTM A615	Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.

B. American Concrete Institute (ACI)

1.	ACI 301	Standard Specifications for Structural Concrete for Buildings.
2.	ACI 315	Details and Detailing of Concrete Reinforcement.
3.	ACI 318	Building Code Requirements for Structural Concrete.
4.	ACI 350	Code Requirements for Environmental Engineering Concrete and Commentary.

C. Concrete Reinforcing Steel Institute (CRSI)

1. Manual of Standard Practice.
2. Placing Reinforcing Bars.
3. Reinforcing Bar Detailing Manual.

D. American Welding Society (AWS):

1. AWS D1.4 - Structural Welding Code for Reinforcing Steel.
2. AWS D12.1 - Reinforcing Steel Welding Code.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Reinforcement Placement Drawings: Reinforcement placement drawings for approval at least 14 calendar days prior to fabrication. Indicate bar sizes; spacings; locations and quantities of reinforcing steel and wire fabric; bending and cutting schedules; and supporting and spacing devices. Show locations of splices. Conform with Drawing structural notes, Reinforcing Bar Detailing Manual, and this Section as applicable.

C. Certified copies of mill test reports and reinforcement material analyses.

D. Smooth dowel coating.

E. Epoxy adhesive data when required or shown.

PART 2 PRODUCTS

2.1 REINFORCEMENT

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade, deformed billet steel bars, size as shown on the Drawings.

B. Smooth Steel Dowels

1. Dowels: ASTM A615, Grade 60 round smooth steel bars, size as shown on the Drawings.

2. Bond Breaking Compound: Use a bond-breaking compound approved by the Engineer.

C. Welded Steel Wire Fabric: ASTM A1064, Plain Type unless otherwise shown. Size as shown on the Drawings

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage annealed type.

B. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement conditions, in accordance with CRSI Manual of Standard Practice.

C. Dowel Epoxy Adhesive: Hilti, Inc., Tulsa, OK; HIT HY-100 Anchor System, or approved equal.

2.3 FABRICATION

A. Fabricate concrete reinforcing in accordance with ACI 315.

B. Locate reinforcing splices not indicated on Drawings at point of minimum stress. Indicate location of splices on placement drawings.

PART 3 EXECUTION

3.1 PLACEMENT

A. Place, support, and secure reinforcement against displacement. Do not deviate from required position.

B. Accommodate formed openings.

C. Surface condition of reinforcement: Before placing concrete, clean reinforcement of loose rust and other substances which would impair bond with concrete. Remove rust by vigorous rubbing with burlap cloth or wire brushing.

D. Place reinforcement in accordance with the Drawings, the Contractor's reinforcing steel placement drawings and the CRSI “Placing Reinforcing Bars”.

E. See Drawings for Structural Notes, and for Reinforcement Cover Requirements.

F. Splice reinforcing bars and welded wire fabric by lapping and securely wiring together. Splices at locations other than those indicated are subject to the concurrence of the Engineer and shall conform, if permitted, to the requirements of ACI 318. Do not use mechanical splices.

3.2 EPOXY DOWEL INSTALLATION

A. Install epoxy dowels only where shown on the Drawings or otherwise approved by the Engineer.

B. Install epoxy dowels in strict accordance with the manufacturer's written instructions, including hole drilling and hole size and depth, hole cleaning and preparation, epoxy injection, dowel placement, and cure times.

3.3 QUALITY CONTROL

A. Perform concrete reinforcement work in accordance with the CRSI "Manual of Standard Practice".

B. Notify the Engineer when reinforcing steel is in place and provide at least 48 hours for the Engineer to inspect the reinforcing steel prior to placement of concrete. Concrete placed without inspection may be subject to rejection and removal at no additional cost to the Owner.

C. Engineer's inspection of steel reinforcing prior to concrete placement will not relieve the Contractor from responsibility to conform to the Drawings and Specifications.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and placing cast-in-place concrete at locations shown on the Drawings.

1.2 REFERENCES

A. American Concrete Institute (ACI)

1.	ACI 117	Standard Tolerances for Concrete Construction and Materials and Commentary.
2.	ACI 301	Specification for Structural Concrete.
3.	ACI 305.1	Hot Weather Concreting.
4.	ACI 306.1	Cold Weather Concreting.
5.	ACI 308.1	Standard Specification for Curing Concrete.
6.	ACI 318	Building Code Requirements for Structural Concrete.
7.	ACI 350	Code Requirements for Environmental Concrete Structures and Commentary.

B. American Society for Testing and Materials International (ASTM)

1.	ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2.	ASTM C33	Standard Specifications for Concrete Aggregates.
3.	ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4.	ASTM C42	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5.	ASTM C94	Standard Specifications for Ready-Mixed Concrete.
6.	ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cements.
7.	ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
8.	ASTM C143	Standard Test Method for Slump of Hydraulic Cement Concrete.
9.	ASTM C150	Standard Specifications for Portland Cement.
10.	ASTM C171	Standard Specification for Sheet Materials for Curing Concrete.
11.	ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
12.	ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
13.	ASTM C260	Standard Specification for Air Entraining Admixtures for Concrete.
14.	ASTM C309	Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
15.	ASTM C441	Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction.

16. ASTM C494 Standard Specification for Chemical Admixtures for Concrete.
17. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
18. ASTM C1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
19. ASTM C1260 Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
20. ASTM C1567 Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
21. ASTM C1602 Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.

C. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M182 Burlap Cloth Made from Jute or Kenaf.

D. American National Standards Institute

1. ANSI/NSF 61 Drinking Water System Components–Health Effects.

1.3 DEFINITIONS

A. Curing: Maintaining a satisfactory moisture content and temperature in concrete during its early stages so that the desired properties may develop.

B. Defective Concrete: Surface defects that include honeycomb, rock pockets, indentations, cracks 0.015-inch wide and larger, and cracks that leak in water-holding structures, spalls, chips, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins, and other projections, form popouts, texture irregularities, and stains that cannot be removed by cleaning and concrete not conforming to required lines, levels, details, elevations, dimensions, tolerances or specified requirements.

C. Cold Weather: When air temperature has fallen to, or is expected to fall below, 40°F during the protection period.

D. Hot Weather: one or a combination of the following conditions that tends to impair the quality of freshly mixed or hardened concrete by accelerating the rate of moisture loss and rate of cement hydration, or otherwise causing detrimental results: high ambient temperature, high concrete temperature, low relative humidity, and high wind speed.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Material Approval Data

1. Mix Design: For each concrete mix design submit proposed mix designs in accordance with ACI 301 for review and approval.
2. Name and manufacturer of each cementitious material, aggregate source, and admixture.

a. The Engineer reserves the right to require submission of manufacturer's test data and certification of compliance with the Specifications.
b. The Engineer reserves the right to require submission of samples of concrete materials for testing before or during use in concrete.

3. Cementitious materials certifications and test reports:

a. Manufacturer's certification and test reports for each lot from which shipments are drawn.

1) Certify materials were tested during production or transfer in accordance with specified reference specification.
2) Submittal of certification and test reports shall not relieve Contractor of responsibility for furnishing materials meeting specified requirement.

C. Concrete Placement Drawings:

1. Drawings for each individual concrete placement. An individual concrete placement is defined as a portion of concrete Work placed in one continuous operation between specified lines or joints.
2. Show locations, dimensions, blockouts, openings, recesses, waterstops, and finishes. Identify construction joints, control joints, contraction joints and expansion joints.
3. Show details of items embedded in or associated with placement except reinforcing steel.
4. Include a separate drawing showing placement sequence.
5. Place a title block with Contractor's name, contract title and number, placement identification, and identifying drawing number in lower right hand corner of each drawing.
6. List reference drawings from which details shown on placement drawing were obtained on each drawing.
7. Reference related steel reinforcement drawings associated with placement on each drawing.

D. Special Placement Procedures: Provide specific procedures for unformed concrete placements such as ogee crests or sloped slabs.

E. Concrete Accessories:

1. Manufacturer data confirming conformance with this Section.

F. Concrete Curing Plan. Submit specific proposed plans to cure concrete, including work sequence, protective measures, and monitoring methods, and documentation of monitoring.

1. The Contractor shall be required to provide cold weather protection of concrete for if concrete is to be placed and cured during cold weather as defined in this Section. Submit specific proposed plan to cure and protect concrete during cold weather, including work sequence, protective measures, and monitoring methods/reporting in accordance with ACI 306.

G. Hot and Cold Weather Placement Plans. Plans that do not contain sufficient detail indicating specifically how concrete will be protected against temperate extremes and damage will be rejected.

H. Batch Tickets.

I. Quality Control Test Results.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with provisions of all applicable ACI standards.

B. Obtain materials from same source throughout the Work.

C. Project Record Documents.

1. Accurately record as-built concrete dimensions and tolerances and locations of embedded utilities and components on placement drawings.

D. Sequencing and Scheduling.

1. Notify the Engineer at least 48 hours prior to commencing concrete Work.
2. Allow the Engineer to perform an immediate inspection of concrete surfaces upon removal of forms.
3. Notify the Engineer upon discovery of any honeycombing, foreign-embedded items, and defective concrete.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement: ASTM C150 Portland Cement, Type II:

1. Meet false-set requirement of ASTM C150 - Table 4.

B. Pozzolan: ASTM C618, Class F, having the following properties:

1. Sulfur trioxide, maximum: 4.0 percent.
2. Loss on ignition, maximum: 2.5 percent.
3. Test for effectiveness in controlling alkali-silica reaction under optional physical requirements in Table 2 of ASTM C618. Use low-alkali cement for test if aggregates not passing the ASTM C1260 test are used.
4. Does not decrease sulfate resistance of concrete.
5. Pozzolan when tested in accordance with ASTM C441, shall conform to the following: 65 percent minimum reduction in mortar expansion at 14 days, and 0.02 percent maximum mortar expansion at 14 days. Expansion shall be less than control sample expansion.
6. Pozzolan Content: Unless otherwise approved, 20 percent plus or minus 5 percent by weight of the total cementitious materials.
7. Store and batch pozzolan and cement separately.
8. Furnish pozzolan from the same source and supplier for all concrete used in the submitted mix designs. Pozzolan from another source other than that used in the approved mix designs will be rejected.

9. Properly store and protect pozzolan from weather, dampness, or other destructive agents. Any pozzolan which is damaged will be rejected and not permitted to be used in the work.

C. Aggregates (except as otherwise specified):

1. Comply with all requirements of ASTM C33 unless otherwise specified.
2. Fine aggregate: ASTM C33.
3. Coarse aggregate ASTM C33, Size No. 8, No. 57, or No. 67.
4. Do not use carbonate-based rock.
5. Coarse and fine aggregates shall not contain any materials that are deleteriously reactive with the alkalis in the cement in an amount sufficient to cause excessive expansion of mortar or concrete, in accordance with ASTM C1260. If aggregates prove to be potentially reactive they can be used if ASTM C1567 testing representing the mix to be used shows the combination to be non-reactive (innocuous).
6. The amount of coal and lignite in the fine aggregate shall be less than 0.5 percent.

D. Water: Water for concrete shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement in accordance with ASTM C1602, including optional requirements of Table 2.

2.2 ADMIXTURES

A. Air Entraining Admixture:

1. ASTM C260.

B. Other Admixtures: Use only when approved and at no additional cost to the Owner. Conform to ASTM C 494:

1. Accelerators: Use accelerating admixtures in cold weather only when approved by the Engineer. Approval does not relax cold-weather placement requirements. Calcium chloride is prohibited.
2. Set-retarders or stabilizers: Use set retarding admixtures during hot weather only when approved by the Engineer. Approval does not relax hot-weather placement requirements.
3. Set-controlling admixtures: Use set-controlling admixtures to increase allowable concrete delivery and placement restrictions in accordance with applicable provisions of this section only when approved by the Engineer.
4. Water reducers: Use Type A, D, E, F or G (ASTM C494), to achieve workability without exceeding specified water/cement ratio and slump.
5. Mineral admixtures to be used or furnished under this Specification shall be certified to comply with this Specification by the supplier. Certification shall include test results on Specifications, source, and location.
6. Add other approved admixtures (water reducer/superplasticizer, etc.) in accordance with the manufacturer's recommendations.
7. If a superplasticizer is used, the following requirements shall be followed:

a. The manufacturer's recommendations for dosage, mixing, and use.

b. A calibrated field dispenser shall be used. Records of dosage for each concrete truck shall be recorded by the Contractor and provided to the Engineer.
c. Each truck shall be mixed after dosing with the minimum number of drum rotations in accordance with the requirements of ACI and the admixture manufacturer.
d. Field concrete tests (air content, temperature, and slump) shall be performed on each truck before and after adding the admixture.

2.3 CURING MATERIALS

A. Water: ASTM C1602, including optional requirements of Table 2.

B. Curing Compound: ASTM C309

C. Polyethylene Film: ASTM C171.

D. Single Use Curing Blanket: Ultracure NCF by Sika Corporation or approved equal.

2.4 CONCRETE MIX

A. Mix and deliver concrete in accordance with ASTM C94.

B. Select proportions for normal weight concrete in accordance with ACI 301 and ACI 350.

C. Provide concrete to the following criteria at point of placement. Concrete mix shall meet all specified requirements. Failure to meeting any one specified requirement shall be sufficient cause for rejection.

D. Structural Concrete Mix (Reinforced and Unreinforced)

1. Minimum Compressive Strength (28 days): 5,000 psi.
2. Maximum water/cementitious material ratio: 0.45.
3. Concrete temperature as placed: 50 to 80 °F.
4. Structural Concrete Mix:

a. Fine Aggregate - ASTM C33: maximum 48 percent of aggregate by dry weight.
b. Coarse Aggregate - ASTM C33: No. 57 or No. 67.
c. Slump (ASTM C143): 3 to 5 inches.
d. Entrained Air (ASTM C231): 5.0 to 8.0 percent.

E. Mudmat and Backfill Concrete

1. Unreinforced concrete complying with the requirements of Structural Concrete Mix with the following exceptions:

a. Compressive Strength (28 days): 3,000 psi.
b. Entrained Air: 0 to 10 %.
c. Maximum water/cementitious material ratio: 0.50.

2.5 CONCRETE CONSOLIDATION EQUIPMENT

A. Consolidation equipment shall be flexible, electric, or pneumatic-drive immersion-type vibrators with an operating speed of 7000 rpm when immersed in concrete.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that joint locations conform to the approved placement drawings.

B. Verify requirements for concrete cover over reinforcement.

C. Verify that anchors, seats, plates, reinforcement, embeds, openings, water stops, and other items to be cast into concrete are accurately placed, positioned securely, and will not cause hardship in placing concrete.

D. Verify appropriate mix design for designated placement.

E. Engineer inspection and approval of foundations is required prior to any concrete being placed on grade. Verify with the Engineer that all surfaces on which concrete is to be placed has been inspected and is adequate for concrete placement.

F. Do not place concrete without written approval from the Engineer. Use Concrete Placement Form at the end of this Section.

3.2 PREPARATION

A. Remove standing water, ice, frost, mud, and debris from foundation, forms, and reinforcement surfaces to be covered by concrete.

B. Prepare rock surfaces free from oil, objectionable coatings, and loose, semi-detached, and unsound fragments. Immediately before placement of concrete, wash rock surfaces with an air-water jet and dry to a uniform surface-dry condition.

C. Thoroughly moisten surfaces of absorptive foundations to be covered with concrete so that moisture will not be drawn from fresh concrete.

D. Remove hardened concrete, wood chips, ice, and other debris from the interior of forms.

E. Place form release agent or wet forms just prior to placing concrete. Form release agent or any other deleterious material is not acceptable on concrete surfaces.

3.3 PLACING CONCRETE

A. Place concrete in accordance with ACI 304, ACI 309 and ACI 318.

B. Notify the Engineer a minimum of 48 hours prior to commencement of operations. The Engineer shall inspect all surfaces on which concrete is to be placed.

C. No concrete shall be placed until all formwork, installation of items to be embedded, and preparation of surfaces involved in the placement have been approved. Formwork and foundation surfaces on which cast-in-place concrete is placed shall be moistened and kept moist until overlying concrete is placed.

D. Place concrete in as nearly a continuous operation as practical and in a manner to produce a concrete mass with sufficient continuity and continuance so that it shall harden and act as a monolithic mass with no discontinuous joints or potential places of separation or weakness.

E. Concrete shall be placed in near horizontal layers; the depth of each layer shall not exceed 20 inches. Place mixture on prepared foundation or previously completed concrete materials with spreading equipment that prevents segregation and that produces layers of widths and thicknesses as necessary for compaction to the required dimensions. Place each successive layer as soon as practicable after the preceding layer is completed.

F. Ensure reinforcement, inserts, embedded parts, and waterstops are not disturbed during concrete placement.

G. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.

H. Deposit concrete as close as practicable to its final position. Concrete shall be placed by methods that do not cause segregation. Do not drop concrete more than 3 feet vertically.

I. Do not re-temper concrete.

J. Provide sufficient concrete placing capacity and equipment to deliver and place concrete without undue delay; do not permit cold joints to occur. Discharge concrete into forms within 90 minutes following the first introduction of water and cement or cement and aggregates, whichever occurs first. If the air temperature is 85 °F or higher, the time limit specified above shall be reduced to 60 minutes unless the Engineer's approval has been obtained for means to maintain acceptable concrete quality without such time reduction.

K. Do not place concrete during heavy rain (more than 0.3 inch per hour or 0.03 inch in 6 minutes as defined by the Weather Bureau Glossary of Meteorology). If unusual adverse weather such as heavy rain, severe cold, heavy snow, high wind, or other adverse weather occurs, or is forecast to occur during placement, an interruption in placing operations may be approved or directed. All placed concrete materials must be fully consolidated before stopping Work. Allow for construction schedule risk and added expense that could occur as a result of adverse weather. Weather delays will receive no additional compensation.

L. Consolidate concrete in accordance with ACI 309. Do not place vibrator against reinforcing or forms or use vibrator to transport concrete within forms. Have one extra vibrator and one extra generator on site at all times during placement of concrete to be used in the event of breakdown of primary equipment. Operate vibrator to penetrate rapidly to the bottom of the layer and at least 6 inches into the preceding layer. Manipulate in an up-and-down motion, generally for 5 to 15 seconds, to knit the two layers together.

M. Do not use concrete which has been subjected to more than 250 total revolutions of any combination of mixing and agitating equipment following the first introduction of aggregates to the mixer.

N. Contractor may place concrete by pumping, at Contractor's option. Appropriate mix design provisions must be included in Contractor's approved concrete submittal before any concrete is placed by pumping methods.

O. Maintain concrete cover around reinforcement in accordance with ACI 350, except where indicated otherwise on the Drawings.

P. Place concrete continuously between predetermined construction, contraction, control and expansion joints. Do not break or interrupt successive pours such that cold joints occur.

Q. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify the Engineer upon discovery of honeycombs or embedded debris.

R. Wait at least five days between adjacent placements of sections of structures with joints, including walls and slabs and before placing structural concrete over backfill concrete, unless otherwise approved by the Engineer.

3.4 CONCRETE FINISHING

A. Finish concrete surfaces on the project as follows:

B. Formed Surfaces:

1. Minimum: ACI 301 Surface Finish 3.0 – unless otherwise approved by Engineer includes patching tie holes and defects larger than ¾ inch wide or ½ inch deep, and removing projections over ⅛ inch.

C. Unformed Surfaces:

1. Exposed: ACI 301 Trowel Finish using steel trowel, and the following:

   a. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
   b. While concrete is still green but sufficiently hardened to bear a person's weight without deep imprint, wood float to true, even plane without visible coarse aggregate.
   c. Use sufficient pressure on wood floats to bring moisture to surface.
   d. After surface moisture has disappeared, hand trowel concrete to produce smooth, impervious surface, free from trowel marks.
   e. Do not use dry cement or additional water during troweling, nor excessively trowel.

2. Unexposed (Buried): ACI 301 Float Finish, and the following:

   a. Finish slabs by screeding with straightedges to bring surface to required finish plane.
   b. Wood float finish to compact and seal surface.
   c. Remove laitance and leave surface clean.
   d. Coordinate with other finish procedures.

D. Broomed Finish: Provide where determined by the Engineer.

1. First provide a monolithic finish as specified above, except immediately after troweling, then brush surface with a stiff bristle brush.
2. Brush in parallel strokes at right angles to the forms.

E. Exposed Edges:

1. Chamfer edges of permanently exposed concrete, except slabs and top edges of walls, with a 45 degree bevel ¾ by ¾ inch unless otherwise shown on the drawings.

2. Tool exposed edges of slabs and top edges of walls to a radius of ¼ inch unless shown otherwise on the drawings.

F. Tolerances for Concrete Construction:

1. Tolerances are defined as allowable variations from specified lines and grades, and dimensions and as the allowable magnitude of the surface irregularities. Allowable variations from specified lines, grades, and dimension shall be in accordance with ACI 301 and ACI 117.

3.5 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

B. If a clear membrane curing compound is used, submit product information to Engineer for approval.

C. Cure and protect concrete for a minimum of 7 days as described in ACI 308.1.

D. Maintain concrete with minimal moisture loss at acceptable curing temperatures for the period necessary for proper hydration of cement and hardening of concrete. Maintain concrete at a minimum temperature of 50 °F without excessive heating or excessive moisture loss for a minimum of 7 days. Provide and remove protection to control rate of temperature change per day (as required to prevent temperature cracking).

E. See additional cold weather concrete requirements.

3.6 FIELD QUALITY CONTROL

A. Furnish a batch ticket (delivery ticket) with each load of concrete. Concrete delivered without a batch ticket containing complete information as specified will be rejected. Collect and complete the batch ticket at the placement site and deliver all batch tickets to the Owner/Engineer on a daily basis. Provide Owner/Engineer access to the batch tickets at any time during the placement. Each batch ticket shall include at a minimum the following information:

1. Supplier's name and date
2. Truck number
3. Project number and location
4. Concrete class designation and item number
5. Cubic yards batched
6. Time batched
7. Mix design number
8. Type, brand, and amount of each admixture
9. Type, brand, and amount of cement and pozzolan
10. Mass (weights) of fine and coarse aggregates
11. Moisture content of fine and coarse aggregate
12. Gallons of batch water (including ice)

B. Add the following information to the batch ticket at the placement site:

1. Gallons of water added by truck operator plus quantity of concrete in the truck each time water is added

2. Admixture additions to loads at the site including type, brand, and amount
3. Number of revolutions of drum at mixing speed (for truck mixed concrete)
4. Discharge time
5. Location of batch in placement
6. Water cement ratio

C. The Contractor will be allowed to add water to the batched concrete once at the site, based upon concrete supplier approval and direction and provided that the specified water to cement ratio is not exceeded and the amount of water withheld at the batch plant or amount of water allowed for addition is on the delivery ticket.

D. Maintain records of placed concrete items. Record truck number, date, start and stop times, location of placed concrete, quantity, air temperature, concrete placement temperature, slump or slump flow, air content, admixture quantities, test samples collected and times, and cast test cylinder numbers.

E. Perform Work in accordance with ACI 301.

F. Maintain one copy of each document on site.

G. Acquire cement from same source for all Work.

H. Acquire flyash from same source for all Work.

I. Acquire aggregate from same source for all Work.

J. Conform to ACI 305.1 when concreting during hot weather.

K. Conform to ACI 306.1 and 306R when concreting during cold weather. Do not allow concrete to freeze and thaw in a saturated condition and before developing a compressive strength of at least 3500 psi. Monitor and maintain concrete temperatures during the protection period with maturity method and embedded thermometers, or other acceptable methods approved by the Engineer to demonstrate that the specified minimum strength has been achieved before protection is removed. At a minimum during cold weather concreting, maintain protection and concrete temperature above 40 °F for a minimum of 7 days unless otherwise approved by the Engineer. Remove protection gradually and in a manner that does not expose concrete to thermal shock.

L. Do not place concrete directly on soil, bedrock or existing horizontal concrete surface without written approval by the Engineer that the foundation has been prepared acceptably for concrete placement.

M. Heat foundation, rebar and surfaces to receive concrete when necessary to provide acceptable placement conditions.

N. Quality Control Reporting

1. Record quality test results on the form at the end of this Section and submit to Engineer.
2. Provide test results within 24 hours for field testing, and within 48 hours of laboratory testing.

3.7 CONCRETE MIX TESTING

A. Conduct quality control inspection and testing in accordance with the standards specified in this Section using qualified personnel and Independent Testing Agency. See Section 01 45 00: Quality Requirements for Independent Testing Agency and technician requirements.

B. Provide access and samples for the Engineer's independent quality assurance testing if requested.

C. Sampling Fresh Concrete:

1. Test Method: ASTM C172.

D. Cylinders

1. Test Method: ASTM C31 and ASTM C39.
2. Frequency: One set of at least six concrete test cylinders for each 50 or less cubic yards of concrete, at least once each day of concrete placement for each mix if different mixes are placed in the same day. The specified set of six cylinders does not include field cylinders required for cold weather, or any additional cylinders for strength confirmation or other purposes. Contractor may collect additional cylinders if desired.
3. Note on Record Drawings placement location represented by cylinders.
4. Unless otherwise approved, test each set of six cylinders for compressive strength as follows:

    a. 2 cylinders at 7 days.
    b. 3 cylinders at 28 days.
    c. 1 hold cylinder, to be retained for possible testing at 56 days in the event the 28 day tests fall below the required strength.

5. Collect at least one additional test cylinder during cold weather concreting to be cured on site maintained in the same conditions as the concrete it represents up to the time it is tested. Cold weather concrete cylinders may be waived if the Contractor develops an acceptable maturity method program for determining strength.

E. Slump

1. Test Method: ASTM C143.
2. Frequency: One per cylinder set, and at least one per truck for each mix.
3. Perform additional tests when concrete consistency appears to change.

F. Air Content, Unit Weight, and Yield

1. Test Method: ASTM C231 and ASTM C138.
2. Frequency: One per cylinder set, and at least one per truck for each mix.

G. Temperature

1. Test Method: ASTM C1064.
2. Frequency: One per cylinder set, and at least one test hourly and one test per truck for each mix when air temperature is 40 °F and below and when 80 °F and above.

3.8 PATCHING

A. Allow the Engineer to inspect concrete surfaces immediately upon removal of forms.

B. Honeycombing, lift lines, or embedded debris in concrete is not acceptable. Notify the Engineer upon discovery, and repair as determined by the Engineer.

C. Patch imperfections as directed by the Engineer.

3.9 DEFECTIVE CONCRETE

A. Defective concrete will be evaluated by the Engineer and repaired or replaced if directed by the Engineer at no additional cost to the Owner. See Section 03 93 00: Concrete Repair for general guidance on repairs.

B. Where concrete is considered deficient, the Engineer may require additional testing to be made at no additional expense to the Owner. If additional tests do not indicate concrete meets the requirements, Contractor may be required to remove and replace deficient concrete as directed by Engineer.

C. Nondestructive Testing: Impact hammer, sonoscope, or other non-destructive device may be permitted by the Engineer but will not be used as sole basis for approval or rejection of concrete.

D. Additional Tests: The Contractor's independent test firm shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Engineer. Testing to determine adequacy of concrete may include cored cylinders in accordance with ASTM C42 or by other methods as directed by the Engineer. Conduct additional tests at no additional expense to the Owner. Concrete in the area represented by a core test will be considered adequate if the average strength of the cores is equal to at least 90 percent of the specified minimum compressive strength (at 28 days) and if no single core is less than 85 percent of the specified minimum compressive strength. Core holes will require repair as determined by the Engineer.

E. Repair of Hardened Concrete Not Within Specified Tolerances: Repair hardened concrete that is not within specified tolerances to bring it within tolerance. Such repair shall be accomplished in a manner approved by the Engineer. Concrete repair to bring concrete within tolerances shall be done only after consultation with the Engineer regarding the repair method. The Engineer shall be notified as to the time when repair shall be performed.

F. Repair concrete that is exposed to public view in a manner that shall result in a concrete surface with a uniform appearance. Limit grinding depth on concrete surfaces exposed to view such that no aggregate particles are exposed more than 1/6 inch in cross section at the finished surface. Where grinding has caused or shall cause exposure of aggregate particles greater than 1/6 inch in cross section at the finished surface, concrete shall be repaired by removing and replacing a portion of the concrete at no additional cost to the Owner.

G. Prevention of Repeated Failure to Meet Tolerances: When concrete placements result in hardened concrete that does not meet specified tolerances, the Contractor shall, upon request, submit to the Engineer an outline of all preventative actions, such as modifications to forms, modified procedure for setting screeds, and different finishing

techniques, to be implemented by the Contractor to avoid repeated failures. The Engineer reserves the right to delay concrete placements until the Contractor implements such preventative actions that are approved by the Engineer.

H. Modify or replace concrete not conforming to required levels and lines, details, and elevations.

I. Repair or replace concrete not properly placed or not of the specified type.

3.10 PROTECTION

A. Protect finished Work under provisions of ACI 301 and as specified herein.

B. Remove formwork in accordance with the requirements in Section 03 10 00: Concrete Formwork.

CONCRETE PLACEMENT FORM

PROJECT _____
LOCATION _____
FEATURE _____
STATION _____
_____
CONTRACTOR _____
PUMPER USED (YES/NO)? _____

DATE				
DAY	SUN	MON	TUE	WED
DAY	THU	FRI	SAT	
WEATHER	Clear	P. Cloudy	Cloudy	Fog
TEMP.	0-32°F	32-50°F	50-75°F	75-100°F
WIND	Calm	Breeze	Moderate	High
WIND DIR.	North	South	East	West
PRECIP.	Rain	Snow	Light	Moderate

CHECKOUT INFORMATION

CHECKOUT ITEM	CONTRACTOR	RPR/ENGINEER	DATE	TIME
Subgrade Preparation				
Dewatering				
Form Lines, Grades and Dimensions				
Formwork Ties and Bracing				
Reinforcing Steel				
Chamfer				
Embedded Items				
Drain Piping				
Blockouts				
Waterstops				
Placement Equipment				
Concrete Protection				
Drains Videoed				
Other (List)				

NOTE: Initial each item that is applicable; put NA (Not Applicable) if an item does not apply.
All of the above shall be inspected and aproved before ordering concrete.

Inspected and Approved _____
Contractor Representative and Date

No Exceptions _____
Resident Project Representative or Engineer and Date

CONCRETE MIX AND VOLUME INFORMATION

MIX	CONCRETE MIX DESIGNATION	VOLUME ORDERED (CY)	VOLUME WASTED (CY)	VOLUME SPILLED (CY)	OUT OF SPEC (CY)	OVER ORDER (CY)	VOLUME WASTED (CY)	TOTAL VOLUME PLACED (CY)
Mix 1								
Mix 2								
Mix 3								

CONCRETE TESTING INFORMATION

TRUCK #	VOLUME (CY)	TRUCK ARRIVE TIME	PLACE START TIME	PLACE END TIME	WATER ADDED (gallons)	TEMP. (°F/°C)	SLUMP (inches)	AIR CONTENT (%)	COMMENTS

NOTES: % - Percent # - Number °C - degrees Celsius CY - cubic yards °F- degrees Fahrenheit TEMP. - Temperature

END OF SECTION

SECTION 03 62 00
NON-SHRINK GROUTING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and placing non-shrink grout for base plate and miscellaneous applications shown or specified.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Manufacturer's product data for approval of non-shrink grout.

C. Manufacturer's certification that product meets specifications.

D. Manufacturer's surface preparation, mixing, installing, and curing instructions.

E. Proposed method for keeping concrete surfaces wet prior to placing grout.

F. Proposed curing method for grout.

PART 2 PRODUCTS

2.1 PACKAGED NON-SHRINK GROUT

A. Non-shrink, non-metallic, non-corrosive, non-gas-generating cementitious pre-proportioned, prepackaged cement-based grout ready for the addition of water, meeting or exceeding the requirements of ASTM C 1107.

B. Grout Properties:

1.	Minimum 28-day Compressive Strength:	5,000 lb/in^2
2.	28-day Bond Strength:	2,000 lb/in^2
3.	Early Height Change:	0.0 to 4.0% expansion
4.	Hardened Height Change:	0.0 to 0.3% expansion
5.	Initial setting time, after addition of water:	Approx. one hour at 70º F

C. Water:

1. Clean
2. Free of detrimental quantities of silt, organic matters, salts, or other impurities.
3. As recommended by grout manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. Mix, place, and cure non-shrink grout at the locations shown on the Drawings and in accordance with grout manufacturer's instructions except as otherwise specified or as approved by the Engineer.

B. Mix grout in accordance with manufacturer's instructions to provide dry pack, plastic, or flowable grout consistency necessary for the particular application.

C. Clean and prepare base concrete or rock surface against which grout will be placed in accordance with manufacturer's instruction, and the following unless otherwise approved:

1. Roughen surface.
2. Remove dirt, laitance loose or defective concrete, curing compound, coatings, and other foreign material.
3. Wash with water.

D. Ensure concrete is prepared to a surface saturated dry condition before grouting of any kind.

E. Base Plate Grouting:

1. Set base plate in position and secure at required elevation or position with steel wedges or leveling bolts as required.
2. Form with watertight forms higher than bottom of base plate and positioned to allow placement.
3. Fill space between bottom of base plate and concrete completely such that full contact between concrete and base plate is achieved without voids or air bubbles.

END OF SECTION

SECTION 03 93 00
CONCRETE REPAIR

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes general provisions for preparing concrete surfaces and furnishing and placing concrete repair materials. It does not cover every circumstance of repair.

B. Report all Contractor-caused damage to existing or new concrete to the Engineer promptly upon discovery. Contractor-caused damage to newly-placed concrete or existing concrete is the Contractor's responsibility and shall be repaired or replaced as directed by the Engineer at no additional cost to the Owner. Since repair types in most cases cannot be accurately determined in advance, the Engineer will assess damaged concrete and prescribe the method of repair and materials to be used. The Engineer's approval is required before starting any concrete repairs.

C. Do not proceed with repairs to existing damaged concrete identified on the Drawings until all submittals have been made and Engineer has approved the Schedule and Plan of Repairs.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1.	ASTM C33	Specifications for Concrete Aggregates.
2.	ASTM C150	Specification for Portland Cement.
3.	ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

B. U.S. Department of the Interior, Bureau of Reclamation (Reclamation)

1.	Reclamation-15	Guide to Concrete Repair
2.	M-47	Standard Specifications for Repair and Maintenance of Concrete, Reclamation

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Product Data

1. Indicate product standards, physical and chemical characteristics, technical specifications, limitations, placement instructions, maintenance instructions, and general recommendations regarding repair materials.
2. Manufacturer's certificates for products supplied or proposed.

C. Equipment Data

1. Data for equipment to be used for saw cutting, excavation, and surface preparation and cleaning of concrete.

D. Schedule and Plan of Repairs

1. Proposed schedule and method of repairs. Include a description of the proposed equipment for mixing and applying concrete and other repair materials, the proposed mix design including all admixtures, the procedure for preparing the concrete surface prior to repair, and the method of repair.

E. Repair Record Documents

1. Accurately record locations of repairs, modifications, and type of repair.

1.4 QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor quality assurance and quality control shall be in accordance with the requirements of Section 01 45 00: Quality Requirements.

B. Mockup Sample Patch

1. Provide mockup sample placement of patching methods and materials for Engineer evaluation.
2. Prepare for each type of patch, procedure, and material as appropriate for demonstration
3. Locate sample(s) as directed by the Engineer.
4. Mockup sample(s) may remain as part of the Work if satisfactory repair is attained, as directed by the Engineer.

C. Delivery, Storage, and Handling

1. Deliver, store, protect and handle products to prevent damage to the products, and provide safety to the workers.
2. Comply with instructions for storage, shelf life limitations, and handling as specified by manufacturers.

PART 2 PRODUCTS

2.1 GENERAL

A. Repair materials shall be as selected by the Engineer for a particular repair and may include some or all of the products and materials listed below.

2.2 REPAIR MATERIALS

A. Manufactured Materials: Suitable for the particular repair and site conditions as approved by the Engineer.

B. Sikacrete 211 SCC Plus by Sika Corporation, Master Emaco S 440 CI by BASF or equal system designed for concrete repair thicknesses as shown on the Drawings, amended with coarse aggregate. Submit proposed materials and instructions.

C. Other Repair Materials (if approved by Engineer):

1. Portland Cement: As specified in Section 03 30 00: Cast-in-Place Concrete.
2. Water: As specified in Section 03 30 00: Cast-in-Place Concrete.
3. Aggregates: Conforming to ASTM C33.
4. Dry Pack Grout:

a. Two parts Type II cement, ASTM C33 fine aggregate, and clean water, or
b. Non-shrink packaged grout in accordance with Section 03 62 00: Non-Shrink Grouting.

2.3 ACCESSORY MATERIALS

A. Curing Materials: As specified in Section 03 30 00: Cast-in-Place Concrete.

PART 3 EXECUTION

3.1 GENERAL

A. The Engineer will delineate the type of repair to be used and the extent of repair areas.

B. Unless otherwise determined by the Engineer prepare concrete surfaces and place repair materials in accordance with this Section and manufacturer's instructions. In case of a conflict, the Engineer will decide.

C. The Engineer may require repairs complying with Reclamation Reclamation-15 or M-47 as deemed appropriate for a particular repair condition.

3.2 PREPARATION

A. Removal

1. Unless otherwise approved or shown on the Drawings, the minimum depth of removal and repair is 3 inches, with at least 1 inch clearance beyond reinforcement when encountered and exposed.
2. Remove damaged, deteriorated, loosened, or unbonded portions of existing concrete by water blasting, bush hammering, chipping hammer, or other Engineer-approved equipment or methods that avoid or minimize micro-fracturing or other damage concrete outside the defined area of repair. Remove damaged concrete to sound concrete surface with a profile of at least ⅛ inch.
3. Concrete removal processes involving the use of jack hammers more than 30 pounds, dry sandblasting, or scrabblers shall not be used without approval by the Engineer.
4. Repair micro-fractured surfaces using contained shotblasting, wet sandblasting, or water blasting to remove any micro-fractured surfaces resulting from the initial removal process.

B. Cleaning

1. Clean repair surface after removal of concrete with pressure washer (3000 psi minimum) to remove loose particles and dirt. Remove any contamination, including oil, solvent, dirt accumulation, or foreign material by additional wet sandblasting and air-water jet cleanup.
2. Clean any corrosion present on reinforcement.
3. Unless otherwise recommended by the repair material manufacturer, prepare the surfaces to receive repair materials as a construction joint in accordance with Section 03 30 00: Cast-in-Place Concrete.
4. After the concrete has been prepared and cleaned, keep the surface in a clean, condition until the repair has been completed.

C. Saw Cut Edges

1. Unless otherwise shown on the Drawings or approved by the Engineer, saw cut perimeters of repair areas perpendicular to the concrete surface to a depth of 1 inch. Slightly undercut, i.e. “dove tailed” the perimeter of the repair areas to mechanically lock in the repair material. Feather-edge repairs to concrete will not be permitted. Core drill corners to prevent over-cutting.

D. Reinforcing Steel

1. Remove all loose scale, rust, corrosion by products, or concrete from exposed reinforcing steel. Reinforcing steel exposed for more than one-third of its perimeter circumference shall be completely exposed to provide 1-inch minimum clearance between the steel and the repair materials. Remove extensively damaged or deteriorated reinforcing steel and replaced with adhesive dowels as directed by the Engineer.

3.3 PLACING, FINISHING, AND CURING

A. Place repair materials to the full depth of repair and such that the finished repaired surface matches the original structure dimensions.

B. Prepare surfaces to receive repair materials by wetting to a surface saturated dry condition and remove standing water.

C. If approved by the Engineer, repair material may be placed without pumping by creating at least 4 inches of head above repair area with a formed trough above the repair area and a chute that allows access for repair materials, vibration, and consolidation. Remove overbuilt material by grinding or other approved methods after material has sufficiently set so repair is not disturbed.

D. Finish and cure repair materials in accordance with the manufacturer’s instructions and as approved by the Engineer.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal fabrications as shown on the Drawings and as specified herein.

1.2 REFERENCES

A. American Institute of Steel Construction (AISC), Code of Standard Practice for Steel Buildings and Bridges.

B. American Society for Testing and Materials (ASTM) Standards

1.	ASTM A36	Standard Specification for Carbon Structural Steel
2.	ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
3.	ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
4.	ASTM A153	Standard Specification for Zinc Coating (Hot-Dip on Iron and Steel Hardware
5.	ASTM A240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
6.	ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
7.	ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
8.	ASTM A312	Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
9.	ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
10.	ASTM A510	Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel
11.	ASTM A513	Standard Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
12.	ASTM A563	Standard Specification for Carbons and Alloy Steel Nuts
13.	ASTM A570	Standard Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled (Withdrawn 2000)
14.	ASTM A575	Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades
15.	ASTM A576	Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
16.	ASTM A635	Standard Specification for Steel, Sheet, and Strip, Heavy-Thickness Coils, hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength

		Low-Alloy with Improved Formability, and Ultra-High Strength
17.	ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Gavannealed) by the Hot-Dip Process
18.	ASTM A992	Standard Specification for Structural Steel Shapes
19.	ASTM B209	Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
20.	ASTM B211	Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire
21.	ASTM B221	Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
22.	ASTM B 247	Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
23.	ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
24.	ASTM B308	Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
25.	ASTM B366	Standard Specification for Factory-Made Wrought Nickel and Nickel Alloy Fittings
26.	ASTM B429	Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
27.	ASTM C881	Standard Specification for Epoxy-Resin Base Bonding Systems for Concrete
28.	ASTM F436	Standard Specification for Hardened Steel Washers
29.	ASTM F593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
30.	ASTM F594	Standard Specification for Stainless Steel Nuts
31.	ASTM F3125	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

C. American National Standards Institute (ANSI).

1.	ANSI Z49.1	Safety in Welding and Cutting

D. American Society for Nondestructive Testing (ASNT):

1. SNT-TC-1A, Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing.

E. American Welding Society (AWS).

1.	AWS B2.1	Specification for Welding Procedure and Performance Qualification
2.	AWS D1.1	Structural Welding Code, Steel

3.	AWS D1.6	Structural Welding Code, Stainless Steel
4.	QC1	Standard for AWS Certification of Welding Inspectors

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Shop Drawings and product data for all fabricated or manufactured items.

1. Indicate materials, profiles, sizes, connection attachments, reinforcing, anchorage, hardware, size and type of fasteners and accessories.

2. Include assembly drawings, sections, elevations and details where applicable.

3. Indicate welded connections using standard AWS welding symbols; indicate net weld lengths and proposed field welds.

4. Submit proposed location of all field welds. Approval required from the Engineer for all field welds.

C. Design: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Professional Engineer responsible for their preparation.

D. Welding Certifications

1. Welder certifications of qualification showing date of qualification; qualification grade and rating; and notarized signature of inspector.
2. Welding inspector credentials
3. Welding inspector's report

E. Before delivery of materials, provide:

1. Certified laboratory test reports of materials.

2. Paint inspection records where applicable.

3. Manufacturer's installation instructions for manufactured items.

4. Anchors: Manufacturer's data sheets, handling and installation instructions; and ICBO reports.

1.4 QUALITY ASSURANCE

A. Qualifications for Welding Work:

1. Welders and welding procedures certified to requirements of AWS D1.1, D1.6, or B1.2 as applicable.

2. Welders, welding operators and tackers shall be qualified by an independent, local, approved testing agency. Submit evidence of qualification, including proof that each welder, welding operator and tacker has been continuously engaged in the given process of welding for which the welder, welding operator or tacker is qualified with no gaps in experience of more than 6 months. Welders, welding operators and tackers with gaps in experience of more than 6 months, and those whose ability is questioned by the Engineer for a

specific reason, shall be re-qualified under the provisions of the applicable standard as specified above.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests. All tests for qualification shall be done in the presence of the testing agency or in the presence of a certified welding inspector appointed by the testing agency. Furnish all material and bear the expense of qualifying welders and furnish copies of all certifications to the Engineer or designated representative.
4. If radiographic testing is used in lieu of the prescribed AWS bend tests, the weld reinforcements do not need to be ground or otherwise smoothed for inspection unless surface irregularities or the juncture with the base metal would cause objectionable weld discontinuities to be obscured in the radiograph. The test coupon shall be radiographed from the top center line to the bottom center line on either side. Radiographic testing shall follow the procedure as specified under AWS D1.1. All film and test specimens shall be furnished to the Engineer.
5. Welding inspector: AWS Certified, AWS QC1 qualified, with prior inspections experience of welds specified. NDT Level II Certified in accordance with ASNT SNT-TC-1A.

B. Field measurements: Take field measurements prior to fabrication to ensure proper fitting of the Work. Allow for trimming and fitting wherever the taking of field measurements before fabrication might delay the Work.

1.5 JOB CONDITIONS, STORAGE AND HANDLING

A. Store materials in a dry area off the ground and floor. Do not leave materials exposed to the weather.

B. Protect existing construction at all times from potential damage caused by construction operations, including delivery of materials, construction traffic, and installation. Patch, repair, and refinish damage to the satisfaction of the Engineer.

C. Fabrications to be in accordance with ANZI Z49.1.

PART 2 PRODUCTS

2.1 GENERAL

A. Verify critical dimensions at the jobsite before product fabrication begins. Field fabrication will not be permitted.

2.2 MATERIALS

A. Carbon Steel:

1. Pipe or Pipe Sleeves: ASTM A53, Schedule 40, galvanized
2. Plates and Bars: Carbon steel, ASTM A36, galvanized
3. Structural Shapes: ASTM A992 Steel, galvanized
4. Steel Tubing: ASTM A500 (cold formed), or ASTM A513, galvanized
5. Wire Rod for Grating Crossbars: ASTM A510

B. Stainless Steel:

1. Type: AISI Type 304, unless otherwise indicated
2. Finish: Mill finish unless otherwise specified
3. Bar Stock: ASTM A276
4. Plate: ASTM A240
5. Sheet: ASTM A240
6. Pipe: ASTM A312

C. Aluminum:

1. Extruded Shapes and Tubes: ASTM B221 or B308, 6061-T6, 6105-T5
2. Extruded Pipe: ASTM B429, 6061-T6
3. Plate and Sheet: ASTM B209, alloy 3003-H16; Use alloy 5005 H16 where anodic coatings will be applied
4. Bars, Rods and Wire: ASTM B211
5. Castings: ASTM B26 or B108; alloy 214 for natural anodized finish, and alloy 43 for color anodized or baked enamel finish; except as otherwise recommended by aluminum producer or finisher
6. Forgings: ASTM B 247, alloy 6061-T6
7. Aluminum Diamond Floor Plate (check on plate): Alloy 6061-T6
8. Aluminum bar grating for stairs and walkways: ASTM B 221, Alloy 6061-T6 or 6063-T6, for bearing bars alloy 6061-T6 for cross bars
9. Aluminum rivets for aluminum bar grating: ASTM B 366, alloy 6053-T4 or 6061-T6
10. Fasteners for stairs or aluminum bar gratings: Use galvanized fasteners complying with ASTM A153 for exterior aluminum units

2.3 FASTENERS, ANCHORS, AND STUDS

A. Steel Fasteners:

1. Bolts: ASTM A307, Grade A, galvanized
2. High Strength Bolts: ASTM F3125 Grade A325, galvanized
3. Nuts: ASTM A563, galvanized
4. Washers: ASTM F436, galvanized

B. Stainless Steel Fasteners

1. Bolts: ASTM F593
2. Nuts: ASTM F594
3. Washers: ASTM F594

C. Welding stud anchors: AWS D1.1, Section 4, Part F. Size and type as shown on the Drawings.

D. Stainless Steel Epoxy/Adhesive Anchors:

1. Anchor Rod and Fasteners:

a. Stainless steel threaded rod ASTM 593

b. Diameter as shown on the Drawings unless otherwise specified

c. Length as required to provide minimum depth of embedment shown

d. ASTM F593/594 Nuts and Washers

e. Clean and free of grease, oil, or other deleterious material

2. Adhesive:

a. ASTM C 881

b. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments

c. Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions

d. Nonsag, with selected viscosity based on installation temperature and overhead application where applicable

3. Packaging:

a. Disposable, self-contained cartridge system capable of dispensing both components in the proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.

4. Cartridge Markings: Include manufacturer's name, product name, material type, batch or serial number, and adhesive expiration date.

5. Manufacturer and Product: Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System (HIT HY-150) or approved equal.

E. Antiseizing Lubricant: Use on all stainless steel threads. Containing substantial amounts of molybdenum disulfide, graphite, mica, talc, or copper. Loc Tite Co., Permatex.

2.4 LADDERS

A. Fabricated of stainless-steel plates, bars and angles conforming to ASTM A276, type 304 or 304L, of the dimensions shown on the Drawings.

B. Rungs.

C. Install ladders with epoxy anchor bolts.

D. Design rungs for a load at the center of the rung of 200 pounds, with a raised button, serrated edge. Fabricated 16-gauge stainless steel 1 5/8-inch wide unless otherwise shown.

2.5 HANDRAILS

A. All rails and posts shall be galvanized steel pipe meeting the requirements of ASTM A501, schedule 40.

B. The rails and posts shall be 1 ½" diameter pipe.

C. Unless noted on drawings, the handrail height shall be 3-feet-6 inches as measured from working surface with three horizontal rails spaced at 14 inches on centers (from top of

grating or other horizontal surface). Post spacing shall not be greater than 6'-0". Posts shall be a single, unspliced length. Lower rails shall be a single unspliced length between posts. Top rails shall be continuous whenever possible, and a single, unspliced length shall, whenever possible, be attached to a minimum of three posts.

D. Expansion joints shall be installed in all rails as per Manufacturer's recommendations.

E. Toe Boards: Provide galvanized toe plates at the railings located along all walkways and platforms around and over basins, stairways, and decks above the main floor of buildings. Use 4 inch high by 1inch by 1/8-inch galvanized steel channels of extruded shapes fastened to railings with stainless steel screws.

F. Safety chain: Install safety chains between posts at all ladder locations. Provide Type 316 stainless steel coil type chain. Rigidly attach each chain to Type 316 stainless steel eye bolt at one post and provide approved Type 316 stainless steel snap latch for connection to eye bolt at opposite post.

G. Provide bracket or plate attachments.

H. All fasteners used to anchor the handrails shall be hot dip galvanized.

I. Design of handrails shall comply with UFAS, ADAAG, and OSHA Standards.

2.6 UNISTRUT CHANNELS

A. Channels and hardware as manufactured by Unistrut Corporation or approved equal.

B. Channel Members: Fabricated from structural grade steel conforming to one of the following ASTM specifications: A 570, A 653.

C. Fittings: Fabricated from steel conforming to one of the following ASTM specifications A 575, A 576, A 36 or A 635.

D. All parts hot dipped galvanized in accordance with ASTM A123 or A 153.

2.7 FABRICATION

A. Fabricate items with joints tightly fitted and secured.

B. Fit and shop assemble in largest practical sections for delivery to site.

C. Remove burrs from all exposed cut edges, remove spatter and grind exposed welds to match adjacent surface.

D. Supply all components required for anchoring metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, except where specifically noted otherwise.

PART 3 EXECUTION

3.1 PREPARATION

A. Examine surfaces for defects which would impair installation.

B. Obtain Engineer's approval before site cutting, field welding, or making nonscheduled adjustments.

C. Clean steel items to bare metal where site welding is scheduled.

D. Provide for erection loads with temporary bracing; keep Work in alignment.

E. Supply setting templates for items required to be cast into concrete.

3.2 INSTALLATION

A. Provide anchor bolts and manufacturer's templates as required.

B. Install items in accordance with manufacturer's published instructions and as shown on the Drawings.

C. Install items plumb and level, accurately fitted, and free from distortion or defects.

D. Install epoxy anchor systems in strict accordance with the manufacturer’s written instructions, including hole drilling and hole size, hole cleaning and preparation, epoxy injection, anchor placement, and cure times.

E. Perform field welding in accordance with applicable AWS standards

3.3 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

B. After installation, touch-up field welds and scratched or damaged painted and steel surfaces in accordance with Section 09 90 00: Painting and Coating.

3.4 QUALITY TESTING

A. Inspect welds using ultrasonic, radiographic, or magnetic particle methods.

B. Perform weld inspection and testing with independent welding inspectors qualified and certified in accordance with AWS Standards of Qualification and Certification of Welding Inspectors (QCI). Only individuals so qualified shall be authorized to perform fabrication/erection inspection and testing, and verification inspection and testing.

C. All welds not meeting the test requirements shall be repaired and retested at no additional cost to Owner.

END OF SECTION

SECTION 13 50 00
DAM INSTRUMENTATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and installing dam instrumentation including structural survey points, movement monuments and benchmarks, station markers, standpipe piezometers, and staff gages.

1.2 DEFINITIONS

A. Benchmarks – Brass caps installed in concrete columns outside of the influence of potential settlement or movement used as reference to survey structural survey points or movement monuments.

B. Movement Monuments - Brass caps installed in concrete columns to monitor vertical and horizontal movement of the dam crest, slopes, and abutment/perimeter reservoir slopes, and to provide station reference for future inspections. Horizontal control surveys are conducted using an electronic distance meter occupying benchmarks set outside the immediate area of the dam. Conventional geodetic level surveys are conducted on the benchmarks for vertical control.

C. Reservoir Staff Gage: Incrementally marked installed to visually monitor reservoir levels.

D. Spillway Staff Gage: Incrementally marked installed to visually monitor spillway levels.

E. Standpipe Piezometer: A groundwater measuring device drilled and installed with a plastic or steel casing and slotted section screened across a water-bearing zone allowing water to rise in the casing to measure the phreatic surface (ground water level).

F. Station Markers – Galvanized square steel tubing with number plates identifying the Station location installed on the downstream slope of the Dam near the crest. Markers are located every 100 feet with labels showing the approximate Dam station facing the crest of the Dam.

G. Structural Survey Points – Brass caps installed in concrete structures to monitor movement of the structures. Horizontal control surveys are conducted using an electronic distance meter occupying benchmarks set outside the immediate area of the dam. Conventional geodetic level surveys are conducted on the benchmarks for vertical control..

H. Concrete Forms: Tubes and/or cores made of fiber, plastic, and composite materials used to form concrete.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1.	ASTM A36	Standard Specification for Carbon Structural Steel.
2.	ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Qualifications:

1. Qualifications of the driller and Contractor Foreman or Geologist/Engineer responsible for installation of the instrumentation.

2. Qualifications of the instrumentation manufacturers and the qualifications of the instrumentation supplier responsible for supervision of the instrumentation installation. The Engineer will reject any manufacturer or instrumentation supplier deemed to be insufficiently qualified.

C. Permits: Copies of all permits.

D. Piezometer Installation Plan:

1. Drilling Plan: Proposed plan for drilling and installation, including:

a. Location and installation and monitoring;

1) Clean-out and development procedures to assure proper installation and operation taking into account all information furnished and all requirements imposed by the Drawings and Specifications.

E. Manufacturer's data for all materials and equipment, including the following:

1. Standpipe Piezometers: PVC well casing, well screen, grout, seal, filter pack, flush-mount casing and other associated materials for piezometers and piezometer installation.

F. Manufacturer's Literature and Specifications:

1. Movement Monuments: Bronze survey markers, rebar, concrete, and any other materials detailed on the drawings or proposed for use.

2. Manufacturer product data for staff gages and mounting hardware, and structural steel support.

G. Shop Drawings: Submit fabrication drawings for the piezometer terminal steel box and protective casing steel pipe for approval. Show welded connections and coating details.

H. Drilling Log: Detailed daily drilling log of events during drilling, piezometer construction and piezometer development. Record the information on daily drilling report forms for each drilling rig in operation. Failure to keep drilling logs up to date shall be grounds for suspension of drilling operations with no compensation for standby time.

I. Submit the following information daily with drilling report forms:

1. Bit assembly and drill string.

2. Water losses, drilling fluid losses, additions of water or manufactured products to the drilling fluid and the drilling depth at the time of the additions.

3. Footage drilled.

4. Information relative to maintenance and repair time, details of repair and presence of Contractor and subcontractor personnel.

5. Log of subsurface materials encountered during drilling based on the Unified Soil Classification System using the procedures in ASTM D2487. The Engineer may also log subsurface materials independently.

6. Keep drilling log onsite and available for inspection at all times. Submit legible daily drilling report forms, suitable for photocopying, daily.

J. Completion Information

1. Piezometer As-Built Report and Drawings: Open Standpipe Piezometer as-built construction drawings including the following information: drilling depth and diameter; casing type and depth; screen description (including material length, location, diameter, and slot size); filter pack gradation, placement method, depth and dimensions; seal placement method including material hydration time and water content; grout mixture ratios and depth; construction details, including any difficulties setting casing and screen and procedures for determining depth; manufacturer and quantities of all materials used; and borehole preparation before installation.

2. Survey data for piezometers and movement monuments, including horizontal and vertical position, using the same vertical and horizontal datum as is shown on the Drawings.

1.5 QUALITY ASSURANCE

A. Conduct as-built surveys with a Professional Land Surveyor licensed in the State of Colorado in accordance with Section 01 71 23: Construction Surveying.

B. Provide an instrumentation installation supervisor to provide direct supervision of all instrumentation work. The instrumentation installation supervisor shall be onsite during all instrumentation work. A written submittal of qualifications is required, for the Engineer's review and approval. If, in the sole judgment of the Engineer, the instrumentation installation work is not being acceptably performed, then, at the written request of the Engineer, replace the supervisor with another qualified person approved by the Engineer. Instrumentation work not performed under the direct supervision of a qualified, approved supervisor will not be accepted by the Engineer.

C. Piezometers

1. Install piezometers in accordance with the State requirements, this Section, and the Drawings.

2. Obtain necessary permits for the work.

3. Install piezometers using a State licensed driller. Perform installation under the direction of an experienced, qualified, and competent geologist or geotechnical engineer approved by the Engineer.

4. Install Piezometers in the presence of the Engineer unless otherwise approved.

D. Field test all equipment provided under this section to the full satisfaction of the Engineer so each part and all components function together in the manner intended by the functional descriptions specified herein.

1.6 DELIVERY, STORAGE AND HANDLING

A. Store all equipment, instruments, and accessories specified in this Section, which are delivered to the project site before the Contractor is ready to install them, in accordance with Manufacturer's instructions.

PART 2 PRODUCTS

2.1 STANDPIPE PIEZOMETERS

A. PVC Well Casing: Minimum diameter and material type shown on the Drawings, flush threaded, manufactured to applicable standards, and equipped with a threaded cap at the bottom and slip cap at the top.

B. Screen: Commercially fabricated of the material type, diameter, and length shown on the Drawings, machine slotted with a slot width of 0.02-inch, flush threaded, and manufactured to applicable standards. Field installation of screen slots is not allowed.

C. Filter Pack: 10/20 silica sand.

D. Bentonite Seal: Sodium bentonite supplied in pellet form with maximum ¼-inch diameter ¼-inch Pel Plug TR30 - Time Release Coated Bentonite Pellets, or equivalent.

E. Water: Potable water, free of contaminants, and obtained from an offsite or onsite source approved by the Engineer.

F. Outer Protective Casing: Standard flush mount surface casing, diameter and material type as shown on the Drawings, equipped with a hinged locking cap suitable for a padlock, and set to the depth shown on the Drawings.

G. Concrete: In accordance with Section 03 30 00: Cast-In-Place Concrete.

2.2 MOVEMENT MONUMENTS AND BENCHMARKS

A. Bronze caps, 2-inch diameter, as manufactured by Berntsen International, Inc., Madison, Wisconsin, or approved equal, set on a Number 4 rebar embedded in concrete as shown on the Drawings.

B. No. 4 Rebar, 4 feet long.

C. Concrete: In accordance with Section 03 30 00: Cast-In-Place Concrete.

2.3 STRUCTURAL MOVEMENT MONUMENTS

A. Bronze caps, 2-inch diameter, as manufactured by Berntsen International, Inc., Madison, Wisconsin, or approved equal.

B. Epoxy adhesive: Hilti HIT 150 or equal.

2.4 BRONZE CAP MARKINGS

A. Use a permanent stamp to indent the bronze caps with a minimum letter height of ¼ inch.

B. All stamping shall deform the disk surface by a minimum of 1 millimeter (0.0394 in).

C. Stamp each monument with the point designation shown on the Drawings, or as determined by the Engineer.

2.5 STATION MARKERS

A. Post: 1.5 inch by 1.5 inch perforated galvanized square tubing, 12 gauge, length as shown on the Drawings.

B. Station Labels: ¼" ASTM A36 plate steel, welded to post with 2-inch high welded numbers. Epoxy paint plates white and numbers black. Cold galvanize or epoxy paint plate to post welds.

C. Concrete: Concrete mix for reinforced concrete in accordance with Section 03 30 00: Cast-In-Place Concrete.

2.6 RESERVOIR AND SPILLWAY STAFF GAGES

A. Stevens stream gage, supplied in Sections, Style E, graduated in 0.1-foot increments, and marked with Stevens 4-inch by 6-inch figure plates every 1.0 feet of vertical elevation as shown on the Drawings.

B. Gage and Number Screws and Anchors: Stainless steel screws. Size and length of the mounting screws for the gage and figure plates to the mounting board shall be as recommended by the manufacturer.

C. Anchors: Stainless steel, minimum ¼-inch diameter threaded rod anchors with matching stainless steel nuts and washers.

D. Anchor Adhesive: Hilti HIT HY 100 epoxy adhesive.

E. Supply staff gages in sections. Type E gage sections can be supplied to the nearest foot. Confirm invert and top of structure elevations before ordering staff gage.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify the locations and elevations of piezometers to be installed as direct burial during construction of the raised embankment.

B. Verify the locations and elevations that the dams and structures to receive instrumentation have been constructed to the lines and grades shown on the Drawings prior to the installation of piezometers to be installed in boreholes, structural survey points, movement monuments, and staff gages.

C. Verify that all drill holes have been drilled to the correct size, depth and orientation prior to installation of instruments.

D. Survey all staff gage devices before installations.

E. Protect structures, facilities, internal seepage collection systems, and facilities during drilling of the piezometers and movement monuments and during trenching for cables.

F. Provide physical access to the piezometers during and after installation.

3.2 STANDPIPE PIEZOMETER INSTALLATION

A. Coordinate with utility locations prior to the start of any Work.

B. All downhole materials and equipment shall be clean and free of chemical contamination of any kind.

C. Protect all structures, such as roads, pipelines, existing wells, fences, and shrubbery during the Work; and shall remove from well locations all cuttings, drilling, debris, and unused materials. Restore the site to its original condition after completion of the Work. Cuttings from installation and any other debris shall be disposed of offsite.

D. Install piezometers at the locations, dimensions, details, and depths shown on the Drawings unless otherwise determined by the Engineer. The Engineer may direct changes to piezometer depth, location, and screened interval based on site conditions and geology.

E. The drill hole diameter shall conform to the nominal size shown on the Drawings.

F. Do not use lubricants on downhole tools and equipment.

G. Do not use drilling fluids other than potable water during piezometer drilling and installation unless otherwise approved by the Engineer.

H. Drilling Equipment: The inside diameter of the drill casing or hollow-stem auger shall be sufficient to allow the installation of the specified well casing and specified thicknesses of annular materials. Allowable drilling equipment is hollow stem auger or sonic drill rig.

I. Casing and Screen Installation:

1. Assembly: All casing and screen shall be new and in good condition before installation. All joints and other accessory parts shall be securely fastened in place. Particular care shall be exercised to avoid damaging the screen and casing during installation and throughout all subsequent operations.

2. Installation: The assembled screen and casing shall be placed in the boring to avoid jarring impacts and to ensure that the assembly is not damaged or misplaced. The well screen shall be placed in accordance with the Drawings. The casing and screen shall be suspended and centered in the boring during placement of filter pack and bentonite seal. Immediately after installation of the screen and casing, the depth shall be measured. The casing top elevation shall be determined and recorded, and the well shall be capped.

3. Alignment testing: Each completed piezometer shall be straight and plumb. No sooner than 12 hours after grout placement, alignment tests shall be conducted by the Contractor in the presence of the Engineer.

4. Alignment: Alignment tests shall consist of slowly lowering a 10-foot length of pipe to the bottom of the well. The outside diameter of the pipe shall be 0.5 inches smaller than the inside diameter of the well casing. If well misalignment results in failure of the pipe to pass freely through any part of the well casing the well shall be rejected. The Contractor shall install another piezometer adjacent to the rejected well at no additional cost to the Owner.

J. Filter Pack Placement: After the screen and casing have been installed, place the filter pack by pouring around the casing, from the bottom of the boring up, in such a manner as

to ensure uniform placement around the screen. Place the filter pack in one continuous run, and in a manner as to provide equal thickness around the outside of the casing. Periodically sound the top of the filter pack with a weighted tape to confirm that the filter pack has not bridged.

K. Bentonite and Cement-Bentonite Seal: Place the bentonite seal in the well annulus within the depth interval shown on the Drawings, and hydrate with clean water. Place cement-bentonite grout using a tremie pipe into the well annulus on top of the bentonite seal. After the grout has set for a minimum of 24 hours, construct the surface completion and protective cover.

L. Capping: At all times before well completion and acceptance, maintain open borings in a manner that will not constitute a hazard to either humans or animals. Install a slip type cap on the casing to prevent extraneous material or substances from falling into the boring or casing.

M. Surface Completion: Install a flush mount steel casing to the dimensions shown on the Drawings and set securely in concrete as shown on the Drawings.

N. Survey coordinates and elevations: After completion of a piezometer, survey the location and elevations of the riser pipe, and adjacent ground surface.

O. Well Identification: Permanently number piezometers with the designation on the Drawings or as directed by the Engineer. The permanent lettering method shall be approved by the Owner and Engineer before installation.

P. Cause for New Piezometer Abandonment and Replacement

1. Loss of a drill hole or other components because of lack of material, inadequate, inappropriate or faulty equipment, or careless operating procedures will be considered cause for abandonment due to fault or neglect on the part of the Contractor.

2. It is the responsibility of the Contractor to properly install all piezometers according to the requirements of this specification so that they are suitable for determining accurate groundwater levels. If the Contractor installs piezometers that are not functional or not installed in accordance with the specified requirements and Drawings, the Engineer will reject the piezometer.

3. In the event that the Engineer requires abandonment of a piezometer or drill hole due to neglect of the Contractor, the Contractor shall abandon the drill hole or piezometer in accordance with the all applicable regulations for piezometer abandonment and install a replacement piezometer at a new location approved by the Engineer in accordance with the requirements herein, at no additional cost to the Owner.

Q. PIEZOMETER DEVELOPMENT

1. General: After the piezometer has been completed in accordance with the requirements of the Contract Documents, notify the Engineer and make the necessary arrangements for conducting the piezometer development. Piezometer development will consist of flushing, bailing, and/or pumping. The intent is to clean the casing and slotted screen pipe to assure the screened section is not plugged and the casing has not been damaged or separated during installation.

2. Begin piezometer development no earlier than 48 hours after the grout has been placed if used as backfill in the piezometer above the bentonite seal. Otherwise development may begin upon completion of the piezometer installation. Piezometer development will be performed using one or more of the following methods: flushing, or bailing, or pumping as determined by the Engineer. The method to be used will be based on hydrogeologic conditions encountered in drilling.

    a. Piezometer casing install below water surface: Remove a minimum of 10 casing volumes of water (as measured from the top of water to the bottom of casing). Water discharged from the piezometer during development shall be in accordance with the conditions of the NPDES permit. Piezometer development shall continue until the water is visually clear and particle-free (as determined by the Engineer).

        1) The Contractor may choose to 'flush' the piezometer with clean water to expedite the development procedure. Confirmation of piezometer development would then be by removal of 3 casing volumes of visually clear and particle-free water. The flushing and removal process would be repeated until the water is visually clear and particle-free (as determined by the Engineer).

    b. Piezometer Casing install above water level (dry): Flush the piezometer casing with clean water for three 30-second intervals or until return water is visually clean and particle-free as determined by the Engineer.

        1) Upon completion of flushing, wait 5 minutes then refill the casing with clean water and remove by bailing to observe the clarity of the water. Repeat once or until the water clarity is to the satisfaction of the Engineer.

    c. Once the piezometer development is completed to the satisfaction of the Engineer, refill the casing to the top and conduct a 30-minute 'recharge' test to check the screened zone functions properly. The Engineer will monitor the test and may choose to continue the test for 24 hours before accepting the piezometer as 'properly installed'. The Contractor is not required to stand by during the extended testing period.

3. It is anticipated that development by pumping/surging shall continue for approximately 12 hours for each piezometer.

3.3 EMBANKMENT MOVEMENT MONUMENTS

A. Install movement monuments at the locations shown on the Drawings.

B. Install movement monuments using the following procedures.

1. Drill an 8-inch diameter hole, 6 feet below the ground surface.

2. Clean the hole with appropriate drilling and cleaning methods.

3. Place concrete in the hole.

4. Insert a 4-foot long, No. 4 Rebar along with a bronze cap so that the cap is level with the embankment dam crest surface.

5. Consolidate concrete by rodding.

6. Use Concrete Forms manufactured by Sonotube® or equivalent, with placing of concrete within the top 1 foot.

7. Trim excess concrete near top of hole where it exceeds the 8-inch diameter hole.

3.4 STRUCTURAL MOVEMENT MONUMENTS

A. Install structural survey points on structures at the locations shown on the Drawings.

B. Drill a hole of suitable diameter in accordance with the epoxy manufacturer's instructions in the concrete, clean hole as recommended by the manufacturer and install bronze cap with epoxy adhesive.

C. Bronze caps may be wet stabbed into fresh concrete with the Engineer's approval.

3.5 STATION MARKERS INSTALLATION

A. Install station markers at the station locations shown on the Drawings. Mark locations by survey methods for Engineer approval before installing.

B. Install station markers using the following procedures.

1. Drill an 8-inch diameter hole, a minimum of 2 feet below the ground surface. Unless otherwise determined by the Engineer, locate the holes on the downstream slope of the dam, approximately 5 feet from the crest.

2. Clean the hole with appropriate drilling and cleaning methods.

3. Place fiber reinforced concrete into the hole.

4. Insert galvanized tubing, plumb and level.

5. Consolidate concrete by rodding while ensuring that the galvanized tubing remains plumb.

6. Use Concrete Forms manufactured by Sonotube® or equivalent, with placing of concrete within the top 1 foot. Form or trim excess concrete from top of hole to form a top a maximum of 8 inches in diameter. Slope the top of the remaining concrete to drain away from the tubing.

3.6 STAFF GAUGE INSTALLATION

A. Install staff gages in accordance with the manufacturer's written instructions, Drawing details, and this Section, unless otherwise approved.

B. Allow a minimum of 7 days for concrete to cure before installing staff gages.

C. Survey staff gages before and after installation.

D. Install staff gage sections so staff gage markings remain accurate in gage elevation through the installed sections.

E. Install separate elevation number plates for Type E gages centered at each vertical foot adjacent to the gage sections. The top and bottom elevation number plates may be installed flush with the bottom and top of the gage respectively.

F. If staff gage sections need to be offset, provide a 1-foot overlap between the offset sections.

3.7 QUALITY CONTROL

A. Observe, measure, and document installation of piezometers to assure compliance with the specified requirements. Document the details of the installation during drilling and construction, including the depth and dimensions of each construction material such as well screen, cement-bentonite grout, gravel pack, and final boring diameter and depth; materials used; and observations. Document installation details information in the installation report and submit to the Engineer.

B. Survey all completed instrumentation installations and record final elevations and locations for as-constructed drawings at a minimum for the following:

1. Standpipe Piezometers: Top of riser, ground surface, and top of protective surface casing.

2. Structural Movement Monuments (First Order Class I survey).

3. Embankment Movement Monuments (First Order Class I survey).

4. Staff Gages: Survey top and bottom markings for all manufactured gages (survey accurate to the nearest 0.01 feet vertically).

C. Properly construct and install, develop, and test piezometers so that the piezometers are suitable for water level monitoring. If the Contractor, due to negligent construction, installs piezometers that are not functional or not in accordance with requirements, the Engineer will reject the piezometer as defective and direct the Contractor to repair or replace it.

D. In the event that any piezometer is damaged to the extent that it is not suitable for accurate water level measurements as determined by the Engineer, the Contractor will be required to perform the following actions, at no additional cost to the Owner, as determined by the Engineer:

1. Seal the drill hole or structure in accordance with State Regulations for well abandonment.

2. Install an equal piezometer at a location approved by the Engineer using materials and procedures as approved by the Engineer.

3. If replacement becomes necessary to make the piezometer acceptable because of accident, loss of tool, defective material, or for any other cause, propose in writing a method for correcting the problem. Suggested methods will be reviewed and approved by the Engineer before work proceeds. Remedial Work shall be completed at no additional cost to the Owner or time extension to the Work.

END OF SECTION

SECTION 26 05 10
ELECTRICAL WORK - GENERAL

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide complete and operational systems for both normal and standby electric power systems, normal and emergency lighting systems, grounding systems and other specified systems, including the installation and wiring of miscellaneous equipment and devices. Perform all work and testing as indicated and in compliance with Contract Documents.

1. Provide conduit, wiring and connections for power, control, lighting, instrumentation and alarms for equipment furnished by others unless otherwise specified and indicated.
2. Provide temporary circuits, overcurrent devices, conduit and wiring, and other equipment required during construction and change-over from existing to proposed electric system. Perform work at the convenience of the Owner.
3. Provide electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment. Make equipment scheduled for relocation free of electrical shock hazard.
4. The equipment enclosure classification of the plant areas are indicated on the drawings. Provide all equipment, devices and material meeting the requirements for these area classifications unless otherwise noted or specified.
5. Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other Divisions of the specifications

1.2 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

1.3 SEQUENCING AND SCHEDULING:

A. Coordinate electrical equipment installation with other building components.

B. Arrange for chases, slots and openings in the building structures during the progress of construction to allow for the electrical installation.

C. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

D. Sequence, coordinate and integrate the installation of electrical materials and equipment for efficient flow of the work.

E. Coordinate the installation of large equipment prior to closing in the building.

1.4 QUALITY ASSURANCE:

A. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (NEC) and in accordance with requirements of State and Local Codes.

1.5 QUALIFICATIONS OF ELECTRICAL SUBCONTRACTOR

A. The Electrical Subcontractor shall have been engaged in work of a similar nature to this contract for the past 5 years.

B. The Electrical Subcontractor shall have a minimum of five projects of equal or greater size with the type of equipment specified under this project.

1.6 SUBMITTALS:

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. The following defines a minimum for all Division 26 shop drawing and data submittals:

1. Submit shop drawings delineated by specification number with all information for one piece of equipment provided as one package.
2. Partial submittals will be returned without action.
3. Submit bills of material: Include a numbered list of all components, with manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.
4. Submittal shall include:

    a. Manufacturer’s drawings
    b. Panel layout
    c. Equipment layout
    d. Schematic diagram
    e. One line diagram
    f. Control sequence diagrams
    g. Interconnection diagrams
    h. Wiring diagrams
    i. Catalog data

5. Submit only completed drawings showing all local and remote devices associated with each item.
6. Mark shop drawings and data submitted showing only items applicable to specific contract.
7. Where additions and modifications are made to existing equipment, provide drawings which include both retained existing equipment and new work.
8. Submit time-current characteristic curves for all submitted protection devices such as circuit breakers and fuses.
9. Submit other documentary or descriptive information as required for each assembly to demonstrate compliance with the applicable contract documents.

C. Shop drawings and data are required for the following list:

1. Starting Equipment Data List -Submit blank list initially to verify acceptable format. Submit final list at completion of the project.
2. Conduit and Fittings
3. Wire and Cable
4. Wiring Devices
5. Transformers
6. Grounding Equipment and Devices
7. Panelboards
8. Lighting Fixtures and Accessories

9. Electric Heat Tracing
10. Control Stations
11. Enclosures
12. Safety Switches
13. Electric Heating Units and Accessories
14. Record Drawings

1.7 NAMEPLATES AND LABELING:

A. Provide nameplates and labels as specified in Section 26 05 53: Electrical Identification.

1.8 INTERFERENCE AND ERRONEOUS LOCATIONS:

A. Locations of electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.

B. Verify in field, all data and final locations of work installed under other sections of specifications, required for placing of electrical work.

C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

1.9 APPROVAL AND MARKING EQUIPMENT:

A. Ensure that devices and materials are listed and/or labeled by UL, wherever standards have been established by that organization. Where a UL listing is not available for equipment, submit certified test reports of a Nationally Recognized Testing Laboratory (NRTL), approved by the local inspecting authority, indicating that equipment is in conformance with local code requirements or any other applicable requirements. Tests and inspections for approval of equipment shall be performed at no additional cost to Owner.

B. Clearly mark equipment, devices and material with name or trademark of manufacturer and rating in volts and amperes and other pertinent information on a nameplate.

1.10 ELECTRIC SERVICE:

A. Electrical power system for the facility operates at 480/277 volt, 3-phase, 4 wire, 60 Hertz.

B. Earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for electrical work is not included under this section and shall conform to requirements specified under applicable sections of Contract for General Construction.

1.11 EQUIPMENT SPECIFIED ELSEWHERE

A. Certain items of control equipment and other equipment are indicated on electrical drawings for connection, but are specified in other sections pertaining to plumbing, heating, ventilating and air conditioning, mechanical process, instrumentation, etc. Such items are not furnished as part of electrical work.

1.12 INCOMING SERVICE

A. Contact the following organization for coordinating the incoming power requirements for the project:

Mountain Parks Electric, Inc.
321 West Agate Ave (P.O. Box 170)
Granby, CO 80446-0170
970.887.3378
Patty Dolan
Engineering Clerk
pdolan@mpei.com
ex 239

B. The organization identified above will furnish and install:

1. Pad-mounted transformer.
2. Primary cable.
3. Connection of all primary and secondary cables.

a. Metering equipment as described below.

4. Provide the following in accordance with the contract documents:

a. Concrete pad for transformer.
b. Primary and secondary ductlines.
c. Secondary cables of sufficient length for termination at the transformer.
d. Grounding at pad and service pole.

C. The final, complete installation shall comply with all state and local statutory requirements having jurisdiction. The Contractor shall arrange for all necessary permits, pay all fees and arrange for all required inspections by local authorities. In general, all work shall comply with the requirements of the National Electrical Code, all state codes and the codes and ordinances of the city or town in which the work is to be done.

PART 2 PRODUCTS

2.1 METERING EQUIPMENT

A. Power Company: Secondary metering equipment furnished by power company.

B. Electrical Contractor: Install secondary metering equipment as directed by the power company.

PART 3 EXECUTION

3.1 METERING EQUIPMENT:

A. Install metering equipment as follows:

1. Ensure that metering equipment installation shall be in accordance with requirements of power company by submitting drawings, sketches, catalog information and other appropriate material for power company approval.

3.2 REMOVAL AND RELOCATION OF MATERIAL AND EQUIPMENT:

A. Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, boxes, as necessary to carry out proposed changes. Rehabilitate and relocate items of equipment as required and as indicated or specified.

B. Remove from site and dispose of material and equipment not indicated for reuse.

3.3 PROTECTION OF ELECTRICAL EQUIPMENT:

A. Store equipment in compliance with manufacturer's recommendations and as specified herein.

B. Protect electrical equipment from the weather, especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.

C. Do not store equipment outdoors.

D. Where equipment is installed or stored in moist areas, or unheated buildings, provide acceptable means to prevent moisture damage. Provide uniformly distributed source of heat in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.4 DEFECTIVE OR DAMAGED EQUIPMENT:

A. Damaged equipment shall not be used. Equipment damaged in shipment, storage, installation or through other means shall be replaced without additional cost to the Owner.

B. All equipment showing signs of water damage shall be rejected regardless of dielectric test results.

C. All electrical equipment is considered "in storage" regardless of location until first energized. Manufacturer's recommendations for storage precautions, conditions and care shall be followed.

3.5 STARTING EQUIPMENT DATA LIST:

A. Obtain data from the equipment supplier shop drawing submittals or equipment nameplates, and prepare a complete tabulation of all motors over 1/3 hp, electric heaters over 3 kW, and starting equipment for both, to be furnished on the project.

1. Include in tabulation firm the following information:

a. Name and identification of equipment.
b. Manufacturer.
c. Horsepower or kilowatt rating.
d. Voltage.
e. Phase.
f. Speed.
g. Full load current.
h. Locked rotor current or code letter.
i. Type of enclosure (open drip-proof, totally enclosed, fan cooled, etc.).
j. NEMA size of starter or contactor.
k. Overload heater size.
l. Type of starter (full-voltage, reduced-voltage, autotransformer, etc.).
m. Breaker trip setting or fuse size.
n. Voltage of starter operating coil.
o. If starter is at a motor control center, list motor control center number.

2. Final acceptance of the electrical system is contingent upon submittal of the complete motor and electric heater tabulation.

3. Arrange tabulation in groups by MCC or building location.
4. Furnish six copies of the tabulation to the Engineer when a submission is made.

3.6 DRAWINGS AND SPECIFICATIONS:

A. Drawings and specifications are typical of work to be done and of the arrangement desired. Provide accessories and appurtenances which the Engineer deems functionally necessary for a complete installation, whether or not explicitly indicated or described.

END OF SECTION

SECTION 26 05 20
ELECTRICAL WIRES AND CABLES

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide wires and cables for complete electrical systems as indicated and in compliance with Contract Documents.

1.2 REFERENCES

A. ASTM International (ASTM):

1. ASTM B3: Soft or Annealed Copper Wire.
2. ASTM B8: Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. ASTM B33: Tinned Soft or Annealed Copper Wire for Electrical Purposes.

B. Insulated Cables Engineers Association, Inc. (ICEA)/National Electrical Manufacturer's Association (NEMA):

1. S-61-4021/WC 5: Thermoplastic Insulated Wire & Cable.
2. S-66-524/NEMA WC 7; Cross-Linked-Thermosetting-Polyethylene Insulated Wire and Cable.
3. S-68-516/WC 8: Ethylene-Propylene-Rubber-Insulated Wire & Cable.

C. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

D. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)/Electronic Industries Association (EIA):

1. ANSI/TIA/EIA-568-B; Commercial Building Telecommunications Cabling Standards.

E. Underwriters Laboratories, Inc. (UL):

1. UL 44: Thermoset-Insulated Wires and Cables.
2. UL 83: Thermoplastic-Insulated Wires and Cables.
3. UL 854: Service Entrance Cables.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

1.4 DELIVERY STORAGE AND HANDLING

A. Deliver wire and cables in full reels protected against injury. Deliver reels with factory attached UL approved tags showing the manufacturers name and the type of insulation, size, and length of wire in each coil or reel.

B. Accept wire and cable on site in manufacturer's packaging. Inspect for damage.

C. Store and protect in accordance with manufacturer's instructions.

D. Protect from weather. Provide adequate ventilation to prevent condensation.

1.5 DESIGN CRITERIA

A. Wire for lighting, single phase circuits shall be Type XHHW or THWN-THHN.

B. Wire for three phase circuits shall be Type XHHW.

C. Service conductors shall be 600V rated type RHW.

D. Single conductor wire for control, indication and metering shall be Type THWN-THHN No. 12 or 14 AWG, stranded.

E. Multi-conductor control cable shall be used for the underground system and shall be No. 12 or 14 AWG, stranded with overall jacket.

F. Wire for process instrumentation shall be twisted shielded pairs No. 16 AWG, stranded with overall jacket.

G. Ground wires shall be Type THW, green. Bare ground wires shall be soft drawn copper, 98 percent conductivity.

H. Wire for power circuits installed in duct banks shall be type RHW.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. 600V Cable:

1. Okonite.
2. Southwire.
3. American Insulated Wire.

B. Control and Metering Wire:

1. Belden Wire and Cable.
2. Alpha Wire.
3. Coleman Cable.

C. Cable Fireproofing Tape:

1. MAC Products, Inc.
2. 3M Electrical Products.

2.2 MATERIALS AND COMPONENTS

A. Furnish copper conductors. Material and stranding of conductors to conform to ASTM B3, ASTM B33, and to ASTM B8, for the appropriate class.

B. Uncoated, soft or annealed copper wire conforming to ASTM B3.

C. Wires and Cables for Maximum 600-Volt Power Circuits: For No. 8 AWG gauge and smaller provide type THWN/THHN or RHW. Where used in lighting or receptacle branch circuits provide No. 12 AWG gauge and No. 10 AWG gauge as solid conductor. Provide other wire with Class C stranding. Provide No. 6 AWG gauge and larger as XHHW-2 with Class B stranding. Provide wires and cable conforming to UL 83.

D. Wires and Cables for Control, Indicating, Metering, or Alarm Circuits: Single and multi-conductor control cable, copper conductors, Class B or C stranding. Insulation; 600-volt polyethylene, polyvinylchloride, or EPR. Continuous rating of 90C dry and 75C wet. Color coding conforming to Table K-2, ICEA/NEMA S-61-4021/WC 5.

E. Shielded Cable for Instrumentation Wiring: 7-strand copper conductors, size No. 16 AWG. Insulate conductors individually with color coded polyethylene or polyvinylchloride. Twist pairs with varying lay (if more than one pair) and cover with cable tape and copper or aluminum coated Mylar shielding tape and tinned copper drain wire. Jacket: polyvinylchloride. Cables: rated 600 volts and 90 degrees C.

F. Category 6 Cable: Category 6 cable shall consist of 4 twisted pairs of different lay and ground wires, enclosed by an overall conductive mylar backed aluminum foil shield. This shall be enclosed by an overall thermoplastic jacket. The cable shall meet the applicable requirements of ANSI/TIA 568 C.2.

PART 3 EXECUTION

3.1 GENERAL

A. Perform work in accordance with the National Electrical Code.

B. Provide power cable identification as follows:

System Voltage	Neutral	Phase A	Phase B	Phase C
208/120V	White	Black	Red	Blue
240/120V	White- Gray Stripe	Black- Blue Stripe	Red- Blue Stripe	None
480/277V	Gray	Brown	Orange	Yellow

C. Use green to identify insulated ground conductors.

NOTE: Colored insulation, tapes or sleeves may be used to provide color coding. Insulated ground conductors must have green covering.

D. Permanently post means of identification of grounded and ungrounded conductors for each nominal voltage system at each panelboard and motor control center.

E. In power and multiconductor cables manufactured without a grounding conductor identify one of the multiconductor as the equipment grounding conductor at each cable end and at every point where the conductors are accessible.

3.2 INSTALLATION OF WIRING

A. Unless otherwise indicated, use no conductor smaller than No. 12 AWG for power, No. 14 AWG for control, and No. 16 AWG for shielded applications.

B. Install conductors continuous from outlet to outlet and make no splices except within outlet or junction boxes.

C. Install cable in underground raceway system without splices. There shall be no splices between connection points unless otherwise indicated.

D. Draw all conductors contained within a single conduit at the same time.

E. Apply wire pulling compound to conductors being drawn through conduits. Use pulling compound, Minerallac No. 100, Y-er-Eas, Yellow 77, High Performance Polywater Cable Lubricant or acceptable equivalent.

F. Use no cable bend with radius of less than eight times its diameter.

G. Wires and cables installed without prior submittal review are subject to removal at no additional expense.

3.3 CONDUCTOR IDENTIFICATION

A. Label each wire at both termination points. Carry individual conductor or circuit identification throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panelboards.

B. Identify each wire in junction boxes, cabinets, and terminal boxes where total number of control, indicating, and metering wires is three or more and no terminal board is provided, including all power wire. Where no termination is made use a plastic-coated, self-adhesive, wire marker and where termination is made use a, plastic, pre-printed sleeve wire marker.

C. In cases similar to above where terminal boards are provided for the control, indicating, and metering wires, identify all wires including motor leads and other power wires too large for connection to terminal boards, by sleeve wire markers as specified above.

D. In manholes and handholes, identify each power wire by laminated plastic tag located so it is easily seen. Control wires to be bundled and marked as listed in conduit and wire schedule.

3.4 CONNECTORS, TERMINAL LUGS AND BOARDS

A. For wiring of circuits consisting of No. 10 or No. 12 AWG solid wires, such as for lighting branch circuits, use self-insulated pressure type connectors for all splices or joints.

B. Terminate all wires connected to terminal boards, terminal blocks, or to other similar terminals by means of ring and tongue, nylon self-insulated, tin-plated copper pressure terminals.

C. Terminal boards shall be 600 volts and rated for 125 percent of the ampacity of the connected circuit. They shall have screw terminals, with white marking strips for wire identification, of the 4-, 6-, 8-, or 12-pole type, as necessary.

D. Wire connections for which terminals are not supplied, for example, at solenoids or motor terminal junction boxes:

1. 10 AWG and smaller: Use self-insulated pressure-type connectors.
2. 8 AWG and larger: Use insulated, mechanical type with set screw or follower bearing directly on the wire. Split bolt connectors are not acceptable.

E. Clearly and permanently mark terminal strips with ink or indelible pencil. Mark each wire consistently throughout entire system, using notation of wires given on manufacturer's wiring diagrams wherever possible.

3.5 FIELD TESTING

A. Submit results of all cable tests on forms indicating cable size, voltage, and date with name of tester and witness.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide a single, complete, integrated grounding system, including conductors, raceways, and connections, as indicated and in compliance with Contract Documents, and in accordance with the National Electrical Code Article 250 and the National Electrical Safety Code.

B. Include grounding of switchgear, substations, motor control centers, electric equipment enclosures etc., outdoor substations, transformers, switch structures, etc.; ground grid systems with ground rod and water pipe connections; structural steel, and lightning protection system.

C. Include grounding conductors completely inter-connecting water supply pipe, ground rods, ground grid, substation, switchgear and motor control center ground buses, other distribution equipment, and other groundable equipment.

1.2 REFERENCES

A. American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C2: National Electrical Safety Code.

B. ASTM International (ASTM):

1. ASTM B3: Standard Specification for Soft or Annealed Copper Wire.
2. ASTM B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. ASTM B33: Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.

C. Institute of Electrical and Electronics Engineers (IEEE):

1. Standard 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Ground System.

D. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code.
2. NFPA 780: Lightning Protection Code.

E. Underwriters Laboratories (UL):

1. UL 467: Standard for Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

C. Submit catalog and dimensional data for the following:

1. Ground rods
2. Exothermic welding
3. Connecting hardware

D. Submit grounding system test results.

PART 2 PRODUCTS

2.1 MANUFACTURER'S COMPLIANCE

A. Manufacturer's acceptance contingent upon products' compliance with the specifications.

2.2 MANUFACTURERS

A. Ground Rods:

1. ERICO Products Inc.
2. Galvan Electrical Products.
3. Nehring Electrical Works.

B. Exothermic Welding:

1. ERICO Products, Inc.
2. American Brass Mfg. Co.
3. Orgo-Thermit, Inc.

C. Connecting Hardware:

1. American Brass Mfg. Co.
2. Thomas and Betts
3. Anderson Electric Corp.

2.3 MATERIALS AND COMPONENTS

A. Conductors:

1. Provide copper grounding conductors bare or insulated, sized as indicated. When not indicated on the drawing provide in accordance with the NEC. Provide protection of conductors in locations where physical damage would result from direct exposure.
2. Ground and bond wires for substations, main panels and distribution points, and ground rod connections shall be annealed bare copper conforming to ASTM B3, stranded, with 98 percent conductivity.
3. Equipment ground conductors run with circuit conductors and grounding electrode conductor shall be 600-volt with green insulation, unless noted otherwise on the Contract documents.
4. Unless noted otherwise, all conductors No. 8 AWG and larger shall be stranded, Class B in accordance with ASTM B8.

    a. Uninsulated conductors shall be bare copper in accordance with ASTM B3, tinned in accordance with ASTM B33.
    b. Use tinned-coated in corrosive environments including when buried in earth or embedded in concrete.

B. Ground Bus:

1. Provide a 4 by 1/4 inch (100 by 6 mm) copper bar complete with bolted type connectors as indicated.
2. Bus bar shall have 18 pre-drilled holes, two standoff insulators, two stainless steel mounting brackets and four stainless steel assembly bolts and lock washer.

C. Connectors and Fasteners:

1. Provide ground clamps which are UL listed for use on copper or brass pipes.
2. Provide ground clamps, for use on iron pipes, of galvanized or malleable iron, or of standard noncorrosive material for use on iron pipes.
3. Provide ground clamps, for use on pipes, with rigid metal base providing good contact by proper seating on the pipe. Do not use strap type clamps.

D. Ground Rods:

1. Ground rods shall conform to the requirements of NFPA 70 and UL Standard 467.
2. Ground rods shall be copper-clad steel rods not less than 3/4 inch (19 mm) in diameter and not less than 10 feet (3 m) long per section.
3. Ground rods shall be clean and smooth with the following characteristics:

   a. Cone-shaped point on the first section.
   b. Die-stamped near the top with the name or trademark of the manufacturer and the length of the rod in millimeters or feet.

PART 3 EXECUTION

3.1 EXOTHERMIC WELDING

A. Welding shall be by the exothermic process.

B. Within the welding procedure, include the proper mold and powder charge and conform to the manufacturer's recommendations.

C. Welding processes shall be the exothermic fusion type that will make a connection without corroding or loosening.

D. The welding process shall join all strands and not cause the parts to be damaged or weakened.

E. Completed connection or joint shall be equal or larger in size than the conductors joined and have the same current-carrying capacity as the largest conductor.

F. Paint buried ground connection with a bitumastic paint.

3.2 INSTALLATION OF GROUNDING AND BONDING CONDUCTORS

A. Install grounding conductors so that they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so no strain on connections.

B. Run grounding conductors associated with direct burial cables in common trenches above cables except as indicated otherwise.

C. Bury equipment grounding conductors 30 inches deep. Bring loops or taps up for connection to equipment or other items to be grounded.

D. Where raceways are used to contain and protect grounding conductors, install in accordance with Sections 26 05 33: Raceway and Boxes for Electrical Systems and 26 05 43: Underground Ducts and Raceways for Electrical Systems.

E. Where bare grounding conductors are contained within metallic raceways, bond ends of raceways to conductors.

F. Install loop type, low impedance, grounding system interconnecting all components so at least two grounding connections are provided for each major item of electrical equipment. Ensure that severing of any single grounding conductor in this system does not remove grounding protection on any major item.

G. Connect structural steel to the external perimeter loop of grounding conductors installed around all sides of building foundation, buried at least 30 inches below grade. Connect to each vertical column by loop or tap. Connect two opposite points on external loop to two different points on grounding system.

H. Buried and concealed ground connections shall use exothermic welding.

I. Make accessible connections to structural members by exothermic welding process or by bolted connector. Connections to equipment or ground bus by bolted connectors.

3.3 INSTALLATION OF GROUND RODS

A. Install ground rods in manholes in accordance with requirements specified under the section Underground Distribution Systems. Connect each grounding conductor entering a manhole to ground rod by exothermic weld.

B. Install ground rods where indicated. Install the top of the rod 12 inch (300 mm) below the ground surface.

C. Make connection to overall grounding system as indicated.

D. Ensure that final resistance of interconnected ground system is 5 ohms, or less. Measure ground resistance in normally dry conditions, and not less than 48 hours after rainfall.

3.4 EQUIPMENT GROUNDING

A. Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment. Grounding conductors installed in conduit with insulated conductors to be furnished with green, 600-volt insulation. Ground conductors are in addition to and not to be considered as the neutral wire of the system.

B. Connect power transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

C. Connect two separate ground connections from ground grid to ground bus of switchgear assemblies, motor control centers, switchboards and all outdoor substation and transformer equipment. Ensure that each connection for item of equipment is from different section of ground grid.

D. Connect a grounding conductor between panelboard and grounding system. Where a grounding bar is furnished with panelboard, connect grounding conductor to bar.

E. Conduits entering metal enclosures shall utilize bonding type locknuts and grounding bushings. Locknuts that gouge into the metal enclosures are not acceptable.

F. Where conduits are not effectively grounded by firm contact with a grounded enclosure, apply grounding bushings on at least one end of conduit run. Conduit connections shall be wrench tight.

G. Install a separate grounding conductor from ground system to motors of 100 horsepower and larger, in addition to raceway system. Ground motor ground connection to motor frame, independent of mounting bolts or sliding base. Ground motor to nearest point on grounding system, unless otherwise indicated.

H. Connect grounding conductors from equipment in area where ground bus is required to ground bus. Connect ground bus to grounding system. Mount ground bus on 600-volt pedestal insulators.

I. Connect lightning arresters to ground system by suitable conductors. Where lightning arresters are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.

J. Connect generator neutral to grounding system by a grounding conductor. Connect grounding conductor to generator disconnect enclosure and generator neutral on generator side of disconnect. Ground generator frame with two separate independent connections, so removal of one connection will not impair continuity of other.

K. Ground each street lighting standard by ground rod driven near base of standard, in accordance with requirements of National Electric Safety Code. Connect ground rods to grounding conductor brought with street lighting feeder cable.

L. Ground transformers, lightning arresters, insulators and other appurtenances, installed on poles, poles and timber structures, or metal structure. Run grounding conductors between poles or structure and ground rods. Protect grounding conductor by molding applied for at least 8 feet (2500 mm) above ground, with both molding and conductor stapled. Install ground rod where indicated and driven until top of rod is 1 foot (300 mm) below ground.

M. Ground wire fences when used to enclose electrical equipment or when overhead electrical lines cross fence. Unless otherwise indicated, provide grounding by buried outside peripheral ground loop; connections to each corner fence post and nearby ground rod; flexible connections to each gate; and at least two connections to grounding system from approximately opposite positions on fence.

N. Connect individual ground rods to the grounding loop using the direct burial grounding cable.

O. Bond individual cable tray sections with bonding jumpers.

3.5 SIGNAL GROUNDING

A. Ground signal surge protection and shields of twisted, shielded cable using a signal bonding conductor. The signal bonding conductor shall be a continuous path from the instrument surge protection or shield to the grounding electrode conductor. The signal bonding conductor shall be isolated from the equipment grounding conductor for its entire path.

B. Where convenient several signal bonding conductors may be combined, providing that all the following conditions are met:

1. The combined signal bonding conductor shall have the equivalent cross section of the conductors that it was combined from or three times the cross section of the largest conductor that it was combined from, whichever is less.
2. The combined signal bonding conductor shall be isolated from the equipment grounding conductor.
3. Where two signal bonding conductors are combined use a three-port insulated splice.
4. Where three or more signal bonding conductors are combined, use a copper bus mounted on 600-volt insulators. Attach each conductor to the bus using an insulated ring tongue lug and screw terminal.

3.6 COMMERCIAL GROUNDING

A. Telephone:

1. Install one No. 2 insulated ground conductor to ground bus in telephone equipment cabinet.
2. Connect one No. 12 insulated ground conductor to all conduits terminating at backboard.

3.7 FIELD TESTING

A. Test grounding systems for ground resistance. Total resistance from any point on the ground network to the building counterpoise must not exceed 50 milliohms.

B. Ground resistance and counterpoise tests must be made during dry weather and no sooner than 48 hours after rainfall. Conditions of soil and weather shall be documented on test forms.

C. Conduct tests using the ratio method that measures the ratio of the resistance to earth of an auxiliary test electrode to the series resistance of the electrode under test and a second auxiliary electrode. Perform measurements in accordance with IEEE Standard 81.

D. Indicating instrument must be self-contained and include a direct-current generator, synchronized current and potential reversers, crossed-current and potential coils, direct-reading ohmmeter, series resistors, and range-selector switch. Calibrate direct-reading ohmmeter for ranges of 0 to 20 ohms and 0 to 200 ohms.

E. Place auxiliary grounding electrodes in accordance with instrument manufacturer's recommendations but not less than 50 feet (15 m) apart, in accordance with IEEE Standard 81.

F. Perform continuity test on all power receptacles to ensure that the ground terminals are properly grounded to the facility ground system.

G. Furnish copies of test reports on ground system.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide supports from building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings as indicated and in compliance with Contract Documents.

1.2 REFERENCES

A. ASTM International (ASTM):

1. ASTM A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A653/A653M: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A924/A924M: Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
4. ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials.
5. ASTM E119: Standard Method for Fire Tests of Building Construction and Materials.
6. ASTM E814: Standard Test Method of Fire Tests of Through Penetration Firestops.

B. FM Global (FM):

1. Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.

C. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

D. Underwriters Laboratories, (UL): Applicable listings.

1. UL FRD: Fire Resistance Directory.
2. UL 263: Fire Tests of Building Construction and Materials.
3. UL 723: Test for Surface Burning Characteristics of Building Materials.
4. UL 1479: Fire Tests of Through-Penetration Firestops.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel or malleable iron.

B. Aluminum where indicated.

C. Stainless steel where indicated.

2.2 COATINGS

A. Protect steel and malleable iron supports, support hardware, and fasteners with zinc coating.

B. Provide products for use outdoors.

C. Use PVC coating where indicated on Drawings.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel springhead type.
3. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for intended service.
4. Nuts, Washers, and Bolts: Stainless steel.

C. Cable Supports for Vertical Conduit: Factory fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers.

D. U Channel Systems: Channels, with 9/16 inch (14 mm) diameter holes, at minimum of 8 inch (200 mm) on center, in top surface. Provide fittings and accessories that mate and match with U channel and are of same manufacture.

2.4 U CHANNEL SYSTEMS

A. Manufacturers, Stainless Steel/Galvanized Steel Channel.

1. Unistrut Corp.
2. Power-Strut.
3. B-Line Systems, Inc.

B. Manufacturers, Fiberglass Channel.

1. Omnistrut, Champion Fiberglass.
2. Durostrut, Enduro Composite Systems.
3. Struttech, Entrum Industries.

C. Provide Type 316 stainless steel channel or fiberglass channel with corresponding accessories.

D. Channels, with 9/16 inch (14 mm) diameter holes, at minimum of 8 inch (200 mm) on center, in top surface.

E. Provide fittings and accessories that mate and match with U channel and are of same manufacture.

F. Provide hot-dipped galvanized after fabrication for steel channel and accessories.

G. Provide channel of the proper material to match equipment classifications.

2.5 FABRICATED SUPPORTING DEVICES

A. Shop or field fabricate supports or manufacture supports assembled from U-channel components.

B. Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with structural system and with other electrical installation.

C. Raceway Supports: Comply with NEC and following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by safety factor of at least 4. Where this determination results in safety allowance of less than 200 lbs (890 N), provide additional strength until there is minimum of 200 lbs (890 N) safety allowance in strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch (25 mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch (6 mm) diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. In vertical runs, arrange support so load produced by weight of raceway and enclosed conductors is carried entirely by conduit supports with no weight load on raceway terminals.

D. Vertical Conductor Supports: Install simultaneously with installation of conductors.

E. Sleeves: Install in concrete slabs and walls and other fire-rated floors and walls for raceways and cable installations.

F. Conduit extending through roof shall pass through ceiling box at roof line.

1. Provide 14 gage (1.9 mm) minimum copper box complete with watertight soldered seams and flanged to serve as pitch pocket for each conduit.
2. Install conduit and pitch pocket in advance of roofing work.

G. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, disconnect switches, and control components in accordance with following:

1. Fasten by means of wood screws or screw type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring tension clamps on steel. Threaded studs driven by powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine or wood screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.
2. Holes cut in concrete shall not cut main reinforcing bars. Fill holes that are not used.
3. Load applied to any fastener shall not exceed 25 percent of proof test load. Use vibration and shock resistant fasteners for attachments to concrete slabs.

3.2 CHANNELS

A. Support electrical components as required to produce same structural safety factors as specified for raceway supports.

B. Install metal U channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

C. Install Type 316 stainless steel for mounting of electrical equipment in outdoor areas and on below grade, outside building and structure walls.

D. Install galvanized steel channels for interior building mounting of electrical equipment except for those locations listed above and unless otherwise indicated.

E. Install fiberglass channel in chemical areas with NEMA 4X enclosures.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide complete raceway systems, with matching accessories, fittings, boxes, and other hardware as indicated and in compliance with Contract Documents. When non-metallic raceway systems are specified, provide green insulated grounding conductor sized per National Electrical Code (NEC) requirements.

B. All raceway runs are indicated diagrammatically to outline general routing of raceway. Unless specifically identified for installation in concrete walls or slabs, raceways shall be run exposed with raceway supporting systems. Avoid interfering with pipes, ducts, structural members, or other equipment. Any installation deviations from the contract requirements shall be corrected at no cost to Owner.

C. Provide raceway systems in accordance with the following:

1. In NEMA 12 or NEMA 1 areas, use galvanized rigid steel raceway systems.
2. In exterior building applications, use galvanized rigid steel raceway systems.
3. Inside concrete slabs or walls, use PVC Schedule 40 raceway systems.

D. All raceway systems shall be installed in accordance with the criteria described in this section. Any proposed deviations from these requirements shall be submitted to the Engineer in writing for review and disposition.

1. Use Type 316 stainless steel support systems for exterior application and in NEMA 4X areas.
2. All NEMA 1 and NEMA 12 areas shall use hot dipped galvanized steel support systems.

1.2 REFERENCES

A. National Electrical Manufacturers Association (NEMA):

1. NEMA RN-1: Polyvinylchloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
2. NEMA TC-2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
3. NEMA TC-3: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

B. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

C. Occupational Safety & Health Act (OSHA).

1. OSHA Regulation 1910.7

D. Underwriter's Laboratories, Inc. (UL):

1. 1: Electrical Flexible Metal Conduit
2. 6: Rigid Metal Electrical Conduit

3. 94: UL Standard for Safety Tests for Flammability of Plastic Materials for Parts in Devices and Appliances
4. 360: Electrical Liquid-Tight Flexible Steel
5. 651: Schedule 40 and 80 PVC Conduit
6. 886: Electrical Outlet Boxes and Fittings for Use in Hazardous Locations, Class 1, Groups A, B, C, and D and Class 11, Groups E, F, and G
7. 1242: Intermediate Metal Conduit
8. 1684: UL Standard for Safety Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

1.4 QUALITY ASSURANCE

A. Items provided under this section shall be listed and labeled by UL or other Nationally Recognized Testing laboratory (NRTL).

1. Term “NRTL” shall be as defined in OSHA Regulation 1910.7.
2. Terms “listed” and “labeled” shall be as defined in NFPA 70, National Electrical Code, Article 100.

B. Regulatory requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Rigid Metal Conduit.

1. Triangle/PWC, Inc.
2. Republic Steel Corporation.
3. Allied Tube and Conduit.

B. Polyvinylchloride (PVC) Conduit:

1. Triangle/PWC, Inc.
2. Robroy Industries.
3. Carlon Electrical Sciences, Inc.

C. Rigid Non-Metallic (RNC) Conduit:

1. Champion Fiberglass, Inc.
2. FRE Composites Inc.

D. Flexible Conduit:

1. American Flexible Conduit Company.
2. Anamet, Inc.

3. Electri-Flex Company.
4. International Metal Hose Company.

E. Boxes and Fittings:

1. O.Z./Gedney Company.
2. Crouse-Hinds Electrical Construction Materials.
3. Appleton Electric Company.

F. Support Systems:

1. Michigan Hanger Co., (O-Strut).
2. Thomas & Betts (Superstrut).
3. Unistrut Corp.

2.2 MATERIALS AND COMPONENTS

A. Rigid Metal Conduit:

1. Provide galvanized rigid metal conduit, each with a coupling on one end and thread protector on other end.
2. Hot-dip galvanize rigid steel conduit over entire length, along interior and exterior surfaces, including threads. Conduit shall conform to UL 6.

B. Flexible-Metal Conduit:

1. Provide flexible-metal conduit for use in dry areas and match fittings, size, and material to rigid conduit to which it is connected. Flexible-metal conduit shall conform to UL 1.
2. Provide liquid-tight flexible-metal conduit for use in damp areas consisting of flexible-metal conduit, with liquid-tight, sunlight-resistant jacket extruded over the conduit. Provide stainless steel, braided flexible conduit in NEMA 4X, corrosive areas. On larger than 1-1/4 inch (30 mm), furnish separate external ground wire. Liquid-Tight flexible-metal conduit shall conform to UL 360.

C. Polyvinylchloride (PVC) Conduit:

1. Provide PVC conduit, Schedule 40 and Schedule 80 conforming to NEMA Standard TC-2 and UL-651.
2. Fittings and Conduit Bodies: NEMA TC 3 as recommended by the conduit manufacturer.

D. Boxes:

1. In NEMA and NEMA 12 areas, provide standard, sheet-metal, outlet and junction boxes constructed of code-gauge, galvanized sheet steel. Size each box as required by the NEC.
2. Provide boxes containing fixture studs for hanging fixtures. Use concrete-tight boxes for installation in concrete. Do not use shallow boxes unless building construction is such that it is impossible to use standard-depth boxes.
3. Provide outlet boxes and fittings for hazardous locations conforming to UL 886 for class, group, and division indicated.
4. Provide cast boxes with covers or device plates suitable for the area classification. Use cover screws of stainless steel or high brass for iron boxes.

5. Provide polyvinylchloride boxes for use as junction boxes and provide high impact strength fiberglass-reinforced polyester boxes for use as device boxes, pull boxes, and terminal boxes for use with polyvinylchloride conduit. Size each box as required by the NEC.
6. Provide pull boxes below motor control center installations (20 inches (500 mm) by 20 inches (500 mm) by 12 inches (300 mm) deep minimum.) Boxes of dimensions 10 inches (250 mm) by 10 inches (250 mm) by 6 inches (150 mm) deep and larger shall be hung from ceilings constructed of angle or channel frames, and shall be made of sheet metal with welded joints. All welds shall be ground smooth. Provide neoprene gaskets for complete sealing. Sectionalize covers longer than 36 inch (900 mm) to facilitate handling and gasket sectionalized covers where covers meet, using angle iron or channel cross members at the joint. Sheet metal shall be not less than No. 12-gage (0.1046 mm) galvanized sheet steel. Fabricate interior angles and supports of galvanized steel. Provide each box with a grounding lug for connection to the nearest ground bus. Current capacity of ground lug shall be at least that required by the NEC for the largest feeder entering the equipment.
7. Construct telephone cabinets of 14 gage (0.0747) galvanized steel with a hinged, lockable, flush door and handle mechanism. Provide backboard of 3/4 inch (20 mm) x 4 feet (1.2 m) x 8 feet (2.4 m) exterior grade plywood behind the cabinet. Cabinet sizes and locations shall be as indicated on the drawings and required by the telephone company. Furnish and install specific telephone cabinet termination materials as directed by the telephone company.

E. Fittings:

1. Provide cast-iron fittings of malleable iron or a mixture of gray iron and cast steel.
2. Provide suitable expansion fittings where conduits cross expansion joints. Equip these fittings with grounding straps, clamps, and copper bonding jumpers.

PART 3 EXECUTION

3.1 INSTALLATION

A. Perform all work in accordance with the NEC.

B. Use no conduit less than 3/4-inch (20 mm) in diameter, unless otherwise indicated.

C. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's printed instructions.

3.2 INSTALLATION OF FITTINGS

A. Install expansion fittings wherever conduits cross structural expansion joints. Keep the fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

B. Do not install fittings to replace elbows and pull boxes, unless space or other problems make use of fittings necessary. Use oversize fittings whenever large cable is installed, in order to maintain proper bending radius.

C. Terminate ends of all floor conduits installed for future use with couplings and readily removable plugs set flush with finished floor surface. Cap spare wall conduits at wall where they enter building.

D. Equip ends of all conduits with conduit fittings. Fit conduits terminating at motor control center or power distribution equipment, or in box above or below, with grounding type bushings, or solidly ground by locknuts or other acceptable fittings. Connect each grounding bushing to ground bus by a bare or green-covered copper wire. Do not use ground wire smaller than 12 AWG. Install ground wire larger than 12 AWG when required by NEC. Where conduits terminate in unprotected areas or where bonding is required over expansion joint, flexible conduit or equivalent; use ground wires 6 AWG. copper or larger.

E. Terminate conduits entering gasketed sheet-metal boxes or gasketed sheet-metal equipment enclosures with gasketed hubs.

F. Terminate conduits entering nongasketed sheet-metal boxes or enclosures with double locknuts and insulated bushings, or with acceptable equivalent.

G. Join raceways with fittings listed for the purpose. Make joints tight. Use raceway fittings compatible with raceway and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, except as otherwise indicated.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.

H. Use insulating bushings to protect conductors.

1. Tighten set screws of threadless fittings with suitable tool.

3.3 INSTALLATION OF RACEWAYS

A. Install exposed raceways parallel or at right angles to walls and ceiling beams. Make all changes in directions with listed bends, elbows, and pull boxes. Space parallel runs uniformly throughout. Secure in place by hangers and fasteners. Ground raceways by connection to properly grounded enclosures, bonding, or other means, to obtain permanent low resistance path to ground throughout installation. Ensure that raceway sections in single run and in parallel runs are of same type and finish.

1. Run parallel or banked raceways together, on common supports where practical.
2. Install raceways level and square and at proper elevations. Provide minimum 7 feet (2 m) headroom.

B. Support raceways concealed above suspended ceilings from slab above ceiling in same manner as exposed raceways. Do not support raceways from ceiling supports.

C. Provide cast-in-place inserts in concrete to support all runs, unless otherwise permitted. Use stainless steel sleeve type concrete anchors for installing boxes, and conduit supports. Provide Type 316 stainless steel nut, bolts, and washers, for use with concrete anchors.

D. Support conduits by hangers or pipe straps spaced according to NEC, but in no case more than 10 feet (3 m) on centers.

E. Provide hot-dipped galvanized supports for galvanized conduit.

F. When specified on the Contract Drawings, install conduits in slabs as close to middle of concrete slabs as practicable without disturbing reinforcement. Do not use conduit with outside diameter exceeding one-third of slab thickness. Do not place conduits closer than three diameters on centers, except at cabinet locations where slab thickness is increased as permitted by Engineer.

G. Where conduits are concealed in bottom floor slab, place in concrete slab and not in fill below slab. Install in middle third of the slab thickness where practical, and leave at least 4 inches (100 mm) of concrete cover.

1. Secure raceways to reinforcing rods and to prevent sagging or shifting during concrete placement.
2. Space raceways laterally to prevent voids in the concrete.
3. Run conduit larger than 1-inch (25 mm) trade size parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.

H. Stub-Up Connections: Extend conduits through concrete floor for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs, and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit. Flexible metal conduit may be used 6 inches (150 mm) above the floor. Where equipment connections are not made under this Contract, terminate ends of floor conduits installed for future use with couplings and readily removable plugs 8 inch (250 mm) above finished floor surface. Cap spare wall conduits at wall entrance to building.

I. Provide sleeves passing through exterior walls and slabs which are wall entrance seals of watertight construction. For new construction, furnish watertight seal between slab and sleeve, and between sleeve and conduit or cable similar to O.Z./Gedney Type "FSK". For existing construction, furnish watertight seal for use in core bit drilled holes that provides seal between concrete and conduit or cable similar to O.Z./Gedney Type "CSM1". Use wall-entrance seals of malleable iron with watertight sealing gland which may be tightened any time after installation.

J. Do not use dissimilar metals in conjunction with each other. Use an insulation between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis. Maintain electrical continuity of system. Use bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials as insulation.

K. Install fittings to match raceway being used.

L. Install expansion fittings wherever conduits cross structural expansion joints at connections between buildings. Keep fittings in line with conduit, and install with regard to temperature so that full working range of expansion is available.

M. Where conduits pass through firewalls, grout hole around the conduit to the full depth of the material penetrated.

N. Provide separate raceways for all low voltage instrumentation raceways (50 volts and below) from control and power raceways.

O. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely, and install the locknuts with dished part against the box; use two locknuts, one inside and one outside the box.

P. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

Q. Install pull wires in all empty raceways. Use 14 AWG zinc-coated steel or monofilament plastic line having not less than 200 lb (890 N) tensile strength. Leave not less than 12 inches (300 mm) of slack at each end of the pull wire.

R. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

S. Complete raceway installation before beginning conductor installation.

T. Use temporary closures to prevent foreign matter from entering raceway.

U. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

V. Where metal conduits rise through floor slabs in wet areas, coat conduits for a distance of 6 inches (150 mm) above and below slab grade with brush coat of waterproof bituminous cement.

3.4 BENDS

A. Make all bends carefully to prevent distortion of circular cross section. Field bend conduit shall have an inside radius of not less than nine diameters.

B. Where bends of less than nine diameters are necessary, use standard factory elbows. Size conduit to permit cable-bending radius within the factory elbow of at least eight times cable diameter.

C. Allow no conduit greater than 50 feet (15.2 meters) to have more than two 90 degree bends or equivalent thereof between pulling points. For conduits less than 50 feet (15.2 meters) in length, allow only three 90 degree bends between pulling points.

3.5 CUTTING, THREADING AND CONNECTING

A. Make all field cuts in conduits squarely, file cut ends, ream to remove rough edges and thread in accordance with NEC. No running thread permitted. Make all connections mechanically strong and tight, and with acceptable connectors. Where conduit surface coating is damaged or removed in the cutting, threading or reaming process, restore the surface to its original condition.

3.6 CONDUIT CLEANING

A. Clean all conduit carefully before and after installation, ream ends free of burrs, and free inside surfaces from all imperfections likely to injure cable.

B. After installation of each complete new conduit run, snake the run with band to which is attached a tube cleaner with cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of conduit. Remove and replace all conduit through which mandrel will not pass.

C. Use a sponge with steel brush to clean steel conduit and use a sponge with nylon brush to clean PVC conduits.

D. After cleaning, protect ends of all conduit with standard caps to prevent entrance of water, concrete, debris, or other foreign substance.

3.7 CONDUIT DRAINAGE

A. Where practicable, pitch conduit to drain to outlet boxes, or install so as to avoid trapping moisture. Where dips are unavoidable in exposed conduits, install fitting with drain hole at low point.

3.8 INSTALLATION OF BOXES

A. Unless otherwise indicated, install sheet metal boxes only in dry, accessible locations. Install cast-metal boxes in exterior concrete or masonry walls, in floor slabs, in basements, all other below grade locations and elsewhere as indicated. Cast metal boxes shall be used (unless otherwise indicated) where vapor-tight fixtures are required, for all surface mounting of wall switches and receptacles and for all outdoor use. Install pull boxes for motor control centers and large ceiling hung boxes where indicated.

B. Install boxes in conformance with all the requirements of NEC. Install boxes designed for type of construction involved. Support boxes in same manner as required for conduit. Size boxes to provide bending radius for wire or cable of at least eight times diameter or in accordance with NEC, whichever is larger.

C. Center all outlets in panels, or spaces and adjust to structural finish. Where specific locations are not indicated, locate outlets with respect to equipment served.

D. Place all outlet boxes, junction boxes and pull boxes, in accessible locations when they are installed above or behind plastered ceilings, furred spaces, or suspended ceilings. Install access panels of suitable size. Mark all access panels for all boxes so panels can be readily located in future. Mark, using metal tabs or plastic buttons which cannot mark ceilings or walls, appropriate for type of construction being used.

E. Assemble cast-metal boxes with threaded conduit hubs in such manner that conduit connections and gasketed covers are watertight. Close all unused threaded openings with pipe plugs and compound.

F. Provide cast boxes with covers and device plates suitable for the area classification. Install screws of stainless steel or high brass for iron boxes.

3.9 FLEXIBLE CONNECTIONS TO MONTORS AND EQUIPMENT

A. At all motors and electrically operated equipment to which conduit connections are made, install with a complete connection between end of conduit and terminal box of motor or other equipment.

B. Install the conduits in locations permitting direct connection to motors.

C. Make connections between rigid raceway and motor or equipment subject to vibration and adjustment using flexible conduit. Make each connection with at least one quarter bend so that no vibration can be transmitted beyond flexible connection.

D. Install flexible metal conduit, fittings, and accessories in dry areas in accordance with requirements of NEC.

E. Install liquid-tight flexible metal conduit in damp and corrosive areas. Locate conduit to reduce the possibility of damage to the exterior coating. Use fittings that screw into flexible conduit and provide gaskets.

F. Use maximum of 6 feet (2 m) of flexible conduit for recessed and semi-recessed lighting fixtures and; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquid tight flexible conduit in wet or damp locations. Install liquid-tight flexible metal conduit in areas subject to wetting due to fire protection sprinklers or broken or ruptured water line. Locate conduit to reduce the possibility of damage to the exterior flexible conduit jacket. Use fittings that screw into flexible conduit and provide gaskets. Install separate ground conductor across flexible connections.

3.10 PROTECTION

A. Provide protection and install in accordance with manufacturer printed instructions. The conduit and raceway equipment manufacturers, to ensure that coatings, finishes, and enclosures are without damage or deterioration at completion of project.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.11 FINAL SYSTEM ACCEPTANCE

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions and at no additional cost to the Owner.

END OF SECTION

SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide complete underground distribution system as indicated and in compliance with Contract Documents.

B. Conform to lines, grades, elevations, and dimensions. Resolve interferences with other underground conduit, piping or equipment, either new or existing with the Engineer. Match components suitable for proper installation.

C. Provide Schedule 80 polyvinylchloride (PVC) conduit for power and control circuits.

1.2 REFERENCES

A. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

C. Provide "Record" drawings.

PART 2 PRODUCTS

2.1 MANUFACTURER'S COMPLIANCE

A. Manufacturer's acceptance contingent upon products' compliance with specifications.

2.2 MANUFACTURERS

A. Polyvinylchloride (PVC) Conduit:

1. Specified in Section 26 05 33: Raceway and Boxes for Electrical Systems.

B. Rigid Steel Conduit, Galvanized:

1. Specified in Section 26 05 33: Raceway and Boxes for Electrical Systems.

PART 3 EXECUTION

3.1 INSTALLATION OF CONDUITS

A. Lay conduits, indicated to be direct buried in the ground, in trench on 3-inch (75 mm) bed of sand and cover with an equivalent 3 inch (75 mm) bed of sand. Ensure that no rocks come in contact with conduit during backfilling. Dig trenches to depth and location indicated.

B. Provide minimum separation of power and control conduits of 3 inch (75 mm) both vertically and horizontally.

C. Separate power and control ducts from instrument ducts by a minimum of 12 inches (300 mm).

D. Install conduit runs following routing on drawing and running in straight lines. Where deviation from a straight line becomes necessary, install bends of radius which allow for rodding and installation of cable.

E. Accomplish changes in direction of runs exceeding total of 10 degrees, either vertical or horizontal, by long sweep bends having minimum radius of curvature of 25 feet (8 m) Manufactured bends can be used at ends of short runs of 100 feet (30 m) or less, and then only at or close to the end of run. Provide long sweep bends made up of one or more curved or straight sections and/or combinations thereof. Install manufactured bends with minimum radius of 36 inch (1,000 mm) where larger radius cannot be used.

F. Lay ductlines to minimum slope of 4 inch (100 mm) per 100 feet (30 m) and slope to manholes and handholes, as indicated. Ductlines are to slope away from buildings.

G. Stagger joints in conduits at least 6 inches (150 mm). Do not allow couplings to rest on bottom of trench. Install couplings for plastic conduit in accordance with manufacturer's recommendations.

H. Roll and grade backfill, and restore surface to condition equal to the site finish grade, or as otherwise indicated.

I. Keep conduits clean of concrete, dirt, and other substances during the course of construction. After the ductlines have been completed, pull a standard flexible mandrel not less than 12 inches (300 mm) long, having a diameter approximately 1/4-inch (6 mm) less than the inside diameter of the conduit, through each conduit, after which pull a brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in the line. Replace conduit runs that do not allow the passage of the mandrel at no additional cost to the Owner. Pneumatic rodding may be used to draw in the lead wire. Install in spare conduits a pull wire or rope, and plug and seal spare conduits after cleaning.

END OF SECTION

SECTION 26 05 53
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identification of electrical materials, equipment, and installations as indicated and in compliance with Contract Documents.

1.2 REFERENCES

A. American Society of Mechanical Engineers (ASME):

1. ASME A13.1: Scheme for the Identification of Piping Systems

B. Institute of Electrical and Electronics Engineers (IEEE):

1. ANSI/IEEE C2: National Electrical Safety Code.

C. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

C. Miscellaneous: Schedule of identification nomenclature to be used for identification signs and labels.

PART 2 PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Manufacturer’s Standard Products: Where more than one type is listed for specified application, selection is Installer’s option, but provide single type for each application category. Use colors prescribed by ASME A13.1, NFPA 70, or as specified elsewhere.

B. Components and installation shall comply with NFPA 70.

C. Conform to ASME A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway or cable size.

1. Color: Black legend on orange field.
2. Legend: Indicates voltage.

D. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl. Legend is over-laminated with clear, wear and chemical resistant coating.

E. Pre-tensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color coded, acrylic bands sized to suit diameter of line it identifies and arranged to stay in place by pre-tensioned gripping action when placed in position.

F. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2-inch-wide (0.08 mm thick by 25 to 51 mm wide).

G. Underground Line Warning Tape: Permanent, bright colored, continuous printed, vinyl tape with following features:

1. Size: Not less than 6-inch-wide by 4 mils thick (152 mm wide by 0.102 mm thick).
2. Compounded for permanent direct burial service.
3. Embedded continuous metallic strip or core.
4. Printed Legend: Indicates type of underground line.

H. Tape Markers: Vinyl or vinyl cloth, self-adhesive, wraparound type with preprinted numbers and letters.

I. Plasticized Card Stock Tags: Vinyl cloth with preprinted and field printed legends. Orange background, except as otherwise indicated, with eyelet for fastener.

2.2 ENGRAVED NAMEPLATES AND SIGNS

A. Manufacturer's Standard Products: Where more than one type is listed for specified application, selection is Installer's option, but provide single type for each application category. Use colors prescribed by ASME A13.1, NFPA 70, or as specified elsewhere.

B. Engraving stock, melamine plastic laminate, 1/16-inch (1.6 mm) minimum thick for signs up to 20 square inches (129 sq cm), 1/8 inch (3.2 mm) thick for larger sizes.

1. Engraved Legend: Black letters on white face.
2. Punched for mechanical fasteners.

C. Baked Enamel Signs for Interior Use: Preprinted aluminum signs, punched for fasteners, with colors, legend, and size as indicated or as otherwise required for application. 1/4 inch (6.4 mm) grommets in corners for mounting.

D. Exterior, Metal Backed, Butyrate Signs: Wear resistant, non-fading, preprinted, cellulose acetate butyrate signs with 0.0396 inch (1 mm), galvanized steel backing, with colors, legend, and size appropriate to application. 1/4-inch (6.4 mm) grommets in corners for mounting.

E. Fasteners for Plastic Laminated and Metal Signs: Self tapping stainless steel screws or No. 10/32 stainless steel machine screws with nuts, flat washers and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1 piece, self-locking, Type 6/6 nylon cable ties with following features:

1. Minimum Width: 3/16-inch (5 mm).
2. Tensile Strength: 50 lb (222 N) minimum.
3. Temperature Range: -40 to 185 degrees F (-40 to 85 degrees C).
4. Color: As indicated where used for color coding.

B. Paint: Alkyd-urethane enamel. Primer as recommended by enamel manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install identification devices according to manufacturer's written instructions.

B. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.

C. Self-Adhesive Identification Products: Clean surfaces of dust, loose material, and oily films before applying.

D. Install painted identification as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime Surfaces: For galvanized metal, use single component, acrylic vehicle coating formulated for galvanized surfaces. For concrete masonry units, use heavy duty, acrylic resin block filler. For concrete surfaces, use clear, alkali resistant, alkyd binder type sealer.
3. Apply 1 intermediate and 1 finish coat of silicone alkyd enamel.
4. Apply primer and finish materials according to manufacturer's instructions.

E. Identify Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communications lines, install continuous underground plastic line marker located directly above line at 6 to 8 inch (150 to 200 mm) below finished grade. Where multiple lines installed in common trench or concrete envelope do not exceed an overall width of 16 inch (400 mm), use single line marker.

1. Install line marker for underground wiring, both direct buried and in raceway.

F. Color Code Conductors: Secondary service, feeder, and branch circuit conductors throughout secondary electrical system.

1. Field applied; color coding methods may be used in lieu of factory coded wire for sizes larger than 10 AWG.

   a. Colored, pressure sensitive plastic tape in half lapped turns for distance of 6 inch (150 mm) from terminal points and in boxes where splices or taps are made. Apply last 2 turns of tape with no tension to prevent possible unwinding. Use 1 inch (25 mm) wide tape in colors as specified. Adjust tape bands to avoid obscuring cable identification markings.
   b. Colored cable ties applied in groups of 3 ties of specified color to each wire at each terminal or splice point starting 3 inch (76 mm) from terminal and spaced 3 inch (76 mm) apart. Apply with special tool or pliers, tighten to snug fit, and cut off excess length.

2. 208/120 Volt System: As follows:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Neutral: White.
   e. Ground: Green.

3. 480/277 Volt - System: As follows:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral: White.
    e. Ground: Green.

G. Power Circuit Identification: Use metal tags or aluminum wraparound marker bands for cables, feeders, and power circuits in vaults, pull boxes, junction boxes, manholes, and switchboard rooms.

1. Legend: 1/4-inch (6.4 mm) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Fasten tags with nylon cable ties; fasten bands using integral ears.

H. Apply identification to conductors as follows:

1. Conductors to Be Extended in Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
3. Multiple Control and Communications Circuits in Same Enclosure: Identify each conductor by its system and circuit designation. Use consistent system of tags, color coding, or cable marking tape.

I. Apply warning, caution, and instruction signs and stencils as follows:

1. Install warning, caution, and instruction signs where indicated or required to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved, plastic laminated instruction signs with accepted legend where instructions or explanations are needed for system or equipment operation. Install butyrate signs with metal backing for outdoor items.
2. Emergency Operating Signs: Install engraved laminate signs with white legend on red background with minimum 3/8-inch (9 mm) high lettering for emergency instructions on power transfer, load shedding, and or emergency operations.

J. Install identification as follows:

1. Apply equipment identification labels of engraved plastic laminate on each major unit of equipment, including central or master unit of each system. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Except as otherwise indicated, provide single line of text with 1/2-inch (13 mm) high lettering on 1-1/2 inch (38 mm) high label; where 2 lines of text are required, use lettering 2 inch (51 mm) high. Use black lettering on white field. Apply labels for each unit of following categories of equipment.

    a. Panelboards, electrical cabinets, and enclosures.
    b. Access doors and panels for concealed electrical items.
    c. Contactors.
    d. Remote controlled switches.
    e. Control devices.
    f. Transformers.

2. Apply designation labels of engraved plastic laminate for disconnect switches, breakers, push buttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm/signal components where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items controlled by each individual breaker.

END OF SECTION

SECTION 26 22 14
DRY-TYPE TRASNFORMERS

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide copper-wound, dry-type transformers as indicated and in compliance with Contract Documents.

B. Provide transformer windings and enclosures rated for the installation location and in accordance with the requirements herein.

C. Transformers shall be “Energy Star” rated.

1.2 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI Z55.1: Gray Finishes for Industrial Apparatus and Equipment

B. ASTM International (ASTM):

1. ASTM D635: Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

C. National Electrical Manufacturers Association (NEMA):

1. NEMA ST 20: Dry-Type Transformers for General Applications (ANSI C89.2). - withdrawn

D. International Electrical Testing Association (NETA):

1. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

E. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

F. Underwriters' Laboratories, Inc. (UL):

1. UL 506: Standard for Specialty Transformers.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

C. Submit shop drawings and manufacturer's product data of the transformer. Information to include:

1. Outline drawings including dimensions.
2. Weight.
3. Ratings and tap configuration.

4. Core and coil material.
5. Insulation system description.
6. Loss data and efficiency.
7. Accessories.
8. Mounting requirements.
9. Nameplate data.
10. Testing data.

D. Submit a Certificate of Compliance indicating conformance to the Seismic Requirements specified. Certificate shall be signed and sealed by a Professional Structural Engineer holding current registration in the state for work of this project.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver transformers individually wrapped for protection and mounted on shipping skids.

B. Accept transformers on site. Inspect for damage.

C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle and stored in accordance with manufacturer's written instructions. Lift only with lugs provided. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.5 REQUIREMENTS OF REGULATORY AGENCIES

A. Furnish transformers in accordance with NEMA ST 20 and UL 506.

B. Furnish transformers with UL listing mark.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Square D Co.

B. Eaton-Cutler-Hammer Corp.

C. Siemens Inc.

D. General Electric Company.

2.2 TRANSFORMERS

A. In NEMA 1 and NEMA 12 designated areas, furnish general purpose, ventilated, dry-type transformers in indoor-style enclosure. On single-phase transformers and three-phase transformers above 9 KVA, provide not less than two windings per phase.

1. Temperature rise at hottest spot shall conform to NEMA Standards, and shall not bake and peel off the enclosure paint after the transformer has been placed in service.
2. Ventilation openings shall prevent accidental access to live components.
3. Thoroughly clean and paint enclosure at the factory with manufacturer’s prime coat and standard finish.

B. In NEMA 4 or NEMA 4X designated areas, provide transformers with encapsulated windings and stainless steel enclosures.

C. Auto transformers shall not be used in place of general purpose dry-type transformers.

D. Furnish at least two 2-1/2 percent full capacity taps above and below nominal in high voltage winding for transformers rated above 15 kVA. Two five percent taps below rated voltage for transformers rated 15 kVA and below.

E. Furnish transformers, single-phase or three-phase, as indicated. Furnish transformers with kVA ratings as indicated.

F. Furnish three-phase transformers, Delta-Wye, Delta-Delta or Wye-Wye connected as indicated, and conforming to latest NEMA standards. Scott Tee connected transformers are not acceptable above 9 kVA.

G. Isolate core and coil from enclosure using vibration-absorbing mounts.

H. Furnish transformers with primary and secondary voltages and frequency, wye connected, as indicated for secondary windings, with neutral brought out for cable termination.

I. Furnish transformers designed for continuous operation at rated kVA with normal life expectancy as defined in NEMA ST 20.

J. For transformers rated 30 kVA or less, ensure that performance is obtained without exceeding 115 degrees C average temperature rise by resistance or 145 degrees C hot spot temperature rise in 40 degrees C maximum ambient and 30 degrees C average ambient. Do not allow maximum coil hot spot temperature to exceed 185 degrees C.

K. Furnish transformers with 220 degrees C insulation materials with proven reliability for 15 kVA transformers and above. Furnish 185 degrees C insulation on transformers below 15 kVA.

L. Transformers rated greater than 30 kVA shall be provided with low-loss 80 degrees C full load operating temperature rise rating.

M. Furnish transformers made of flame retardant materials that will not support combustion as defined in ASTM D635.

N. Furnish core mounting frames and enclosures of welded and bolted construction with mechanical rigidity and strength to withstand shipping, erection and short circuit stresses.

1. Cores shall be grain oriented, non-aging, and silicon steel.
2. Coils shall be continuous windings without splices except for tapes.
3. Coil loss and core loss shall be minimum for efficient operation.
4. Primary and secondary tap connections shall be razed or pressure type.
5. Coil windings shall have end fillers or tie downs for maximum strength.

O. Transformers located in areas where fire protection system sprinklers are located shall be provided with NEMA 2 rated enclosure to protect transformer from water falling at an angle of 75 degrees from the vertical.

P. Furnish transformers designed to meet UL thermal overload test of 200 percent of rated current for one half hour.

Q. Furnish transformers not to exceed the 65 degrees C rise established by UL as safe limit for maximum surface enclosure temperature.

R. Furnish transformers with sound level not exceeding:

	Average Sound Level in dB
kVA	NEMA ST 20
0-09	40
10-50	45
51-150	50
151-300	55
301-500	60

S. Install transformers with sound levels greater than 50 dB on resilient vibration isolating mounts to prevent amplification of sound. Transformers rated 15 kVA and larger to be provided with rubber washer anti-vibration pads and molded neoprene assemblies to isolate noise from the transformer to the mounting surface.

2.3 SHOP TESTING

A. Submit results of audible-sound-levels tests in accordance with NEMA ST 20 of similar size transformer.

B. Production test each unit in accordance with NEMA ST 20.

PART 3 EXECUTION

3.1 INSTALLATION

A. Set transformer plumb and level. Install and guard transformers as specified by latest NEC and ANSI standards, and in accordance with manufacturer's printed instructions.

B. Furnish adequate space around transformer to dispose of transformer full load losses by ventilation without creating excessive ambient temperature. Verify working clearances as required by the NEC are met.

C. Unless indicated otherwise on drawings, wall mount with suitable supports, transformers rated 15 kVA and below. Floor mount transformers rated above 15 kVA unless otherwise indicated on the drawings. In addition, all transformers located in NEMA 4 or NEMA 4X designated areas shall be wall mounted on Type 316 stainless steel channel supporting systems with Type 316 stainless steel concrete inserts, minimum 7 feet-6 inches (2.3 m) AFF. Provide all required seismic restraints.

D. Provide lifting lugs and jacking plates on transformer enclosure.

E. Provide concrete pad for all floor mounted transformers.

F. Clean metal parts, excepting cores and core mounting frames, then rust-proof and apply heavy coating of inert primer. Paint coverplates and external metal parts with two finish coats of ANSI Z55.1 No. 61 or 49 Gray.

G. Verify mounting pads are in place to reduce noise.

H. Install grounding and bonding in accordance with the drawings and Section 26 05 26: Grounding and Bonding for Electrical Systems.

3.2 FIELD TESTING

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.2.1.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide panelboards rated 600 volts or less and 1200 amperes or less.

B. Provide with circuit breakers and cabinets complete, as indicated and in compliance with Contract Documents.

1.2 REFERENCES

A. Federal Specifications (FS):

1. FS QQ-S-365B: General Requirements for Silver Plating, Electro Deposited
2. FS W-C-375B: Automatic Circuit Breakers.
3. FS W-P-115A: Panel, Power Distribution.

B. National Electrical Manufacturers Association (NEMA):

1. NEMA 250: Enclosures for Electrical Equipment (1000 volts maximum)
2. NEMA AB 1: Molded Case Circuit Breakers
3. NEMA PB 1: Panelboards

C. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC)

D. Underwriter's Laboratories, Inc. (UL):

1. UL 50: Cabinets and Boxes
2. UL 67: Panelboards
3. UL 86A: Wire Connectors and Soldering Lugs for Use with Copper Conductors
4. UL 489: Circuit Breakers, Molded Case and Circuit Breaker Enclosures

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

1.4 QUALITY ASSURANCE

A. All panelboards shall be designed, manufactured and assembled in accordance with the referenced standards.

B. Listing and Labeling: All panelboards shall be listed and labeled by Underwriter’s Laboratories, Inc. (UL), or other nationally-recognized testing laboratory (NRTL).

C. Service Entrance panelboards shall be UL/NRTL-labeled as suitable for that purpose.

D. Single-source Responsibility: Provide panelboards products that are new, and from the same manufacturer for each building or job. Panelboard components shall be from the same manufacturer, or listed as an assembly thereof.

PART 2 PRODUCTS

2.1 PANELBOARD MANUFACTURERS

A. Manufacturers acceptable contingent upon products' compliance with the specifications:

1. Cutler-Hammer Products.
2. General Electric Company.
3. Siemens Corp.
4. Schneider Square D.

2.2 PANELBOARDS

A. Factory assembled deadfront type panelboards.

B. Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs only as indicated.

C. Furnish panelboards with full capacity separate ground bus, separate insulated neutral bus and furnish panelboards connected to a 3 phase, 4 wire service or single phase, 3 wire service as indicated.

D. Provide panelboards with the voltage, frequency and current ratings as indicated conforming to NEMA Standard PB1, Federal Specification W-P-115A. U.L. 67, and the NEC.

E. Furnish the panelboard main and neutral buses, with minimum 98 percent conductivity rectangular copper bars provided with bolted type lugs as necessary.

F. Drill buses to fit either "A", "B" or "C" Phase connectors, and ensure that connectors are inter-changeable and installed in a distributed phase sequence.

G. Silver plate buses, connectors and terminals to a minimum thickness of 0.005-in., conforming to the requirements of Federal Spec. QQ-S-365B.

H. Prevent terminal lugs from turning per NEMA standard PB 1 and ensure they are suitable for the conductor material and size.

I. Provide main bus-bracing for each panel board adequate for 10,000 amperes symmetrical short circuit at 240 volts and 14,000 amperes symmetrical short circuit at 480 volts unless otherwise indicated.

J. Where the word “space” occurs on panel schedules, provide all necessary hardware in the space, including connection straps, mounting brackets, and filler plates so that only the addition of a future circuit breaker is required. Connection straps shall be rated a minimum of 100A in panelboards of 400A rating or less and a minimum of 225A in panelboards above 400A rating, unless otherwise noted on panel schedules.

2.3 CIRCUIT BREAKERS

A. Each circuit breaker shall be bolted into position in the panelboard, whether by direct bolted connection to the bus or by being bolted to the panelboard frame. Each circuit breaker shall be replaceable without disturbing adjacent units. Plug-on circuit breakers held in place only by spring force of the bus lug and the pressure of the deadfront are not acceptable.

B. Furnish frame sizes, trip settings and number of poles as indicated. Clearly and visibly mark circuit breakers with ampere trip rating. Furnish breakers meeting the requirements of F.S. W-C-375B and NEMA AB1.

C. Furnish all breakers with quick-make, quick-break, toggle mechanisms and thermal-magnetic, inverse time-limit overload and instantaneous short circuit protection on all poles, unless otherwise indicated. Automatic tripping indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position. Furnish breaker handle that is trip-free on overloads.

D. Do not use single pole breakers with handle ties or bails in lieu of multi-pole breakers.

E. For each panelboard, furnish quantity four handle lock devices for individual breakers to prevent the manual opening of the selected breakers. Turn devices over to Owner at completion of the project work.

F. Ensure that voltage and interrupting rating of all breakers in a panelboard is not less than voltage and short circuit rating of the panelboard main buses, as indicated. Furnish breakers suitable to operate satisfactorily at the frequency indicated.

G. Furnish ground fault interrupter (GFI) circuit breakers for certain circuits as indicated on the drawings.

H. Furnish single pole breakers with full module size. Do not install two pole breakers in a single module.

I. Furnish time-current characteristic curves and catalog information and data for each size of breaker furnished.

2.4 CABINETS

A. Provide cabinets with NEMA enclosure type as indicated and without knockouts. Drill cabinets only for the exact conduit entrances and mounting bolts.

B. Finish cabinet fronts, trims and surface-mounted boxes in ANSI No. 61 or 49, light-gray enamel over a rust-inhibitive primer. Attach the fronts (exterior trims) to the boxes or interior trims, by quarter-turn, indicating trim clamps. Design cabinets for surface or flush mounting as indicated.

C. Unless otherwise specified, construct panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of ample size for the risers and outgoing circuits. Ensure that the cabinets do not exceed 78 inch (1980 mm) in height.

D. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab.

Equip locking tab with provision for a screw such that removal of trim requires a tool, at the Owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.

E. Provide enclosure with the following side gutter dimensions:

1. Left side minimum 4-1/2 inch (114 mm) measured from inside lip of the box to the installed deadfront.
2. Right side; minimum 4-1/2 inch (114 mm) measured from inside lip of the box to the installed deadfront. With the door-in-door cover in place; minimum 3-1/4 inch (83 mm) from installed outer door hinge to the installed deadfront.

2.5 FACTORY TESTING

A. Standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of NEMA and UL standards.

PART 3 EXECUTION

3.1 INSTALLATION

A. Mount panelboards, plumb and rigid without distortion of the box. Mount such that the height of the top operating handle does not exceed 6 feet 7 inches (2 m) from the floor.

B. Hang each door of the cabinet on semi- or fully-concealed hinges with a combination catch and lock.

C. On cabinets 48 inch (1200 mm) high and over, install a 3-point catch assembly latching at top, bottom and approximate middle.

D. Verify all panelboard locks are keyed alike.

E. Provide typed directory card filled-out to clearly indicate the load served.

F. Door hinge to be on the side opposite escape route if applicable.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTION DEVICES

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide Surge Protection Devices (SPDs) components in combination with the electrical distribution system equipment as indicated and in compliance with Contract Documents. The distribution system includes switchboards, motor control centers, 480V distribution panels and 120V panelboards.

B. The components shall provide protection for electrical and electronic devices against the damaging effects of surges, transients and electrical line noise.

C. Where indicated on the electrical contract drawings, provide separate, modular components from the electrical distribution equipment enclosures. Provide conduit, cable and all associated components for a complete SPD system installation. It shall be the Electrical Contractor's responsibility to verify adequate space for locating modular SPD equipment adjacent to associated electrical distribution equipment.

1.2 REFERENCES

A. American National Standard Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41.1: IEEE Guide on the Surges Environment in Low-Voltage (1000V and Less) AC Power Circuits
2. C62.45: Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits

B. Military Standard (MIL):

1. MIL 220A: Radio Frequency Interference and Electromagnetic Interference

C. National Electrical Manufacturers Association (NEMA):

1. NEMA 250: Enclosures for Electrical Equipment (1000 volts maximum)
2. NEMA LS 1: Low Voltage Surge Protection Devices

D. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

E. Underwriters Laboratory (UL):

1. UL 1449: Standard for Safety, Surge Protective Devices - Fourth Edition.
2. UL 1283: Standard for Safety, Electromagnetic Interference Filters

1.3 SUBMITTALS:

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

1. Shop drawings, manufacturer's product data, and component ratings in accordance with this section and the requirements of Section 26 05 10: Electrical Work - General.

2. SPD type, model number, system voltage, phases, modes of protection, Maximum Continuous Operating Voltage (MCOV) Voltage Protection Rating (VPR), Short Circuit Current Rating (SCCR), and Nominal Discharge Current (In).
3. Provide outline drawings and internal wiring diagrams.
4. List all required installation criteria including circuit breaker trip rating to meet UL 1449, Fourth Edition.
5. Identify all cable sizes, distance limits and accessory devices when SPD units are to be provided in separate enclosures, where applicable.
6. For informational/purposes only, submit installation instructions and separate from all other submittals.
7. UL 1449 listing and summary of factory test data.

1.4 QUALITY ASSURANCE

A. SPD units and all components shall be designed manufactured and tested in accordance with the latest applicable UL Standard ANSI/UL 1449 Third Edition.

1.5 DELIVERY, STORAGE AND HANDLING

A. Provide in accordance with Section 26 05 10: Electrical Work - General and as specified.

B. Shipping:

1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and quantity of items.
2. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
3. Deliver spare parts after installation but before start-up of system as specified. Deliver to Owner after completion of work.

C. Storage:

1. Inspect and inventory items upon delivery to site.
2. Store and safeguard equipment, material and spare parts.

1.6 WARRANTY AND SERVICE

A. The Surge Protection Device (SPD) manufacturer is to warranty the components against defective materials and workmanship for a period of five years following delivery from the manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Surge Protection Device components.

1. Eaton/Cutler-Hammer.
2. Phoenix Contact.
3. Siemens.
4. General Electric Company.

2.2 PROVISIONS

A. Environmental Requirements:

1. Operating Temperature: minus 40 degrees C to 60 degrees C.
2. Relative Humidity: 5 to 95 percent.
3. Operating Altitude: 0 to 12,000 Feet (0 to 3,660 meters).
4. Audible Noise: Less than 35 dBA at 3 feet (1 m).

B. Electrical Requirements:

1. The maximum continuous operating voltage of all suppression components utilized is not to be less than 115 percent of the nominal operating voltage at the installed location.
2. ANSI/UL 1449 3rd Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 3rd Edition VPR for the device shall not exceed the following:

Volts	L-N	L-L	N-G
208Y/120	460V	1000V	700V
480Y/277	1100V	1800V	1000V

3. The ANSI/IEEE C62.41.1-1991 Category C3 let through voltages shall not exceed the following

Volts	L-N	N-G
208Y/120	550V	470V
480Y/277	900V	920V

4. The SPD components are to be rated as follows:

480V Service Entrance at each structure	250 kA per phase 125 kA per mode
480V Distribution Panels	160 kA per phase 80 kA per mode
120/208V Panelboards	120 kA per phase 60 kA per mode

5. The mode of operation is to protect against surges and transients as follows:

System Configuration	Protection Mode
Single Phase, Two Wire (L,N) + Ground	L to G,L to N, and N to G
Single Phase, Two Wire (L,L) + Ground	L to L, and L to G
Split Phase, Three Wire + Ground	L to L, L to G,L to N, and N to G
Three Phase, Three Wire (Delta) + Ground	L to L, and L to G
Three Phase, Four Wire (Wye) + Ground	L to L, L to G,L to N, and N to G

2.3 OPERATION

A. The suppression system shall incorporate a hybrid designed Metal-Oxide Varistors (MOV) surge suppressor. The system shall not use silicone avalanche diodes, air gaps or other methods of suppression.

B. Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 50 dB at 100 kHZ.

C. SPD shall provide surge current diversion between each phase conductor and the neutral conductor, between each phase conductor and ground and between the neutral conductor and ground. For delta systems, the SPD shall have components directly connected between each phase conductor and between each phase conductor and ground.

D. The SPD shall provide a low impedance path for surge current using oversized conductors with equal impedance paths to each suppression element. Plug-in style connections or printed circuit boards for use in the path of surge current shall not be used.

E. Operating Parameters:

1. The maximum response time shall not exceed 1 nanosecond.
2. Provide with a noise filtering system capable of managing noise levels produced by electro-magnetic interference and radio frequency interference. The noise filtering system shall reject a minimum of 50db at 100 kHz as measured by the 50 Ohm Insertion Loss Method (Military Standard 220A).
3. The parallel system components shall operate over a minimum frequency range of 47 Hertz to 63 Hertz.
4. The SPD components shall limit total harmonic distortion produced to less than one percent.
5. SPD component ratings to be per UL 1449.
6. Each unit shall be factory tested at the maximum continuous operating voltage and short circuit tested, prior to delivery.

F. Product Components:

1. Protection and Filtering Elements:

   a. The SPD components shall consist of replaceable protection modules designed to suppress and divert transient voltages and surge currents. Each protection module shall contain one or more individually fused metal oxide varisters capable of withstanding over 1000 surges of Category C (IEEE/ANSI C62.41.1) current rated at 10,000 amperes.
   b. Each protection module shall contain filtering elements capable of providing noise attenuation.
   c. The SPD components shall substantially limit transient waveform rise-time characteristics. The components are to be configured as parallel connected, current carrying elements designed to enhance the surge suppression and diversion performance of the protection modules.

2. Provide individual fusing to allow the SPD to be isolated during fault conditions.
3. Provide red and green solid-state status lights which indicate operational status of each unit and visual diagnostic monitoring of each component and module. Provide audible alarm to activate on fault condition, with a silence switch and push-to-test alarm switch.

4. Provide surge counter with battery backup to retain memory upon loss of AC power.
5. Provide remote status monitoring with form C dry contacts monitoring all phases.

2.4 SHOP TESTING

A. Perform factory performance testing on each unit. The test to consist of the following:

1. High voltage impedance test.
2. Current test.

B. Tests shall be in accordance with the following standards:

1. ANSI/IEEE C62.41.1 Cat. A, B, & C.
2. ANSI/IEEE C62.45.
3. Military Standard 220A.
4. Underwriters Laboratory UL 1449.

C. Submit certified documentation of all factory tests performed.

D. Perform above tests in addition to standard factory tests.

2.5 SPARE PARTS

A. Provide one spare protection module of each type for on-site spare parts purposes.

PART 3 EXECUTION

3.1 INSPECTION

A. Visually inspect delivered unit(s) and accessories for conformance with drawings and specifications. Replace all components found to exhibit defects.

3.2 INSTALLATION

A. Install unit in compliance with the manufacturers printed instructions. All electrical installation work shall be in accordance with UL Listing Requirements and applicable National or Local Electrical Codes.

B. For units mounted adjacent to electrical distribution equipment, verify conduit and wire for the SPD components are as specified by the SPD manufacturer and installed in strict accordance with the National Electrical Code.

C. Verify UL 1449, fourth edition, label is provided on each unit.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.1 DESCRIPTION

A. Provide complete outdoor lighting systems as indicated and in compliance with Contract Documents.

B. Light fixture schedules are provided on the Contract Drawings. These Specifications are to be considered supplementary to the information contained in the light fixture schedule. In areas of conflict the scheduled items shall be provided.

C. Fixtures shall be “Energy Star” rated.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO LTS-3: Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals

B. American National Standards Institute (ANSI):

1. ANSI C78: Fluorescent Lamps - Rapid-Start Types

C. ASTM International (ASTM):

1. ASTM A500/A500M: Cold Formed Welded and Seamless Carbon Steel Structural Tubing.
2. ASTM B209/B209M: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
3. ASTM B429/B429M: Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

D. Alliance for Telecommunications Industry Solutions (ATIS):

1. ATIS O5.1: Specifications and Dimensions (for Wood Poles).

E. American Wood Preserver's Association Standard (AWPA):

1. AWPA C4: Poles - Preservative Treatment by Pressure Processes; American Wood

F. Institute of Electrical and Electronics Engineers (IEEE):

1. C62.41.1: IEEE Guide on the Surges Environment in Low-Voltage (1000V and Less) AC Power Circuits
2. C62.41.2: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits
3. C136.20: Roadway Lighting Equipment - Fiber-Reinforced Plastic (FRP) Lighting Poles

G. National Electrical Manufacturers Association (NEMA):

1. NEMA C136.13: For Roadway and Area Lighting Equipment – Metal Brackets for Wood Poles

H. National Fire Protection Association (NFPA):

1. NFPA 70: National Electrical Code (NEC).

I. Underwriters' Laboratories, Inc. (UL):

1. 773: UL Standard for Safety Plug-In Locking Type Photocontrols for Use with Area Lighting-Fourth Edition
2. 844: UL Standard for Safety Luminaires for Use in Hazardous (Classified) Locations-Twelfth Edition
3. 1029: Standard for Safety High Intensity Discharge Lamp Ballasts.
4. 1598: UL Standard for Safety Luminaires

1.3 DEFINITIONS

A. Fixture: Complete lighting device. Fixtures include lamp or lamps and parts required to distribute light, position and protect lamps, and connect lamps to power supply.

B. Lighting Unit: Fixture or assembly of fixtures with common support, including pole or bracket plus mounting and support accessories.

C. Luminaire: Fixture.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Submit shop drawings and manufacturer's product data in accordance with the requirements of Section 26 05 10: Electrical Work - General.

C. Submit manufacturer's shop drawings including photometric laboratory test data to show that luminaires proposed are of same type, construction and quality as those indicated. Luminaires are to be listed and labeled by Underwriters' Laboratories.

D. Submit manufacturer's data for each ballast provided. Include detailed information for each luminaire showing wattage, voltage, and full load amp draw for each.

E. Submit photometric calculations based on maintained lighting foot candle levels for areas where lighting fixtures are substituted. Substituted fixtures must provide similar lighting performance and energy usage as those scheduled, and must be constructed of similar quality and materials.

F. Product Data:

1. Describe fixtures, lamps, ballasts, poles, and accessories. Arrange Product Data for fixtures in order of fixture designation. Include data on features, poles, accessories, finishes, and following:

a. Outline drawings indicating dimensions and principal features of fixtures and poles.
b. Electrical Ratings and Photometric Data: Certified results of laboratory tests for fixtures and lamps.

G. Shop Drawings:

1. Wiring diagrams detailing wiring for control system showing both factory installed and field installed wiring for specific system of this Project and differentiating between factory installed and field installed wiring.
2. Anchor Bolt Templates: Keyed to specific poles and certified by manufacturer.

H. Operating and Maintenance Data (O&M): Maintenance data for products to include operation and maintenance information.

1.5 QUALITY ASSURANCE

A. Comply with IEEE C2.

B. Items provided under this section shall be listed or labeled labelled by UL or other Nationally Recognized Testing Laboratory (NRTL).

1. Term "NRTL" shall be as defined in OSHA Regulation 1910.7.
2. Terms "listed" and "labeled" shall be as defined in National Electrical Code (NEC), Article 100.

C. Regulatory Requirements:

1. National Electrical Code (NEC): Components and installation shall comply with National Fire Protection Association (NFPA) 70.

1.6 STORAGE AND HANDLING OF POLES

A. Store poles on decay resistant treated skids at least 12 inches (300 mm) above grade and vegetation. Support pole to prevent distortion and arrange to provide free air circulation.

B. before pole installation. Handle poles with web fabric straps.

C. Metal Poles: Retain factory applied pole wrappings until just before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

PART 2 PRODUCTS

2.1 FIXTURES AND FIXTURE COMPONENTS:

A. Metal Parts: Free from burrs, sharp edges, and corners.

B. Sheet Metal Components: Corrosion resistant aluminum, except as otherwise indicated. Form and support to prevent warping and sagging.

C. Housings: Rigidly formed, weather and light tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed fixtures.

D. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position. Provide for door removal for cleaning or replacing lens. Arrange for door opening to disconnect ballast.

E. Exposed Hardware Material: Stainless steel.

F. Reflecting Surfaces: Minimum reflectances as follows, except as otherwise indicated:

1. White Surfaces: 85 percent
2. Specular Surfaces: 83 percent
3. Diffusing Specular Surfaces: 75 percent

G. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

H. Lenses and Refractors: Materials as indicated. Use heat and aging resistant, resilient gaskets to seal and cushion lens and refractor mounting in fixture doors.

2.2 LAMPS

A. Furnish lamps of types and wattages shown in luminaire schedule.

2.3 LED FIXTURES

A. Provide fixtures on the Design Lights Consortium (DLC) Qualified Products List.

B. Thermal Management: Liquids or other moving parts shall be clearly indicated in submittals, and shall be consistent with product testing.

C. Color Rendering Index (CRI): >70.

D. Correlated Color Temperature: 4000K.

E. Minimum luminaire efficacies: 85 lumens per watt. Nominal input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

F. Fully enclosed wiring and LED diodes enclosed to prevent penetration of dust, insects, and other debris into the lamp and driver compartment.

G. Driver/LED combined system shall have rated life based on IESNA LM-80-2008 (or latest) of 50,000 hrs at 70 percent lumen maintenance.

H. Driver is high efficiency type with THD < 20 percent and power factor > 0.90.

I. Outdoor fixtures capable of reliable operation in temperature range of -30 degrees C to +40 degrees C minimum.

2.4 FIXTURE SUPPORT COMPONENTS:

A. Pole Mounted Fixtures: Conform to AASHTO LTS-6.

B. Wind load strength of total support assembly, including pole, arms, appurtenances, base, and anchorage, is adequate to carry itself plus fixtures indicated at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of 100 mi./h (160 km/h) with gust factor of 1.3.

C. Arm, Bracket, and Tenon Mount Materials: Match poles' finish.

D. Mountings, Fastenings, and Appurtenances: Corrosion resistant items compatible with support components. Use materials that will not cause galvanic action at contact points. Use mountings that correctly position luminaire to provide indicated light distribution.

E. Pole Shafts: Square, straight.

F. Pole Bases: Embedded type with underground cable entry.

G. Aluminum Poles: ASTM B429/B429M, 6063-T6 alloy. Provide access handhole in pole wall.

H. Concrete for Pole Foundations:

1. Use 3000 psig (20 MPa) strength, 28 day concrete.

2.5 FINISHES:

A. Metal Parts: Manufacturer's standard finish, except as otherwise indicated, applied over corrosion resistant primer, free of streaks, runs, holidays, stains, blisters, and similar defects.

B. Other Parts: Manufacturer's standard finish, except as otherwise indicated.

PART 3 EXECUTION

3.1 INSTALLATION

A. Set units plumb, square, level, and secure according to manufacturer's written instructions and accepted submittals.

B. Pole Installation: Use web fabric slings (not chain or cable) to raise and set poles.

C. Fixture Attachment with Adjustable Features or Aiming: Attach fixtures and supports to allow aiming for indicated light distribution.

D. Lamp fixtures with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

3.2 GROUNDING:

A. Ground fixtures and metal poles according to Section 26 05 26: Grounding and Bonding for Electrical Systems.

1. Poles: Install 10 feet (3 m) driven ground rod at each pole.
2. Nonmetallic Poles: Ground metallic components of lighting unit and foundations. Connect fixtures to grounding system with No. 6 AWG conductor.

3.3 FIELD QUALITY CONTROL:

A. Inspect each installed unit for damage. Replace damaged fixtures and components.

B. Tests and Observations:

1. Give advance notice of dates and times for field tests.
2. Provide instruments to make and record test results.
3. Replace or repair damaged and malfunctioning units, make necessary adjustments, and retest. Repeat procedure until units operate properly.

3.4 ADJUSTING AND CLEANING:

A. Clean units after installation. Use methods and materials recommended by manufacturer.

END OF SECTION

SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of all surface debris, grass, trees, and shrubs from the disturbance limits indicated on the Drawings, and as required to perform the Work.

B. The general work areas which require site clearing may include, but are not limited to:

1. Excavation and foundation areas for new construction.
2. Contractor staging and stockpile areas.
3. Borrow Areas.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Clearing and Grubbing Plan:

1. Describe method for vegetation removal and disposal.
2. Describe temporary barriers and methods to protect existing structures and property, existing plant life and features designated to remain, and areas beyond limits of disturbance as identified on the Drawings.
3. Plan shall include delineations for Type A and Type B Clearing and Grubbing

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 PROTECTION

A. Protect and preserve in place all trees, plants, grassland, structures, and areas that are specifically designated on the Drawings as wetlands (if not directly impacted by new features) or otherwise to be preserved or are not required to be removed for the performance of the Work. See also Section 01 35 43: Environmental Procedures.

B. Verify with the Engineer the area to be cleared and existing plant life and features designated to remain or be protected before initiating any clearing operations in that area.

C. Unauthorized clearing will not be approved for payment, and the Contractor is responsible for replacement of damaged existing plant life and features designated to remain.

D. Flag, barricade, and clearly mark existing plant life, environmentally sensitive areas, and features designated to remain. Maintain fencing and flagging in good condition for the duration of the Work.

E. Conduct clearing and grubbing operations in a manner that will preserve and protect vegetation beyond the limits of clearing and grubbing. Protect any trees, plant growth, and site features not designated for removal or designated for protection. Remove only those trees and plant growth required for the Work.

F. Do not disturb trees or shrubbery in public right-of-way or on property outside of the limits of disturbance shown on the Drawings.

3.2 CLEARING AND GRUBBING

A. Remove all trees, shrubs, undergrowth, deadwood, and other surface debris as required to perform the Work, within the limits of disturbance shown on the Drawings, except for those trees and shrubs designated to be protected.

B. Clear and grub only the areas to be disturbed by proposed facilities and grading: excavations, embankments, structures, slabs, and roadways.

C. Remove all trees, stumps, branches, brush, and other material from clearing and grubbing activities. Cut tree trunks and branches into 10-foot maximum lengths and stockpile in staging and stockpile areas designated on the Drawings.

D. Do not leave logs, stumps, rocks, etc., lying in the public right-of-way or on adjacent property without written approval by the Engineer.

3.3 DAMAGED VEGETATION

A. The Contractor is responsible for injuries to vegetation caused by Contractor operations, personnel, or equipment. Remove and replace damaged vegetation designated for protection with vegetation of same type and size at no additional cost to the Owner.

3.4 PLACEMENT AND DISPOSAL

A. Dispose of excess vegetative materials and debris materials in accordance with all applicable rules and laws and in accordance with the requirements of Section 01 74 19: Construction Waste Management and Disposal.

3.5 MAINTENANCE OF CLEARED AREAS

A. Maintain cleared Work areas in a condition free from additional vegetation growth for the duration of the Project.

B. Follow site Noxious Weed Control Program when applicable regarding the use of herbicides.

C. Compensation for clearing each area will occur only one time. If weeds and brush growth require additional clearing, this shall be performed solely at the Contractor's expense.

END OF SECTION

SECTION 31 14 13
TOPSOIL STRIPPING, STOCKPILING, AND PLACEMENT

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes stripping non-wetland and wetland topsoil from selected areas within the project disturbance limits; use of existing topsoil stockpiles; testing chemical attributes of existing in-place and stockpiled topsoil sources to determine suitability for topsoil use in planting areas; stockpiling and segregating stripped topsoil, placing topsoil in seeding and planting areas; and testing placed topsoil to determine amendment/fertilizer application rates.

B. Seedbed and planting area preparation including fertilizer/amendment application is covered in Sections 31 14 13: Native Seeding and Section 32 96 10: Native Planting.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1. ASDM D4972 Standard Test Methods for pH of Soils
2. ASTM D5268 Standard Specification for Topsoil Used for Landscaping and Construction Purposes.

1.3 DEFINITIONS

A. Direct Use Topsoil: Topsoil sourced from the site that can be placed as topsoil, outside of wetland areas as shown on the Drawings, without prior amendment.

B. Indirect Use Topsoil: Topsoil sourced from the site that must be amended prior to placement as topsoil outside of wetland areas as shown on the Drawings,

C. Wetland Topsoil: Topsoil sourced from existing wetland areas and placed to create new wetland Zones as shown on the Drawings.

D. Tubifex Contaminated Topsoil: Soil within the limits of the existing reservoir area that is considered contaminated with Tubifex worms is only permitted for use at the new wetland located within the reservoir, in Zone 4 and Zone 6 and can be buried beneath the topsoil to be placed as part of the channel construction.

E. Unsuitable Topsoil: Existing in-place or stockpiled topsoil not meeting the specified requirements.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Proposed Topsoil Management Plan at least 14 calendar days prior to performing any topsoil stripping. Plan to include:

1. Plan to conduct screening testing of topsoil sources
2. Equipment and methods to pothole and stake topsoil stripping areas.
3. Plan to sample and test site topsoil before use.

4. Equipment and methods to excavate, strip and stockpile topsoil including plans to minimize time to place wetlands topsoil.
5. Methods to preserve wetland topsoil seed bank preservation.
6. Methods to ensure Tubifex Contaminated Topsoil is properly managed and placed in the allowed zones or buried.
7. Methods and equipment to prepare subgrade for topsoil placement.
8. Site plans showing stockpiled topsoil of the following types: Direct Use, Indirect Use, Wetland, Tubifex Contaminated, and Unsuitable topsoil designated for fill as applicable.
9. Topsoil Material Balance Diagram showing topsoil materials and quantities from source through stockpiling and final placement.

C. Total available quantities for each type of topsoil based on potholing, and planned distribution and thickness to be placed in seeding and planting areas.

D. Proposed independent topsoil testing laboratory qualifications.

E. Chemical Attributes test results.

F. Fertilizers and Amendments

1. Guaranteed chemical analysis, name, trade name, trademark, and conformance to state law.

G. Soil Nutrient analysis test results and proposed amendment/fertilizer recommendations including application rates.

H. Methods, equipment, materials, conditioning time and sequencing for pH amendment.

1.5 COORDINATION

A. Coordinate with Engineer and provide equipment and labor to sample existing topsoil sources pothole and stake topsoil stripping areas with stripping depths and limits.

1.6 QUALITY ASSURANCE

A. Topsoil Testing Laboratory: Independent commercial testing facility with minimum 10 years' experience testing topsoil for the specified properties.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver soil amendments and fertilizers to the site in the original, unopened containers bearing the manufacturer's chemical analysis or separate chemical analysis certification accompanying bulk deliveries.

PART 2 PRODUCTS

2.1 GENERAL

A. Unless otherwise approved, source topsoil from within project disturbance limits and from existing topsoil stockpiles as shown on the Drawings.

B. Keep each type of topsoil stockpiles separate and identify clearly with signs and submit drawings. Take special care with stockpiled Tubifex Contaminated Topsoil to make sure it does not contaminate other topsoil stockpiles or areas where it is prohibited.

C. Do not use any topsoil until acceptable analysis results have been submitted, and the Engineer has approved it for use, with or without amendment.

D. Unamended Topsoil: Topsoil to be used on the project shall be tested in-place and in stockpiles and meet the chemical attributes in Table 31 14 13-1 unless otherwise approved.

Table 31 14 13-1
Topsoil Chemical Attributes

Chemical Attribute	Acceptable Range
pH	6.8 - 7.5
Organic Matter	>1%
Salinity	EC≤2 mmhos/cm

E. Nutrient Amended Topsoil: Nutrient testing shall determine the quantities and type of soil amendments required to meet local growing conditions for the seed species.

2.2 DIRECT USE TOPSOIL

A. Unless otherwise determined by the Engineer, direct use topsoil to be stripped from the site is the near surface friable loamy soil that has supported vegetation, contains organic matter with an in-place pH ≥6.0 and ≤7.5, salinity EC≤2 mmhos/cm and organic material >1%.

B. Direct use topsoil may also include existing stockpiled topsoil contained in the existing waste piles downstream from the existing dam.

C. Free from objects larger than 6 inches maximum dimension including hard clods of heavy clay, shale, decomposed shale or other subsoil, rocks, noxious weed parts (roots, seeds, or shoots), grass, refuse, stumps, roots, brush, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

D. Remove roots larger than 6 inch, and rocks larger than 6 inches prior to stockpiling. Do not include subsoil, noxious weed seed or reproductive vegetation plants, heavy clay, hard clods, toxic substances, or other material which would be detrimental to plant growth in stockpiled topsoil.

2.3 INDIRECT USE TOPSOIL

A. Unless otherwise determined by the Engineer, indirect use topsoil to be stripped from the site is the near surface friable loamy soil that has supported vegetation, contains organic matter with an in-place pH ≥5.7 and <6.0, salinity EC≤2 mmhos/cm and organic material >1%.

B. Indirect use topsoil may also include existing stockpiled topsoil contained in the existing waste piles downstream from the existing dam.

C. Free from objects larger than 6 inches maximum dimension including hard clods of heavy clay, shale, decomposed shale or other subsoil, rocks, noxious weed parts (roots, seeds, or shoots), grass, refuse, stumps, roots, brush, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

D. Remove roots larger than 6 inch, and rocks larger than 6 inches prior to stockpiling. Do not include subsoil, noxious weed seed or reproductive vegetation plants, heavy clay, hard

clods, toxic substances, or other material which would be detrimental to plant growth in stockpiled topsoil.

2.4 WETLAND TOPSOIL

A. Wetland topsoil material shall consist of moist organic soil, including any existing delineated wetland vegetation and seeds obtained from existing wetlands disturbance areas shown to be disturbed by the Work on the Drawings.

2.5 AMENDMENTS AND FERTILIZERS

A. All fertilizer shall be a standard commercial product of uniform composition, free flowing and conforming to applicable State and Federal laws and free of cyanamide compounds.

B. Amendments and fertilizer types shall be based on specified nutrient analysis conducted on topsoil and as approved by Engineer.

PART 3 EXECUTION

3.1 PREPARATION

A. Complete clearing and grubbing in existing non-wetland areas in accordance with Section 31 11 00: Clearing and Grubbing before stripping topsoil. Cut or mow grassed areas and remove excessive vegetation.

B. Salvage topsoil prior to beginning excavating, fill or hauling in a manner that will facilitate measurement, minimize sediment loss from runoff and/or erosion, and not obstruct natural drainage.

3.2 SALVAGING, STOCKPILING, AND PLACING TOPSOIL

A. General

1. Protect stockpiled topsoil from sediment transport with surface roughening, watering, and perimeter silt fencing or other approved means.
2. Stockpile topsoil in staging and stockpile areas shown on the Drawings or as approved in the contractors work plan. Stockpile topsoil from wetland areas, non-wetland areas, and Tubifex Contaminated Topsoil (from the existing reservoir) separately and keep all topsoil stockpiles separate from other stockpiled materials.
3. Any topsoil stockpile remaining longer than 30 days post construction season shall be seeded with an approved seed mixture.
4. Do not exceed 10 feet height for stockpiled topsoil unless otherwise approved.
5. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or in conditions otherwise detrimental to the Work.
6. Place topsoil directly on graded and prepared subgrade whenever conditions and progress of construction permit.
7. Prior to final placement of topsoil, loosen areas compacted by construction activities by repeated ripping in rows 12 inches or less apart, in opposite directions to a depth of 12 inches as approved.
8. Roughen uncompacted topsoil subgrade areas with furrows spaced 4 to 6 inches deep to key the topsoil into the subsoil.
9. Spread topsoil evenly at the calculated average depth required to meet grades and elevations shown on Drawings.

B. Wetland Topsoil

1. Excavate wetland topsoil material from areas shown on the Drawings to be disturbed by the Work and as approved by Engineer to a typical depth of approximately 18 inches, unless otherwise determined with potholing.
2. To the extent practical, place wetlands topsoil directly or within 24 hours in the wetland relocation site.
3. If wetlands topsoil can be placed directly, sequence work to prepare wetland relocation sites to the lines and grades shown on the Drawings or as approved by Engineer prior to excavating the wetlands topsoil.
4. Where the Engineer determines immediate relocation or relocation within 24 hours is not possible, wetland topsoil may be stockpiled in an approved area, and remain undisturbed until the relocation site has been prepared.
5. Protect wetland topsoil stockpiles using approved methods that preserve the wetland seed bank. Maintaining soil moisture is critical.
6. Minimize storage time with wetland topsoil.
7. Place wetland topsoil material over graded and prepared subgrade in wetland areas to a minimum depth of 6 inches unless specified otherwise on the Drawings, unless otherwise determined with potholing.
8. After the wetland topsoil is spread, remove all large stiff clods, rocks, roots and other detrimental foreign matter and debris as approved by the Engineer.

C. Topsoil – Direct Use

1. Excavate topsoil from either disturbed areas or stockpiles.
2. Amend soils with lime according to pH test recommendations so it meets the range in Table 31 14 13-1.
3. Place topsoil material over graded and prepared subgrade in areas to a minimum depth of 6 inches unless specified or shown otherwise on the Drawings, unless otherwise determined with potholing.
4. After the topsoil is spread the surface shall contain less than 15% rock, large clods or root material as approved by the Engineer. Remove detrimental foreign matter and debris as approved by the Engineer.

D. Topsoil – Indirect Use

1. Excavate topsoil from either disturbed areas or stockpiles.
2. Amend soils with lime according to pH test recommendations.
3. Re-test topsoil and demonstrate that the pH $\geq$6.0 and $\leq$7.5, salinity EC$\leq$2 mmhos/cm and organic material >1% prior to placement. Once placed, Indirect Use topsoil is subject to the same requirements as Direct Use topsoil and must be amended. If the re-test of the topsoil demonstrates that it meets with the requirements in Table 31 14 13-1, it can be placed as topsoil and requires no further amendment.
4. Place topsoil material over graded and prepared subgrade in areas to a minimum depth of 6 inches unless specified or shown otherwise on the Drawings, unless otherwise determined with potholing.
5. After the topsoil is spread the surface shall contain less than 15% rock, large clods or root material as approved by the Engineer. Remove detrimental foreign matter and debris as approved by the Engineer.

E. Tubifex Contaminated Topsoil

1. Excavate tubifex contaminated topsoil material from within the existing reservoir area and as approved by Engineer to a typical depth of approximately 6 to 12 inches, unless otherwise determined with potholing.
2. Place tubifex contaminated topsoil material over graded and prepared subgrade in Planting Zones 4 and 6 and at the new wetland located within the reconfigured reservoir.
3. In order to minimize the spread of Tubifex contaminated soil the contractor shall clean all equipment prior to crossing moving water transporting or moving topsoil known to have Tubifex contaminated soils. Remove all mud and debris from equipment (tracks, turrets, buckets, drags, teeth, etc) with a high-pressure water rinse in an area approved by the Engineer and where wash water can be properly controlled and not spread contamination.

F. Unsuitable Topsoil:

1. Topsoil not within the specified range of topsoil chemical attribute ranges can be incorporated into channel grading fill, or reservoir wetland fill, below topsoil and is subject to the same restrictions for area placement as Tubifex Contaminated Topsoil.

3.3 FIELD QUALITY CONTROL

A. Existing Topsoil Chemical Attributes Screening: Test existing in-place and stockpiled topsoil in accordance with the test methods in ASTM D 5268 and ASTM D 4972 to determine suitability for use as topsoil based on the Chemical Attributes specified in Part 2 of this Section. Sample collection on site shall be based on a submitted and approved sampling plan with a grid and random selection to sample at a minimum frequency of one test per 200 cubic yards. This testing is only intended to determine suitability of the topsoil for use.

END OF SECTION

SECTION 31 19 00
BORROW AREAS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sources of materials for dam construction and fill placement from onsite and offsite sources.

B. General requirements for borrow areas and for processing of materials from borrow areas.

1.2 FINE GRAINED BORROW AREA USE RESTRICTIONS

A. Fine Grained Borrow Area as shown on the Drawings is not to be utilized between March 1st and June 1st.

B. Disturbance of Fine Grained Borrow Area is not permitted until it is confirmed, by survey undertaken by the Engineer, that there is no Sage Grouse nesting and Sage Grouse Leks present at the borrow area.

C. Nighttime activity at the Fine Grained Borrow Area is not permitted to limit sound and light pollution that may impact roosting Sage Grouse. Nighttime activity is defined as being between 7pm and 6am Mountain Daylight Time (MDT) and 6pm to 7am Mountain Standard Time (MST).

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1.	ASTM C 117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
2.	ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
3.	ASTM D 75	Standard Practice for Sampling Aggregates.

1.4 DEFINITIONS

A. Potential On-site Borrow Materials:

1. Potential onsite borrow materials include materials excavated from borrow areas designated on the Drawings and required excavations. These borrow areas include those to the north or Highway 40 as shown on Drawing G-04.
2. Locations of previous geotechnical explorations at the site and in the borrow areas are shown on the Drawings and in the Windy Gap Geotechnical Data Report (AECOM 2021).
3. Some processing may be required to produce material meeting the specifications. The Contractor is fully responsible for determining the amount of processing that will be required to use onsite or imported materials in fill areas.

B. Material processing:

1. Material processing for the purpose of these specification is intended to include the required handling to produce a material suitable for use as any material defined in Part 2. Such handling includes:

a. Sorting of suitable material for fill from waste material.
b. Producing material to a suitable particle size distribution by crushing and screening or by manual methods, such as rock raking, or screening through a grizzly.
c. Conditioning material to the proper/near proper moisture content.

2. The identification of 'Processed Material' excludes pit-run borrow that does not require special or multiple handling to remove oversized particles or to moisture condition prior to placement in the designated fill area.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Material Balance Diagram

1. Drawing showing the plan for managing materials from all sources to placement clearly labeled with quantities and shrinkage, bulking, and waste factors.

C. Borrow Area Development Plan for each borrow area and material type. Identify all material sources and include the proposed methods for obtaining, processing, and stockpiling borrow area materials to produce materials meeting the Specifications. The Plan shall address the following issues:

1. Proposed stockpile areas for pre and post processed materials.
2. Method and rate of moisture conditioning, including drying and wetting.
3. Method of excavation and material handling, including proposed equipment and production rates of excavation.
4. Material mixing plan.
5. Sequence of excavation.
6. Proposed haul roads, and traffic safety plan, (i.e., signage, speed limits, crossings, and traffic control).
7. Noise monitoring plan.
8. Dust control.
9. Drainage, surface water, and erosion control.
10. Safety and security.

D. Information on rock processing plant(s) for rock including.

1. Plant configuration.
2. Lists of major equipment, including physical size, manufacturer, model number, and horsepower. Include proposed equipment such as crushers, feeders, grizzly feeders, vibrating screens, material classification equipment, and weigh scales.
3. Equipment specifications, including operational characteristics, maintenance frequency, and any other manufacturer data or equipment history.
4. Two copies of manufacturer's brochures for each piece of major equipment.

1.6 QUALITY CONTROL AND QUALITY ASSURANCE TESTING

A. The Contractor is responsible for Quality Control (QC) testing of materials after processing and before placement. The Engineer may conduct Quality Assurance (QA) testing to check conformance with material specifications. Where any non-conformance is revealed, further testing will be requested from the Contractor. The Contractor will be responsible for corrective

measures, to the extent of complete replacement of material, until conformance is achieved, and for all costs for QA retests because of failing tests.

PART 2 PRODUCTS

2.1 MATERIALS

A. Dam Fill: Fill obtained from required excavations, approved onsite borrow areas, or approved offsite sources meeting the specified requirements.

B. CRCC Fill: Fill obtained from required excavations, approved onsite borrow areas, or approved offsite sources meeting the specified requirements.

C. Structural Fill: Fill obtained from an approved offsite borrow source or commercial supplier that meets the specified requirements

D. Riprap Bedding: Fill obtained from an approved offsite source or commercial supplier or screened rock obtained from site excavations that meet the specified requirements.

E. Riprap: Fill obtained from an approved offsite source or commercial supplier or screened rock obtained from site excavations that meet the specified requirements.

PART 3 EXECUTION

3.1 GENERAL

A. Clear, grub, and strip the portions of quarries and borrow areas in accordance with Section 31 11 00: Clearing and Grubbing.

B. Conduct stockpile and process operations without damaging or removing existing structures or substructures not designated for demolition on the Drawings.

C. Dispose of excess and unsuitable materials derived from borrow area operations in accordance with Section 15 74 19: Construction Waste Management and Disposal.

D. Moisture condition borrow material to the required moisture content for its use prior to placement in the designated fill areas.

E. In addition to the Contractor's required quality control testing, the Engineer will observe, sample, and perform QA field and laboratory tests on the materials from borrow areas on a periodic basis. Provide access for the Engineer to areas where observation, sampling, and testing is to be performed and schedule construction operations to avoid interference with the sampling and testing operations.

3.2 SOIL PROCESSING AND STOCKPILING

A. Unless otherwise approved, moisture condition and stockpile processed materials before placement and test to confirm the suitability of the material use in the designated fill area(s).

B. Do not allow equipment to contaminate the stockpiles or stockpile areas with mud, leaking oil, hydraulic fluid, or other contaminants.

C. Place a two-foot layer of the same material as is being stockpiled under stockpiles. Perform stockpiling in such a manner as to minimize segregation.

D. Maintain sufficient stockpiles of processed materials to support at least 3 days of construction requirements in the event of planned or unplanned interruptions in material processing, including the operation of crushing and screening plants.

3.3 MATERIAL ACCEPTANCE

A. Final fill material acceptance will be based on test results of materials in-place, after compaction, in accordance with applicable Specifications.

3.4 ON-SITE BORROW AREA DEMOBILIZATION AND CLEAN-UP

A. At the end of onsite borrow area operations, remove all equipment, including rock processing plant(s) and equipment, lighting, temporary fencing, and water removal and drainage systems. Stabilize excavation slopes as shown on the Drawings or as approved.

B. Grade borrow, processing, and stockpile areas in a manner that provides stable slopes, and if located outside the reservoir limits, acceptable distributed drainage, and blends into surrounding areas. Revegetate such borrow, processing, and stockpile areas in accordance with Section 32 92 19 Native Seedings. Revegetation will not be required in the reservoir borrow area below the normal pool elevation.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Subgrade preparation for the dam foundation and appurtenant structures.

1.2 DEFINITIONS

A. Complete Coverage: Successive passes by a piece of equipment with sufficient overlap to ensure all areas of a subgrade or foundation have been subjected to the equipment loads.

B. Proof-Rolling: Testing of soil subgrade with approved equipment and methods to detect soft or loose subgrade or unsuitable material and identify the areas that would not support future loading without excessive settlement and require rework.

C. Subgrade: Excavated and approved foundation surface for fill, concrete, or other material placement except as otherwise specified.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Equipment and methods for proof rolling, subgrade preparation, moisture conditioning and compaction. Submit as part of the with the comprehensive earthwork plan required in Section 35 73 10: Dam Embankment.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Complete excavation to grade and cross-section shown on the Drawings or otherwise approved by the Engineer.

B. Do not proceed with subgrade preparation until the Engineer has approved the excavation, including removal of objectional materials.

C. Dewater foundation areas in accordance with Section 31 23 19: Dewatering before preparing foundation.

D. Notify the Engineer as soon as possible of any unusual soil conditions, soil conditions that vary from test borings, or soils of questionable strength or bearing capacity.

E. For areas identified by the Engineer as unsuitable foundation, remove the material to the depths and limits established by the Engineer. Replace removed material with suitable compacted fill material placed per these specifications and to the required elevations. Areas will not be deemed unsuitable because of inadequate dewatering.

F. Prepare subgrades unfrozen and free of ice, snow, soft areas or boils as determined by the Engineer.

G. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

H. Protect prepared subgrade from excessive traffic to avoid creating instability and pumping. If instability is created by traffic, repair subgrade as determined by the Engineer.

I. Maintain prepared foundation surface in finished condition until overlying material is placed.

3.2 MOISTURE CONDITIONING AND COMPACTION

A. Scarify to depth of 6 inches, moisture condition, and uniformly compact surface. Subgrade scarifying may be eliminated or reduced if the subgrade can be moisture conditioned, compacted, and stabilized with an alternative method as approved by the Engineer. Where scarification is required, moisture condition in accordance with the following:

1. Dry Subgrade: Scarify, add water, then mix to uniform moisture content throughout by blading, discing or harrowing.
2. Wet Subgrade: Scarify, aerate material by blading, discing, harrowing, or other methods, to promote drying process.

B. Compact with at least 4 coverages of an approved vibratory roller as specified for dam fill in Section 35 73 10: Dam Embankment.

3.3 PROOF ROLLING

A. Proof-rolling is intended to apply equipment loads over the entire subgrade surface to detect latent areas where removal and reworking to a depth greater than 6 inches may be necessary, and if compaction efforts are complete in all areas.

B. Proof rolling may be done with one of the following methods:

1. Two complete coverages with the tires of a full loaded minimum 12-cubic yard end dump truck, or fully loaded minimum 3,000 gallon water wagon.
2. Four complete coverages of approved compaction equipment.
3. Equipment producing equivalent ground pressure as determined by the Engineer.

C. Coordinate with the Engineer to identify and mark areas requiring rework.

D. Excavate soft/yielding subgrade as determined by the Engineer and replace with the appropriate compacted new fill material.

3.4 QUALITY CONTROL

A. Notify Engineer 24 hours before subgrade is ready for compaction or proof-rolling or when compaction or proof-rolling is resumed after period of extended inactivity.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes specifications for excavations as shown on the Drawings:

B. Work not included in this section:

1. Work associated with clearing and grubbing and stripping and stockpiling topsoil and are not considered excavation and shall be performed in accordance with Section 31 11 00: Clearing and Grubbing and 31 14 13: Topsoil Stripping, Stockpiling, and Placement.

C. No blasting is allowed for excavations.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Submit proposed excavation plan at least 14 calendar days prior to performing any excavations. Proposed excavation plan shall include: proposed excavation method(s) to be used; proposed excavation slopes, trench shields, bracing or other methods of construction to complete the Work safely; proposed excavation equipment; and proposed excavation sequence. Combine the excavation plan submittal in the Earthwork Plan required in Section 35 73 10: Dam Embankment.

1.3 SAFETY AND PROTECTION

A. Comply with all OSHA safety requirements for excavations.

B. Protect existing survey monuments, and other existing structures and facilities to remain.

C. Repair damage caused by the Contractors activities to existing structures and facilities at no cost to the Owner and to the satisfaction of the Engineer.

1.4 EXISTING SITE CONDITIONS

A. Use equipment and methods appropriate for site conditions.

B. Field and laboratory investigations cannot be relied on to accurately characterize all conditions that may exist in the foundations and that may be encountered during construction. Therefore, final excavated lines and grades will be determined in the field by the Engineer.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL EXCAVATION REQUIREMENTS

A. Identify required excavation lines, levels, contours, and datum, as shown on the Drawings.

B. Notify local One-Call or equivalent utility location service to locate underground utilities prior to excavating in accordance with local regulations and requirements. Protect buried and overhead utilities and existing structures during excavation. Repair any utilities or existing structures damaged during construction at no additional cost to the Owner.

C. Excavate to the lines and grades as shown on the Drawings unless otherwise determined by the Engineer.

D. Repair damage to the Work caused by the Contractor's operations including disturbance of the material beyond the required excavation at no additional cost to the Owner. Make repairs in accordance with this Section as directed by the Engineer, and at no additional cost to the Owner.

E. Assume all responsibility for deductions and conclusions as to the nature of the materials to be excavated and the difficulties of making and maintaining the required excavations.

F. The Engineer reserves the right, during the progress of the Work, to vary the slopes, grades, or the dimensions of the excavations from those specified herein. Where the Engineer determines that foundation material is unsuitable through no fault of the Contractor, additional excavation will be ordered in writing and payment will be made in accordance with the applicable provisions of the Contract Documents

G. Take all necessary precautions to preserve the material below and beyond the established lines of all excavation. Any damage to the Work or the prepared foundations due to the Contractor's operations shall be repaired as determined by the Engineer.

H. Unless authorized in writing by the Engineer, all excavations shall be in the dry.

I. Do not excavate in frozen materials, except with written approval of the Engineer.

J. Side slopes of all earth excavations shall be no steeper than that shown on the Drawings. In all cases, excavations shall conform to all safety requirements of OSHA.

K. Notify the Engineer as soon as possible of any unusual soil and rock conditions, soil and rock conditions that vary from test holes, or soil or rock of questionable stability or bearing capacity.

L. Dispose of excavated materials which are excess or deemed unsuitable. Dispose of unsuitable/excess excavated materials in accordance with Section 01 74 19: Construction Waste Management and Disposal.

M. Do not waste any excavated material without the approval of the Engineer.

N. Excavated material will not be judged “unsuitable” due to moisture content alone.

O. If slumping, heaving, or any other evidence of instability is observed during excavation, immediately report evidence of instability to the Engineer, whether it is observed during working or non-working hours.

P. Be prepared to temporarily backfill any unstable excavation to stabilize the area, as determined by the Engineer.

3.2 EXCAVATED MATERIAL SUITABLE FOR FILL

A. Stockpile excavated materials that are acceptable for use as fill materials. Suitability of excavated material shall be based on specified material requirements.

B. Transport excavated materials suitable for use as fill to designated (or mutually agreeable) stockpile areas.

C. Condition and re-use suitable materials from required excavations in the permanent construction as determined by the Engineer.

D. Perform operations so that the excavations will yield as much suitable material for construction purposes as practicable.

E. Separate suitable materials for construction purposes from materials to be wasted as part of excavation and loading operations; and minimize handling by placing suitable materials directly in the designated final locations, if possible and as approved by the Engineer.

F. Sequence excavation and conditioning of materials suitable for fill with direct placement of fill to the extent practical and as approved by the Engineer.

3.3 GENERAL FOUNDATION EXCAVATION

A. Excavate foundations to final grade using procedures that do not disturb the subgrade. Backfill over excavation due to the Contractor's operations as directed by the Engineer at no additional cost to the Owner.

B. Should the excavation be carried below the lines and grades specified on the Drawings or should the bottom of the rock excavation be disturbed because of the Contractor's operations, refill to the proper elevation with backfill concrete in accordance with Section 03 30 00: Cast-In-Place Concrete, at no additional cost to the Owner.

C. For areas identified by the Engineer as unsuitable foundation in soil areas, remove this material to the depths established by the Engineer, and refill the excavation to the proper elevation with appropriate compacted dam fill material meeting the requirements in Section 35 73 10: Dam Embankment as approved by the Engineer.

D. Structure foundations – Excavate the bottom and side slopes of soil excavations upon or against which concrete will be placed to the required dimensions as shown on the drawings or as required by OSHA. Do not allow material from incomplete excavations to extend within the neat lines of concrete structures.

3.4 FIELD QUALITY CONTROL

A. Prepare dam foundations and structure foundations to receive concrete in accordance with Section: 31 23 13 Subgrade Preparation. The Engineer will conduct visual inspections of excavation bottoms and foundation subgrades. The Engineer will accept

suitable subgrades in writing. Excavate and backfill soft or yielding areas as approved by the Engineer.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

A. Provide all material, equipment, and labor to install and maintain all pumps, piping, drains, well points, wells, and other facilities required to effectively control, collect, and dispose of groundwater or surface water to permit safe and proper completion of the Work in the dry. Use appropriate equipment and methods for dewatering based on existing site conditions.

B. Provide observation wells as necessary to verify satisfactory performance of the dewatering system.

C. Maintain the foundations and other portions of the Work free from water as required for constructing each part of the Work.

D. Comply with all applicable environmental protection laws and requirements in operation of the dewatering system.

E. Remove all components of the dewatering system after it is no longer required.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Dewatering Plan: Submit a Dewatering Plan prepared by a qualified dewatering specialist, with at least 10 years of experience in design, installation, and operation of dewatering installations. The Dewatering Plan shall be prepared by a Licensed Professional Engineer registered in the State of the project where dewatering occurs, and include the following:

1. Details regarding the anticipated types and locations of various dewatering facilities, proposed number and locations of observation wells, and design calculations required substantiating the Dewatering Plan.
2. Superintendence plan and schedule, indicating who will be responsible for observing the dewatering system and the proposed schedule describing when personnel will be on site to observe and maintain the system.
3. Proposed locations, depths, and construction details of observation wells. Data from these wells shall be used as appropriate, along with other available information, to modify dewatering requirements.
4. Coordination with other work including schedule, dewatering and diversion methods and operations, erosion and sediment control measures, equipment, and location and elevation of pumps, pipes, and any other features planned for use in the dewatering plan
5. Final recommendations for dewatering.
6. If the Contractor purchases, rents, installs, or mobilizes to the site any elements of the dewatering system before approval of the dewatering submittal, the Contractor does so at its own risk, and will not be due any additional compensation from the Owner if such elements are not subsequently used for the work.

7. Approval of the dewatering system proposed by the Contractor will only be with respect to the basic principles of the methods the Contractor intends to employ. Approval does not relieve the Contractor of full responsibility for adequacy of the dewatering system.

1.3 DEFINITIONS

A. Dewatering: Removing water by single or multiple stage wellpoints, deep wells, ejector wells or sumps, as approved based on the Contractor's submittals.

B. Hydrostatic Groundwater Level: The groundwater level at any location during construction and before dewatering.

C. Observation Well: Temporary well to observe dewatering system performance during construction.

D. Sump: A depression excavated or constructed, from which water is pumped as part of dewatering.

1.4 AVAILABLE DATA

A. It is the Contractor's responsibility to evaluate and verify conditions at the project site with respect to dewatering and diversion facilities. Verify that the Work and property upstream, downstream, and adjacent to the Work will not be damaged by water quality protection, erosion and sediment control, and dewatering operations and facilities.

B. Refer to Section 02 32 00: Geotechnical Investigations for geotechnical boring logs, laboratory test data, and other data regarding subsurface conditions and groundwater.

C. The Contractor may refer to the provided logs but is required to draw its own conclusions as to the applicability of the information contained therein. The Contractor may choose to perform additional investigations to develop their dewatering plan. It is the Contractor's responsibility to evaluate site subsurface conditions with respect to required dewatering facilities.

D. The subsurface conditions and groundwater observations from the test pits and borings apply only to the locations of the test pits and borings and at the time of the explorations and measurements. The subsurface conditions at the site may be different at the time of construction as compared to when observations were made and recorded, and the groundwater level can be expected to fluctuate. These factors should be appropriately considered in developing the Contractor's Dewatering Plan.

1.5 QUALITY ASSURANCE AND QUALITY CONTROL

A. Dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

PART 2 PRODUCTS

2.1 DEWATERING SYSTEM

A. The dewatering system shall be single- or multiple-stage wellpoints, deep wells, ejector wells, or sumps used for dewatering and which fulfill the dewatering requirements

specified in this Section. The materials and construction of the dewatering wells will be selected by the Contractor and the Contractors' dewatering specialist.

2.2 OBSERVATION WELLS

A. Install observation wells within the excavation limits at the locations and depths indicated in the approved Dewatering Plan. Install functional observation wells before initiation of dewatering activities and excavation.

B. Unless otherwise approved, provide observation wells in accordance with the following criteria

1. Well Length: Locate bottom of wells at least 10 feet below the bottom of the required excavation.
2. Well Casing: 2-inch-diameter, Schedule 40, PVC pipe installed in a drilled hole.
3. Slot Size and Spacing: Maximum 0.02 inch width manufacturer fabricated slots, spaced at 1/4 inch center-to-center along three separate rows for the entire length of the slotted section. Slot at least 5 feet of the pipe bottom, and slot to within 3 feet of the surface.
4. Plug pipe bottom with a PVC cap or plug and provide removable cap at top.
5. Surround the entire slotted section of the pipe with a minimum 1/2-inch-thick annular zone of 10-20 silica sand or equivalent.
6. Install a bentonite and concrete seal from the top of the well to a depth of 3 feet to prevent infiltration of surface water into the wells.
7. Construct observation wells so the risers can be removed incrementally as excavation work progresses.
8. Test observation wells by adding or removing water from the well risers and subsequently monitoring the stabilization of the water levels in the wells to demonstrate that observation wells are functioning properly before taking water level readings.

PART 3 EXECUTION

3.1 GENERAL

A. Design, furnish, install, maintain, and operate a dewatering system that prevents loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottom of excavations so that every phase of the work can be performed in the dry. Operate dewatering systems such that excavation bottoms are firm, suitably dry, and free from standing water at all times. Provide the number of observations wells as approved in the Dewatering Plan.

B. Verify lowering of the groundwater level a minimum of 2 feet below the excavation bottom by observation well readings before commencement of excavation below the hydrostatic groundwater level.

C. Locate elements of the dewatering system such that interference with excavation and construction activity is minimized. Locations are subject to approval by the Engineer.

D. At all times during construction, provide ample means and devices to remove promptly, and dispose of properly, all water entering excavations and keep the bottoms of excavations firm and free of standing water until structures to be built thereon are completed and/or backfill to be placed therein is placed. Conduct pumping and

dewatering operations such that no disturbance to foundation subgrade materials or to fill materials supporting any other work will result. Discharged water shall be piped to an approved area.

E. Install silt barriers or other discharge control measures at dewatering discharge locations, to control and prevent siltation. Provide suitable discharge controls in accordance with applicable federal, state, and local permit regulations, and Section 01 57 13: Temporary Erosion and Sediment Control. Do not allow dewatering discharge to cause siltation or other negative environmental impact on natural waterways or other property.

3.2 INSTALLATION AND OPERATION

A. Before any excavation deeper than 2 feet above the hydrostatic groundwater level, operate the dewatering system to lower water levels as required and then operate continuously 24 hours per day, 7 days per week until all facilities and structures affected by the dewatering have been satisfactorily constructed, including placement of fill materials to an elevation at least 2 feet above the hydrostatic groundwater level.

B. Maintain groundwater levels low enough to fulfill the requirements of this Section and do not allow the water level to rise until constructed facilities are complete, so that the water can be allowed to rise without damaging facilities, their foundations, or surrounding areas and structures.

C. Provide superintendence in accordance with the approved plan during all periods of dewatering. Superintendence means providing qualified Contractor personnel knowledgeable in operation and maintenance of dewatering system(s). The Contractor is responsible for any damage resulting from failure to maintain the dewatering system.

D. Provide complete standby equipment and power sources available for immediate operation as may be required, to adequately maintain the dewatering on a continuous basis in the event that all or any part of the dewatering system becomes inadequate or fails. Provide an automatic switchover system to the standby power source to ensure uninterrupted power supply to pumps in an emergency. Spare pumps shall be automatically engaged if primary pumps fail for any reason.

E. When the dewatering system does not meet the specified requirements, and as a consequence, loosening or disturbance of the foundations strata, instability of the slopes, or damage to the foundations or structures occurs, the Contractor is responsible for supplying all materials and labor and performing all work for restoring foundation soils, slopes, foundations, and structures, to the satisfaction of the Engineer, and at no additional cost to the Owner.

F. When failure to provide adequate dewatering and drainage causes disturbance of the soils below design foundation or excavation grade, provide adequate dewatering and excavate and re-fill the disturbed areas with approved, properly compacted fill material. Such work shall be at the Contractor's expense and at no additional cost to the Owner.

3.3 REMOVAL

A. Obtain written approval from the Engineer before discontinuing operation of any portion of the dewatering system(s).

B. Remove all elements of the dewatering system(s) and observation wells from the site at the completion of dewatering work.

C. Abandon observation wells by removing casing and backfilling holes with approved cement grout.

END OF SECTION

SECTION 31 23 30
ROADWAY EXCAVATION AND FILL

1.1 SECTION INCLUDES

A. New access road construction as shown on the Drawings. Work includes excavation, fill placement and compaction, and drainage features.

1.2 DEFINITIONS

A. Coverage: One coverage is defined as the result of successive passes by a piece of compaction equipment, which by means of sufficient overlap, will ensure that all areas of the layer or lift being compacted have been subjected to one pass of the compaction equipment.

B. Lift: Loose (uncompacted) layer of material.

C. Road Fill: Materials used for constructing road embankments within the travel lane, for the overflow spillway embankment and under drainage ditches as shown on the Drawings.

D. Suitable Material: Material from required excavations that meets the specification requirements for use in road fill on the project and is free of unsuitable materials as defined herein.

E. Unsuitable Materials: Materials that contain waste, debris, roots, organic matter, frozen matter, or any other materials determined by the Owner to not meet the specifications for Road Fill.

F. Well-Graded: A mixture of particle sizes that has no specific concentration, or lack of particles, of one or more sizes. A material type that, when compacted, produces a fill with a minimum of voids.

1.3 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1.	ASTM C 117	Standard Test Method for Materials finer than 7-μ (No. 200) Sieve in Mineral Aggregates by Washing
2.	ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3.	ASTM D 698	Standard Specification for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
4.	ASTM D 6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil- Aggregate by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

PART 2 PRODUCTS

2.1 ROAD FILL

A. Well graded suitable fill material with a maximum particle size of 8 inches.

2.2 AGGREGATE BASE COURSE:

A. Well-graded blended composite of natural crushed stone or gravel complying with material requirements of CDOT Section 703.03 and Table 703-2 for Class 4 Base Course.

Table 31 23 30-1

Aggregate Base Course Gradation Band

Sieve Size	Percent Passing by Weight
2 inch	100
1-1/2 inch	90-100
3/4 inch	50-90
No. 4	30-50
No. 200	3-12

2.3 COMPACTION EQUIPMENT

A. In accordance with Section 35 73 10: Dam Embankment

PART 3 EXECUTION

3.1 PREPARATION

A. Stake the road alignment centerline in accordance with Section 01 71 23: Layout of Work and Surveying

B. After staking, inspect the road alignment with the Owner to determine if there are any physical impediments to road construction including structures, features or plant life to be protected.

C. Verify existing plant life and features designated to remain with the Owner before initiating any clearing or excavation operations in that area. Remove only plant life required for the Work.

D. Verify locations of buried underground utilities and overhead utilities prior to excavations with Owner and Utilities as required. Immediately notify the Owner if underground utilities or other unexpected underground structures are encountered.

E. Protect existing site improvements from damage during construction.

F. Restore damaged improvements to their original condition, as acceptable to the Owner.

3.2 GENERAL ROAD EXCAVATION REQUIREMENTS

A. Identify required excavation lines, levels, contours, and datum, as shown on the Drawings.

B. Excavate road to the lines and grades as shown on the Drawings in accordance with Section 31 23 16: Excavation and this Section.

C. Excavate road back slopes no steeper than that shown on the Drawings. Clean and scale cut slopes above the road to remove all material that would pose a hazard.

D. Notify the Owner of any soil conditions that are detrimental to road construction.

3.3 GENERAL ROAD CONSTRUCTION

A. Bring the roadway to the required grade and cross section by back sloping, ditching, removing stones and boulders from the roadbed surface, and any other work necessary, including hauling suitable excess material outside the road section for use as fill on other parts of the road or project.

B. Perform operations so that the excavations will yield as much acceptable material for fill and road surfacing material as practicable.

C. During roadway construction, maintain roadway, ditches, and channels in a well-drained condition at all times by keeping the excavation areas and embankments sloped to the approximate section of the ultimate earth grade. Perform blading or leveling operations when placing fill and during the process of excavation.

D. Construct drainage inlets, outlets, and intercepting ditches, dikes, and channels where shown on the Drawings and as approved by the Owner. Maintain drainage inlets, outlets, and intercepting ditches, dikes, and channels to the required Section until acceptance. Perform the Work in proper sequence with other Work to provide adequate drainage and to minimize erosion and siltation.

3.4 FILL PLACEMENT

A. Prepare areas to receive road fill by clearing vegetation and stripping topsoil if present.

B. Prepare excavated road foundations for fill placement in accordance with Section 31 23 13: Subgrade Preparation. Coordinate and schedule final foundation preparation operations with the rate of road construction.

C. Place fill only on accepted foundation surfaces.

D. Transport, handle and stockpile fill materials to avoid segregation and contamination. Fill materials that are segregated or contaminated, either in stockpile or in-place in the embankments, will be rejected by the Engineer.

E. Remove all unsuitable and rejected materials and replace them with suitable material.

F. Dump and spread Aggregate Base Course materials in level, continuous, approximately horizontal lifts that do not exceed 8 inches in thickness before compaction.

G. Aggregate Base Course Placement and Compaction:

1. Dump and spread Aggregate Base Course in level, continuous, approximately horizontal lifts that do not exceed 8 inches in thickness before compaction.
2. Moisture condition fill to a condition near optimum as approved by the Engineer.
3. Compact with a minimum of 4 passes with an approved 12 ton roller.

H. Road Fill Placement and Compaction:

1. Dump and spread Road Fill in level, continuous, approximately horizontal lifts that do not exceed 12 inches in thickness before compaction.
2. Moisture condition fill to a condition near optimum as approved by the Engineer.
3. Compact with a minimum of 4 passes with an approved 12 ton roller.

3.5 SPECIAL COMPACTION

A. Special compaction is required within 3 feet laterally of all structures, and in tight, restricted, or steep areas not accessible by larger rollers, and within 2 feet of pipes. The intent of the zones of special compaction is to prevent damage to structures or pipes from compaction equipment loads.

B. Place specially compacted fill in accordance with fill requirement except for the following:

1. Maximum particle size of 2 inches.
2. Compact in maximum 6-inch thick loose lifts.
3. Compaction equipment used in special compaction areas shall be small rollers, walk-behind sheep's-foot rollers, vibratory plates, or other small compactors appropriate for the material and as approved by the Engineer. No equipment may be used which by its weight or movement will damage, move, or tilt out of alignment any part of the pipe or structure above, adjacent, or below the ground surface.

3.6 FIELD QUALITY CONTROL

A. Give advance notice of at least 48 hours to Engineer for the following:

1. Before commencement of foundations proof-rolling.
2. Before commencement of placement and compaction of fill.
3. Before sampling or testing fill materials.

B. Specified QC testing is the responsibility of the Contractor and shall be performed by qualified, approved personnel and by a qualified, approved commercial testing laboratory/firm, subject to approval by the Engineer.

C. The final acceptance or rejection of the fill will be based on the Engineer's judgment considering test results and the general disposition of the fill.

D. If the fill is rejected, remove and replace rejected material at no cost to Owner.

E. Conduct testing using the approved independent testing firm at the minimum frequencies specified.

F. Unless otherwise approved, the Engineer will select the locations of testing. All testing and sampling locations are subject to Engineer approval. When observations indicate proper moisture conditioning and compaction are not being followed, or if there is a

pattern of failing tests, the Engineer reserves the right to increase the specified testing frequency. Such additional testing shall be at no cost to the Owner.

G. The Engineer may retain its own quality assurance laboratory for material testing services. The Contractor shall provide equipment and labor to assist the Engineer in any quality assurance testing and in obtaining soil samples. The Contractor shall cooperate in every way with this effort.

Table 31 23 30-2

Road Fill Quality Control Laboratory and Field Testing

Material	Test Type	Test Method	Minimum Testing Frequency
Road Fill	Gradation	ASTM C 117 And C 136	2 Per Source
Aggregate Base Course	Gradation	ASTM C 117 And C 136	2 Per Source
	Atterberg Limits	ASTM D4318	2 Per Source

END OF SECTION

SECTION 31 37 00
RIPRAP AND BOULDERS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Screening, sorting, and processing of riprap from imported offsite sources, or processed from onsite sources to meet the specified gradation.

B. Furnishing boulders in the sizes specified and shown on the Drawings.

C. Placing riprap at the locations shown on the Drawings.

D. Furnishing and placing riprap bedding at the locations shown on the Drawings.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. List of equipment proposed for use in hauling and placing riprap and riprap bedding.

C. Proposed source(s) of riprap, riprap bedding, and boulders.

D. Certified copies of test certificates from a qualified testing laboratory stating that the riprap, boulders, and riprap bedding conforms to the requirements of this Section.

E. Samples of each type of riprap, boulders, and riprap bedding if requested by the Engineer. Minimum sample size: 1 ton for riprap, and 50 pounds for riprap bedding.

F. Proposed plan and list of equipment for screening, sorting, stockpiling, and processing existing on-site riprap.

1.3 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1.	ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
2.	ASTM C 127	Test Method for Specific Gravity and Absorption of Coarse Aggregate.
3.	ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
4.	ASTM C 531	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
5.	ASTM D 5519	Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials

B. American Association of State Highway and Transportation Officials (AASHTO)

1.	AASHTO T103	Standard Method of Test for Soundness of Aggregates by Freezing and Thawing

C. Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, 2005.

PART 2 PRODUCTS

2.1 RIPRAP

A. Riprap: Dense, angular, reasonably well-graded rock material, and with sound fragments resistant to abrasion. Free of cracks, seams, clay, organic material, and other defects that would hasten degradation by water and/or frost action. Rounded boulders or cobbles are not acceptable as riprap.

B. Sources for riprap include the riprap rock material removed from the existing dam slope, commercial suppliers, and rock approved by the Engineer from an approved borrow source that complying with this Section specifications.

C. Screen, sort, and process riprap obtained from Site excavations to create mixtures of material that are graded to meet the specified riprap grading. Placed graded material in separate stockpiles and obtain the Engineer's approval before placing.

D. Riprap material shall meet the following properties:

1. Bulk specific gravity (saturated surface dry) shall be equal or greater than 2.5, and absorption <1.0% as determined in accordance with ASTM C 127.
2. The weight loss of the material as tested under ASTM C 88 for 5 cycle sodium sulfate soundness shall be 10% or less.
3. The weight loss of the material when tested for resistance to abrasion in accordance with ASTM C 531 shall be not more than 40% after 1000 revolutions.
4. The weight loss of the material when tested for resistance to disintegration by freezing and thawing in accordance with AASHTO T 103 shall be 5% or less.
5. Neither the breadth nor thickness of any piece of riprap shall be less than one-third of its length.

E. Riprap shall be well-graded, from the smallest to the largest size, and shall be graded within the limits in Table 31 37 00-1 below for the riprap D_{50} size shown on the Drawings.

Table 31 37 00-1
Riprap Gradation

D_{50} Size[1] (Inches)	% Of Total Wt Smaller Than Given Size[2]	Typical Stone Dimensions[3] (Inches)	Typical Stone Weight[4] (Pounds)
6	70-100	12	85
	50-70	9	35
	35-50	6	10
	2-10	2	0.4
9	70-100	15	160

	50-70	12	85
	35-50	9	35
	2-10	3	1.3
12	70-100	21	440
	50-70	18	275
	35-50	12	85
	2-10	4	3
18	70-100	30	1280
	50-70	24	650
	35-50	18	275
	2-10	6	10
24	100	42	3500
	0-70	33	1700
	35-50	24	650
	2-10	9	35

[1] D_{50} = nominal stone size
[2] based on typical rock mass
[3] equivalent spherical diameter
[4] based on a specific gravity = 2.5

2.2 SOIL RIPRAP

A. Where called for on Drawings, mix rock meeting the specified riprap requirements with topsoil in a proportion of 65% riprap and 35% topsoil to create a uniform mixture of soil and riprap without voids.

B. Topsoil shall meet the requirements in Section 31 14 13 Topsoil Stripping, Stockpiling and Placement. Coordinate with the Engineer to select suitable topsoil for the soil riprap mixture.

2.3 RIPRAP BEDDING

A. Riprap bedding shall be a free draining, well graded natural or crushed sand and gravel mixture. Import riprap bedding from approved off-site sources.

B. The weight loss of the material when tested for resistance to abrasion in accordance with ASTM C 531 shall be not more than 40% after 1000 revolutions.

C. Provide material graded within the following limits:

Table 31 37 00-2
6-inch and 12-inch D_{50} Riprap Bedding Grading Limits

US Standard Sieve Size	Percent Passing by Weight
3-inch	90 – 100
1-inch	55 - 80
3/8-inch	20 - 45
#4	0 - 25

Table 31 37 00-3
18-inch D_{50} Riprap Bedding Grading Limits

US Standard Sieve Size	Percent Passing by Weight
3-inch	100
2.5-inch	100 - 90
2-inch	70 - 35
1.5-inch	0 - 15
3/4-inch	0 - 5

2.4 BOULDERS

A. Furnish boulders complying with the specified material properties for riprap except that size is to be selected by the nominal size shown on the Drawings and in accordance with the requirements in Table 31 37 01-1. Boulders are subject to Engineer approval for the intended use and location.

Table 31 37 00-3
Boulder Size Requirements

Nominal Size (inches)	Range in Smallest Dimension of Individual Rock Boulders (inches)	Maximum Ratio of Largest to Smallest Rock Dimension of Individual Boulders
24	20-28	1.5
30	26-34	1.5
36	32-40	1.5
42	38-46	1.5
48	44-52	1.5

PART 3 EXECUTION

3.1 PLACING RIPRAP BEDDING

A. Place riprap bedding at the locations, thicknesses, lines, and grades shown on the Drawings.

B. Prepare surfaces to receive bedding materials smooth and firm, free from deleterious materials, and to the lines and grades shown on the Drawings.

C. Prepare the surfaces by rolling and trimming as necessary to enable a uniform lift of bedding of the specified thickness to be placed thereon. Surface preparation includes, bringing all low spots up to the lines and grades shown on the Drawings with compacted fill and removing all material projecting above subgrade lines and grades shown on the Drawings.

D. Place the bedding materials in a manner that minimizes segregation and results in uniform lifts of bedding materials of the thicknesses shown on the Drawings. Place riprap bedding materials from the bottom of the slope working up the slope.

E. Moisture condition the materials as necessary to control dust and to minimize segregation.

F. Compaction is not required for the bedding materials; however, bedding materials shall be spread in such a manner as to form a smooth, uniform layer under bedding and riprap.

G. Grade surface of bedding free from irregularities and to a tolerance of ±0.2 foot from established grade.

3.2 PLACING RIPRAP

A. Place riprap at the locations, thicknesses, lines, and grades shown on the Drawings.

B. If riprap is shown to be installed on geotextile, limit drop height to three feet or less as necessary to prevent damage to geotextile. Repair damage in accordance with Section 31 05 19: Geotextile.

C. Place riprap by dumping and working with a hydraulic excavator and smoothed by moving rocks in such a manner as to produce a well-graded mass of rock with a minimum practical percentage of voids and that the material, when in place, is stable.

D. Place riprap from the bottom of the slope working up the slope.

E. The finished riprap shall be free from objectionable pockets of unacceptable soil fines, small stones, and clusters of nested large rocks, as determined by the Engineer.

F. Place riprap materials to full layer thickness in one operation in such a manner as to minimize segregation and avoid displacement of underlying bedding materials.

G. Chinking: Provide laborers during placement for rearrangement of loose rock fragments, "chinking" of void spaces, and hand placement as needed to comply with the requirement of a well-keyed and stable layer of rock riprap.

3.3 SOIL RIPRAP

A. Create adjacent stockpiles of riprap and topsoil in the specified proportions and mix at the stockpile location, not at the location where soil riprap is to be placed.

B. Coordinate and select topsoil material with the Engineer and use moisture and control procedures that ensure a homogenous mixture such that the soil fills the inherent voids in the riprap without displacing riprap.

C. Consolidate the mixture with suitable vibratory equipment, backhoe bucket, or other suitable means as approved by the Engineer to create a tight, dense interlocking mass.

D. Add water in a controlled manner to encourage void filling with soil.

E. Fill remaining large voids with rock and small voids with soil.

F. Do not create thick zones of soil prone to washing away (for example, no thicknesses greater than 6 inches).

G. Thoroughly wet the final surface for good compaction, smooth and compact with suitable equipment; hand rake surface to receive planting or seeding.

3.4 BOULDER PLACEMENT PREPARATION

A. Prepare surfaces to receive boulders in a stable condition, free from deleterious materials.

B. Determine subgrade and finished grades for boulders from the height of each boulder used.

C. Excavate in accordance with 31 23 16: Excavation to the lines and grades shown on the Drawings. Remove unstable material encountered and replace with compacted fill. Unstable material removal required due to dewatering or water control inadequacy will not be paid for.

D. Compact subgrade to 95% of Maximum Standard Proctor Density (ASTM D698) in accordance with Section 31 23 13: Subgrade Preparation unless otherwise approved by the Engineer.

E. Place boulders at the locations in conformance with the details shown on the Drawings, and as determined by the Engineer.

F. Place boulders on subgrade without granular bedding or riprap unless otherwise approved by Engineer. Do not support boulders with any other material to meet design grade; appropriate boulder dimension is required.

G. Compact backfill behind boulders without disturbing and/or damaging the integrity of the boulder channel edge.

3.5 BOULDERS

A. Position top of all boulders as shown on the Drawings.

B. Carefully select and arrange boulders so that adjacent rock surfaces match within 2 inches in top elevation and 2 inches along the vertical exposed face or channel side of rock unless otherwise approved by the Engineer.

C. Place boulders such that adjacent boulders are 1-1/2 to 3-1/2 inches away and voids do not exceed 4 inches to allow grout to penetrate and lock boulders. Minimize voids and grout placed between boulders to the extent practical as approved by the Engineer.

D. If necessary, support the boulders from falling over before and during the placement of grout, backfill,and completing compaction on either side of the boulder.

E. Smaller rocks may be used to chinked in and fill voids behind the boulders and gaps largerthan 4 inches.

3.6 TESTING

A. Testing specified for the material requirements of riprap and riprap bedding shall be conducted by the Contractor's independent testing laboratory. The Engineer may require additional testing if it appears the material quality or grading has changed.

B. A minimum one test for each of the following tests will be required for riprap and boulders.

1. Bulk Specific Gravity and Absorption: ASTM C 127.
2. Sodium Sulfate Soundness: ASTM C 88.
3. LA Abrasion: ASTM C 531.
4. Freeze/Thaw: AASHTO T 103.
5. Gradation ASTM D5519:

C. A minimum one test for each of the following tests will be required for riprap bedding.

1. LA Abrasion: ASTM C 531.
2. Gradation ASTM C 136:

D. Riprap or boulders obtained onsite and accepted by the Engineer will not require testing for physical properties before use.

E. Test placements of riprap and riprap bedding (with a minimum volume of 50 cubic yards each) shall be prepared by the Contractor and observed by the Engineer to develop a procedure for placement of riprap and riprap bedding, and to confirm the placement methods result in suitably placed riprap and riprap bedding.

F. Provide all equipment, materials, and labor to conduct large scale gradation tests in accordance with ASTM D5519. Conduct one test for each type of riprap at the start of work. If tests fail, conduct additional tests until accepted by the Engineer.

G. After initial testing, control of riprap gradation will primarily be by visual inspection. The Engineer will be the sole judge of riprap gradation acceptability by visual inspection.

END OF SECTION

SECTION 31 52 00
COFFERDAMS AND STREAM DIVERSION

PART 1 GENERAL

1.1 SUMMARY

A. This Section specifies requirements for designing and providing cofferdams and stream diversion during construction.

1.2 RESPONSIBILITY FOR DESIGN

A. The Contractor has full responsibility for planning, design, installation, and monitoring of cofferdam and diversion systems. Acceptance by the Owner and/or Engineer shall not relieve the Contractor of full responsibility for the adequacy of the systems including responsibility for repairing any damage to adjacent property, foundations, permanent structures, pipelines and utilities, or damage to any part of the Work caused by failure or inadequacy of any part of the system.

B. Basic flood hydrology, historical stream flow, inflows, required downstream flows, and other data applicable to the site are presented in: Windy Gap Basis of Design Report (AECOM 2021) and other referenced reports associated with hydrology and the CRCC design.

C. The data, facilities, and equipment discussed in these specifications are for information only and their use will not relieve the Contractor of full responsibility for the adequacy, safety, and maintenance of the cofferdam and diversion systems and for the repair of any damage occurring to the Work as a result of flooding caused by any and all stream flows. Work specified in this Section shall be performed by an individual or firm of established reputation in the design of cofferdams.

D. Assign a registered Professional Engineer responsible for stream diversion design including cofferdams with at least 5 years experience in the design of cofferdams and stream diversion systems.

1.3 MINIMUM LEVEL OF PROTECTION

A. The minimum level of protection required for the project is the inflow flood with a recurrence interval of at least 1 in 10-year-event or as approved by the Engineer. The Contractor may elect to reduce their risk by selecting a greater level of protection.

1.4 DIVERSION REQUIREMENTS

A. General

1. Design diversion and sediment control facilities to divert water around the construction area, or convey through the area in a controlled manner, and to control the quality of water leaving the construction area from diversion, dewatering and Contractor operations.
2. The methods of diverting and controlling stream flows including designs and implementation are fully the responsibility of the Contractor.
3. Design temporary cofferdams, diversion pipes, temporary diversion channels, and pumping facilities to divert stream flows to minimize seepage and provide adequate slope stability.

4. Construct all diversion and erosion control facilities to protect facilities from erosion or damage.
5. Construct facilities as needed to maintain water quality from diversion, drainage, dewatering and all construction activities in compliance with the NPDES and other applicable permits.
6. Approvals: The Contractor's design, including computations, schedule of operation, and Drawings shall be submitted to the Engineer for approval. After the system is in operation, the Engineer will monitor progress of the construction to confirm the timing when the system can be safely removed and will provide written notice to the Contractor that it can be removed.

1.5 COFFERDAM DESIGN

A. Design cofferdams to meet the following criteria:

1. Meet or exceed the minimum level of protection.
2. Maintain flow rate into excavations not exceeding a flow rate that can be handled in accordance with Section 31 23 19: Dewatering to conduct Work in the dry.
3. Withstand all soil and hydrostatic loadings that might occur during the various stages of construction and for any surcharge loading. The diversion designer is responsible for determination of proper load distributions caused by such conditions, and the installer shall assure that those conditions are not exceeded in the field during construction. The designer shall make a determination of the lateral earth and water pressures and surcharge loads that could result from the installer's methods and dewatering activities and shall design cofferdams for those pressures and loads. Design of the cofferdam shall also consider the installers sequence of excavation and placement of any lateral support elements.
4. Meet all applicable OSHA regulations, and all applicable federal, state, and local regulations.
5. Prevent damage to other existing or proposed adjacent properties, buildings, structures, utilities, and other work.

1.6 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Diversion plan at least 30 calendar days prior to constructing stream diversion.

C. The diversion plan shall contain, as a minimum, the following information:

1. Design of temporary cofferdams, showing embankment material description, embankment slopes, crest width, crest elevations, seepage control provisions, embankment fill gradations, and embankment placement procedure.
2. Design of diversion pipes and pumping, including pipe material and equipment specifications, fittings, excavation plan and sections for the pipe, thrust blocks, and other necessary connections.
3. Design of temporary diversion channels, including location of channel, channel slope and length, channel width, side slopes, and backfill materials and backfilling procedures.
4. Plan for diversion to protect the Work without violating water quality permit requirements.
5. Proposed installation and removal procedures and construction sequence.

D. Name(s), qualifications, resumes, and references of proposed cofferdam designer.

E. Design calculations demonstrating that the cofferdam system meets the design criteria specified herein. All design calculations shall be stamped by a Professional Engineer registered in the State of Colorado. The design calculations shall include, as a minimum:

1. An evaluation of the existing ground conditions to determine the basis for excavation support.
2. A list of all assumptions, criteria, and stress values used for all excavation support materials.
3. A list of references substantiating all design assumptions, criteria, and stress values used.
4. A list of all calculation methods used, including references of all calculation methods.
5. An analysis of all design loads, including earth and hydrostatic pressures, and any anticipated live loads.
6. An analysis of seepage stability uplift, and bottom heave of the excavation.

F. Approval by the Engineer of the cofferdam proposed by the Contractor will only be with respect to the basic principles of the methods and procedures the Contractor intends to employ. Approval by the Engineer does not relieve the Contractor of the full responsibility for the cofferdam system design.

1.7 PROJECT/SITE CONDITIONS

A. Contractor's designated on-site water pollution control specialist shall monitor water quality conditions, including the following:

1. Ensure all water quality protection and erosion control facilities are designed, constructed, and maintained to avoid water quality standards violations.
2. Ensure that any sediment problems including, but not limited to, those associated with borrow excavation, construction of temporary construction roads, and stockpiling, are promptly corrected and their impacts mitigated.
3. Monitor and modify construction practices, as necessary, to protect water quality.

B. The Contractor shall be responsible for compliance with all permit conditions and shall be responsible for any water quality violations, penalties, fines, and work suspensions resulting from construction activities.

1.8 MAINTENANCE

A. Maintain all diversion, water quality protection and erosion control facilities as needed to meet specification and permit requirements.

B. Maintain diversion channels, cofferdams, gates, pipes, sedimentation check dams, sedimentation dikes, drains, pumps, and/or other temporary diversions and protection works to prevent surface water from entering excavations, foundation areas, and other portions of the Work intended to be performed in the dry.

C. Maintain trash racks and pipe openings at the inlets free from debris.

D. Repair any damage resulting from diversion operations at no cost to the Owner.

1.9 MAINTAINING DAM SAFETY AND PUBLIC SAFETY

A. Most of the work is planned to be performed with the reservoir drained. However, depending on inflows and outflows, reservoir water surfaces may rise or fall during construction. Proper diversion and construction sequencing is essential to construction, to the safety of the dam, and to public safety. Improper diversion by the Contractor may endanger the safety of the workers, the Work, and the safety of the dam. Failure of the dam may result in both loss of life and property damage.

PART 2 PRODUCTS

2.1 COFFERDAM FILL

A. The Contractor can use Owner identified borrow sources or other sources for the cofferdams. It is the sole responsibility of the Contractor to justify the suitability of the material to be used for the project through materials testing. The material shall be approved by the Engineer for the Project.

PART 3 EXECUTION

3.1 GENERAL

A. Verification of Conditions: Verify that Work and property upstream, downstream, and adjacent to Work will not be damaged by water quality protection, erosion and sediment control diversion operations and facilities.

B. Divert surface water and inflows without causing damage to Work or property upstream, downstream, and areas of Work.

C. Schedule and construct necessary diversion features consistent with provisions outlined herein and the Contractor's needs.

D. Diversion System Facilities: Install the diversion system per the approved plan and modify as needed to comply with specified requirements.

3.2 FIELD QUALITY CONTROL

A. Provide testing and monitoring as required by the National Pollution and National Pollutant Discharge Elimination System (NPDES) permit, and other permits required by these Specifications.

B. Repair at no expense to the Owner any damage to the foundations, structures, adjacent property, or any part of the diversion or protective works.

3.3 REMOVAL

A. At the end of construction, remove the cofferdams, diversion pipes, and other temporary diversion facilities. Timing of the removal of cofferdams, diversion pipes, and other diversion facilities is subject to the approval by the Engineer.

B. Earthen materials used for cofferdam construction that came from the site may be incorporated as fill in available areas of site grading that would not detract from the design intent or may be spoiled by spreading the reservoir as approved by the Engineer.

Dispose of imported materials from diversion facilities in accordance with Section 01 74 19: Construction Waste Management and Disposal.

END OF SECTION

SECTION 31 56 13
SOIL-BENTONITE SLURRY WALLS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Constructing a soil-bentonite slurry trench cutoff wall in the dam embankment as shown on the Drawings including specified design and construction operations.

1.2 REFERENCES

A. American Petroleum Institute (API):

1.	API Spec 13A	Specification for Drilling-Fluid Materials.
2.	API RP 13B-1	Recommended Practice for Field Testing Water-Based Drilling Fluids.

B. American Society for Testing and Materials (ASTM):

1.	ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
2.	ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete.
3.	ASTM D6913	Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
4.	ASTM D1140	Standard Test Method for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing.
5.	ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
6.	ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

1.3 ABBREVIATIONS AND DEFINITIONS

A. Excavation Refusal – The inability to achieve the full depth penetration into the confining stratum across a 10-ft cut with a rock ripping bucket and a large excavator (Komatsu PC 800 or similar) in proper and effective operating condition, after 1 hour of excavation with little or no progress in depth. Upon apparent excavation refusal, excavation effort shall continue for a period of up to 15 minutes in the presence of the Engineer. If the excavation has not progressed 1-foot in depth or achieved the full key depth, in the 15-minute period, the bottom of the trench shall be cleaned, and the excavation shall be considered complete. If a minimum of 1-foot of depth is achieved within 15 minutes excavation refusal has not occurred and normal trench excavation shall continue. Excavation refusal shall be determined with mutual agreement of the Contractor and Engineer.

B. Slurry Trench - A narrow, vertical-walled trench of specified width excavated by the slurry trench method and backfilled with specified materials to form a cutoff wall of low

permeability. The terms “Slurry Trench” and “Slurry Wall” are used interchangeably in these specifications.

C. Slurry Trench Method - A method of excavating a narrow, vertical trench using a slurry mixture to support the trench walls and prevent movement of groundwater or reservoir water into or through the excavated trench.

D. Water-Bentonite Slurry - A stable colloidal suspension of powdered bentonite in water. The terms “slurry” and “bentonite slurry” are used interchangeably in these Specifications.

E. Soil-Bentonite (SB) Backfill - A homogeneous mixture of specified soil material, bentonite, and water. The terms “soil-bentonite backfill” and “backfill” are used interchangeably in these Specifications.

F. Slurry Trench Specialist - An individual employed by the Contractor who has had proven and successful experience in slurry trench construction and is knowledgeable of: (1) the proper methods employed to mix slurry and backfill, (2) the use, testing and control of bentonite as a slurry, (3) construction equipment, (4) excavation and backfill operations, and (5) testing for slurry trench quality control.

G. Work Pad - The work pad is the surface of compacted dam embankment fill which the slurry wall is constructed. The work pad is to be relatively level and stable.

H. Supplemental Fines – The soil that contains a greater percentage of fines content (passing the - #200 sieve or .075 mm in the largest dimension) as compared to the soil excavated from the trench that is added to the excavated soil for the purpose of increasing the overall fines content of the soil-bentonite backfill.

I. Confining Stratum – the geologic unit that identifies the top of the slurry wall key as determined prior to and during construction by the Engineer.

J. Key Depth - The depth to which the slurry trench is excavated into the confining stratum.

K. Set – The segment of the slurry trench that is actively being excavated. Typically, a Set is 20 to 30 feet in length and excavation shall not advance to the next Set until all requirements have been met.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

1. Qualifications of Contractor

a. Evidence including resumes and references that the Contractor or its subcontractor is experienced and competent to construct a soil-bentonite slurry trench. The slurry trench company shall have at least 7 years of prior experience in constructing slurry walls, with at least five SB slurry walls of similar scope and magnitude. The slurry trench company shall have sufficient competent experienced personnel to carry out the operations specified.

1) A slurry trench specialist employed by the Contractor shall supervise the construction, slurry preparation, and Contractor's quality control. The slurry trench specialist shall have at least 3 years of experience and/or three projects in successful construction of slurry walls, with at least two SB slurry walls of similar scope and magnitude.

2) The company name, key contact, and qualifications of independent offsite laboratory shall be submitted. The laboratory will have previous experience with slurry wall backfill materials, experienced laboratory technicians, and flexible wall permeability testing equipment.

2. Work Plan - Detailed operating plan describing the proposed construction equipment, procedures, and schedules. This shall include, but not be limited to plan for:

a. Coordinating the construction, maintenance and removal of work pad and haul roads with other site construction.
b. Equipment set-up and site use layout including storage areas, haul roads and work pad dimensions.
c. Equipment specifications including maximum depth capability of excavator; number and type of backfill mixing equipment; and specifications of slurry mixing and desanding equipment.
d. Procedure for bentonite slurry mixing, transportation, recirculation, desanding and use.
e. Procedure for mixing and placing soil-bentonite backfill, including methods for proportioning specified supplemental fines and additional dry bentonite.
f. Cold weather construction procedures.
g. Procedure for trench excavation and backfilling.
h. Procedure for desanding the in-trench slurry.
i. Material properties, sources, and (manufacturer's) certificates of quality.
j. Water test results.
k. Quantity of supplemental fines required per lineal foot of slurry trench to achieve the specified backfill properties.
l. Control of drainage, spills, wastes, etc.
m. Clean-up, spoils disposal, slurry disposal.
n. Slurry wall construction work scheduled when temperatures are below freezing require an additional section in the Work Plan Submittal detailing cold weather construction procedures.
o. Procedures for Construction Staking and Elevation Control.
p. Procedures for removing oversize particles from the backfill.
q. Procedures for controlling backfill gradation within the specified ranges.
r. Procedures in the event of trench instability and slurry loss.

3. Quality Control Plan

a. Quality Control Plan with details on personnel, responsibilities, inspections, and organization for ensuring the quality of construction required by these Specifications. Include a listing of field lab equipment, test result requirements, minimum testing frequencies test methods for

dry bentonite, mix water, fresh slurry, in-trench slurry, supplemental fines, and soil-bentonite backfill.

4. Bar Chart Schedule and Sequence of Operations

a. Detailed schedule and sequence of operations in a bar chart format. Include a description of the schedule including typical working hours and days, sequence of operations, and maintenance schedule.

B. During Construction - The following reports shall be submitted to the Engineer on a regular schedule during the progress of the work.

1. Reports

a. Daily reports shall be submitted by noon of the day following the date of the report.

2. Soundings and As-Built Profile

a. Daily record of soundings taken during construction including the depth of the trench, key, and backfill slope obtained each morning and evening. Submit as-built profile at the completion of construction.

3. Fresh Bentonite Slurry Mix

a. A record of plant-mixed bentonite slurry quantities, proportions, test results, and admixtures made during construction. Adjustments to the slurry mixture shall be noted.

4. Trench Bentonite Slurry Mix

a. A record of in-trench bentonite slurry test results made during construction. Procedures and admixtures used to modify slurry properties shall be noted.

5. Soil-Bentonite Backfill Mix

a. A record of SB backfill material quantities, properties, and mix adjustments made during construction. Location of sample and number of molded specimens for laboratory testing shall be noted.

6. Supplement Fines Testing – Results of supplemental fines tests performed on borrow sources samples and/or supplemental fines staged along trench.

7. Quality Control Data

a. A record of quality control samples, tests, and test results

PART 2 PRODUCTS

2.1 BENTONITE SLURRY

A. Stable colloidal suspension of bentonite in water complying with the specified requirements in Table 31 56 13-1.

2.2 BENTONITE

A. Pulverized (powder or granular) premium grade sodium-cation montmorillonite complying with the API Standard 13A, Section 9. The yield of the bentonite shall be 90 barrels per ton.

2.3 WATER

A. Fresh water, free of excessive amounts of deleterious substances that adversely affect the properties of the slurry or backfill.

2.4 ADDITIVES

A. Admixtures of the type used in the control of oil-field slurries such as softening agents, dispersants, retarder or plugging or bridging agents may be added to the water or the slurries to permit efficient use of materials and proper workability. Submit justification, admixture information and obtain Engineer approval before use.

2.5 SOIL-BENTONITE BACKFILL

A. The material for trench backfilling shall be composed of fresh slurry, trench slurry, supplemental fines and selected soils obtained from trench spoils. The backfill mix shall contain a minimum of 2 percent dry-added bentonite by dry unit weight of backfill. The backfill shall be free from roots, organic matter, refuse, or other deleterious materials. The backfill shall be thoroughly mixed. Backfill shall meet the following gradation requirements:

Table 31 56 13-1
Soil-Bentonite Backfill Gradation Requirements

Sieve Size	Percent Passing by Weight
6 in.	100
3 in.	95 – 100
2 in.	85 – 100
¾ in.	60 – 100
No. 4	45 – 80
No. 30	25 – 55
No. 200	20 – 30

B. Permeability, slump, and density of the backfill shall comply with the specified requirements in Table 31 56 13-2.

C. Supplemental fines (if used) shall be windrowed along the slurry wall alignment at the rate determined by the Contractor.

2.6 EQUIPMENT

A. Trench Excavation

1. Excavation of the slurry trench cutoff wall shall be accomplished by use of any suitable earth-moving equipment, or combination thereof, such as a backhoe,

clamshell, chisels, and ripper teeth so the trench can be carried to its final depth of cut continuously along the trench alignment. The excavator shall have the capability to excavate at least 10 feet deeper than the maximum depth shown on the Drawings. Special chopping, chiseling or other suitable equipment shall be used as necessary to satisfactorily remove obstructions and accomplish the required excavation. The width of the excavating tool shall be equal to or greater than the specified minimum width of the slurry trench. Additional equipment such as airlift pumps and slurry desanders shall be used to clean the trench-bottom slurry in accordance with the requirements of this Specification. The trench excavation equipment shall be capable of excavating the required key into the confining stratum.

B. Slurry Batching Plant(s)

1. The slurry batching plant shall include the necessary equipment including a high shear mixer capable of producing a colloidal suspension of bentonite in water, pumps, valves, hose, supply lines, and all other equipment as required to adequately supply slurry to the trench and/or the backfill mixing operation. Storage ponds shall be provided to store initially mixed slurry to allow hydration, and to retain a reserve in case substantial slurry loss through underlying pervious zones occurs. All slurry held in storage shall be agitated or recirculated to maintain a homogeneous mix. All slurry for use in the trench or backfill shall be prepared using a suitable mixer. No slurry is to be made by hand or in the trench. Mixing of water and bentonite shall continue until all particles are fully hydrated and the resulting slurry is homogeneous.

C. Backfill Mixing and Placing

1. Equipment for mixing and placing backfill may consist of suitable earthmoving or grading equipment, such as bulldozers, or blade graders or backhoes, or blenders such as a pug mill, that are capable of thoroughly mixing the backfill materials into a homogeneous blend having the required gradation and properties and placing the material in the trench as specified. Soil clods shall be broken to 3-inch maximum size by the backfill preparation equipment and methods employed. Oversize particles shall be removed from the backfill by screening or other approved methods to comply with the specified backfill gradation.

PART 3 EXECUTION

3.1 WORK PAD

A. Construct the work pad in accordance with the Drawings and accepted work plan submittal.

3.2 CONSTRUCTION STAKING

A. Provide, install, and maintain approved staking and survey to locate the centerline of the wall as shown on the Drawings and for elevation references.

3.3 SLURRY TRENCHING

A. Excavation shall proceed continuously from the starting point to the finishing point. Slurry shall be introduced into the trench at the time trenching begins and shall be maintained in the trench during excavation and until backfilled. Maintain the stability of the excavated trench for its full depth. The level of the bentonite slurry shall always be maintained at least 4 feet above groundwater level and shall not be permitted to drop more than 2 feet below the surface of the work pad. The Contractor shall have personnel, equipment, and prepared slurry ready to raise the slurry level at any time. To this end, the Contractor shall have personnel on call as necessary to check the trench levels and to raise the slurry level on weekends and/or holidays. The excavated trench shall have a minimum nominal width of 36 inches.

B. If cracks develop in the construction work pad along and adjacent to the cutoff wall excavation, or slurry loss occurs:

1. Implement emergency procedures as submitted and approved to stabilize the trench.
2. Notify the Engineer.
3. Survey the limits of cracks or caving.
4. Cooperate with the Engineer to evaluate embankment integrity and take additional measures as determined by the Engineer to ensure continued stability of the dam embankment.
5. Conditions such as cracking, caving, or slurry loss will be evaluated by the Engineer to determine if the integrity of the dam embankment has been compromised. The Contractor is responsible for the costs associated with evaluations or investigations to determine integrity of the dam embankment because of cracking, caving, or slurry loss, and costs to restore the integrity of the dam embankment.

3.4 KEY DEPTH

A. Unless otherwise directed, the bottom of the slurry trench will be keyed to a minimum penetration of 6 feet into the confining stratum indicated. If the backhoe or a clamshell is unable to achieve the minimum specified penetration into the confining stratum and has demonstrated Refusal as defined above, the key depth will be modified on a case-by-case basis as approved by the Engineer. The depth to the top of the stratum shall be measured after the stratum has been identified by the Engineer in the excavation spoils. The final depth and key penetration of the trench shall be measured and checked by the Contractor. The Engineer will determine when the excavation has encountered the confining stratum.

3.5 CLEANING TRENCH BOTTOM

A. Upon completion of excavation, any loose material or cuttings shall be removed from the bottom of the trench with the excavation tools or other suitable means accepted by the Engineer before the backfill advances. If the unit weight of the slurry in the trench exceeds the specified limits, or becomes unworkable, the heavy slurry shall be removed from the trench by airlift pump, clamshell, or other methods approved by the Engineer or the excess solids shall be removed from the slurry by settling ponds, screening, or desanding. The trench bottom shall be cleaned of debris and excess sand sediment prior to backfilling. The trench shall be sounded immediately before placing backfill, and soundings shall be compared to the trench-excavation soundings to verify the bottom has

been adequately cleaned. At a minimum, to monitor for cave-ins or excessive settlement, soundings shall be taken each morning and each evening and as specified and compared. The spacing of each sounding shall be 10 feet along centerline.

B. Show to the satisfaction of the Engineer, that the required bottom depth of the cutoff wall trench has been achieved and that the bottom depth is uniform as required (no scallops) for the length of the set and from one set to the next.

3.6 BACKFILL MIXING

A. The backfill shall be mixed on site. If the backfill is mixed beside the trench, the Contractor shall control and provide sufficient equipment and work pad space to support slurry spills, trench stability, stockpiling and mixing equipment operation. Unmixed materials shall not be allowed to fall into the trench. If the backfill is mixed in a remote location, the Contractor shall build and maintain adequate haul roads and the mixing pit or work pad. The mixing pit or work pad shall be lined with compatible soils or other materials to prevent contamination from unsuitable materials. The Contractor is responsible for the quality of the backfill regardless of mixing location.

B. Backfill materials and bentonite may be pre-mixed by mechanical blenders or by windrowing, disk harrowing, bulldozing, blading or by other approved methods. Mixing and blending shall be performed in such a manner as to produce the required gradation of backfill. The backfill material shall be thoroughly mixed into a homogeneous mass, free of large soil clods, lumps or pockets of fines, sand, or gravel.

C. Slurry, dry-added bentonite, trench-excavated soil, and supplemental fines as required shall be mixed until homogeneous, tested for acceptability, and then immediately placed in the trench.

D. The backfill shall be sluiced with bentonite slurry from the trench or fresh bentonite slurry during blending operations. Sluicing with water will not be permitted. Just prior to placing, the backfill material shall have a slump of 3 to 6 inches. The materials shall be sampled and tested for permeability, density, and slump after mixing is complete and before placement.

3.7 BACKFILL PLACEMENT

A. Remove deleterious materials, debris, and oversize particles from the backfill before placement. The backfill shall be placed continuously from the beginning of the trench, in the direction of the excavation, to the end of the trench. The advancing toe of backfill shall be within reach of the trench excavator at all times such that the trench bottom can be cleaned in accordance with specified trench cleaning requirements. Excavation must permit inspection and measurement immediately after completion and prior to backfilling. Placing operations shall proceed in such fashion that the surface of the backfill below the slurry shall follow a reasonably smooth grade and shall not have hollows, which may trap pockets of slurry during subsequent backfilling. Free dropping of backfill material through the slurry will not be permitted. Initial backfill shall be placed by lowering it to the bottom with clamshell bucket or backhoe until the surface of the backfill rises above the surface of the slurry or by lead-in slope. Additional backfill may then be placed in such manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, sufficient backfill shall be piled behind the crest of the existing backfill slope to cause a mud-wave action at

the face of the backfill. The backfill shall not be dropped or deposited in any manner that will cause segregation. The self-seeking slope is typically inclined at 5H:1V to 10H:1V. The toe of the backfill slope shall extend to the bottom of the excavation trench, such that the main slurry trench excavator can readily reach the toe of the backfill slope at all times.

B. An acceptable substitute for the initial placing of backfill using a clamshell bucket may be a lead-in trench. The lead-in trench shall begin at a point outside of the limits of work and provide sufficient distance for the backfill face to form, by placing the backfill into the trench before the toe of the backfill reaches the point where the cut-off is required. The lead-in trench shall be 1H:1V or flatter.

3.8 COLD WEATHER CONSTRUCTION REQUIREMENTS

A. No mixing or placing of the backfill will be allowed when the air temperature is below 30°F. No frozen backfill or slurry shall be placed in the soil-bentonite slurry wall trench. All ice forming on the surface of the slurry trench shall be removed prior to the start of each shift. No frozen or frost bearing backfill material shall be placed into the trench. When freezing temperatures exist the Engineer will conduct visual inspections of the slurry in the trench and the soil-bentonite backfill. The inspection may include measurement of the temperature if necessary, to evaluate the potential for frozen material. The frequency of these inspections will be a minimum of once per day, typically early in the day prior to the placement of any backfill. Additional inspections may be required if conditions warrant or change.

3.9 TREATMENT FOR TOP OF BACKFILL

A. Slurry wall backfill shall be mounded over the top of the trench to anticipate settlement. If the slurry wall backfill settles below the work pad, the low area shall be refilled to at least one foot above the work pad elevation, with soil-bentonite backfill.

B. The surface of the backfill shall not be allowed to desiccate prior to placing the final cap. A temporary covering may be used to protect the backfill prior to placing the final cap. Temporary crossing of extra thick compacted soil or trench plates shall be used for heavy equipment crossings. The temporary covering shall consist of at least one foot of uncompacted backfill placed within one day after the backfill is placed.

C. After a minimum of one week the temporary cover may be removed. Any depressions or settlement shall be repaired by placing additional backfill or the permanent cap.

D. Upon completion of backfill placement and before desiccation of the backfill surface can occur; the cutoff trench shall be covered in accordance with the final cap details shown on the Drawings.

3.10 CLEAN-UP

A. After completion of the backfill, all remaining excavated material and slurry shall be removed, and the surface shall be cleaned and leveled as directed by the Engineer. Excess slurry shall be disposed by drying, mixing with dry materials, or spreading in thin layers on adjacent areas designated by the Engineer. No slurry shall be left in ponds, and all ponds shall be pumped dry and backfilled in a manner approved by the Engineer.

3.11 QUALITY CONTROL

A. Testing services shall be performed by the Contractor. The Engineer will conduct its own testing if and as deemed necessary. Testing requirements for the project are summarized in Table 31 56 13-2.

Table 31 56 13-2
Quality Control Program

Required Testing	Frequency	Required Value
Key Depth Soundings	One per 10 linear feet	• 6 foot key depth
Water	One per source	
pH (API 13B-1)		• 6.0 to 8.0
Hardness (API 13B-1)		• ≤ 200 ppm
Bentonite (API 13A)	Manufacturers certificate on each truck load	• API Standard 13A
Slurry Introduced into Trench (API 13B-1)		
Unit Weight	Twice per shift	• ≥ 1.03 gm/cc (64.27 pcf)
Viscosity	Twice per shift	• ≥ 40 sec. - Marsh @ 68°
Filtrate Loss	Once per shift	• Loss ≤ 30 cc in 30 minutes @ 100 psi
pH	Once per shift	• ≥ 7 and <10
Slurry in Trench (API 13B-1)		
Unit Weight	Twice per shift	• 1.03 - 1.40 gm/cc (64.27 to 87.36 pcf)
Viscosity	Twice per shift	• ≥ 40 sec. - Marsh @ 68°
Filtrate Loss	Once per shift	• Loss ≤ 30 cc in 30 minutes @ 100 psi
Sand Content	Once per shift	• ≤ 20% by volume
Supplemental Fines	One sample of supplemental fines staged along the trench per each 200 lineal feet of trench	
Gradation (sieve analysis)		• ≥ 30% passing No. 200
Atterberg Limits (ASTM D1140), (ASTM D4318)		• PI ≥ 15
Soil-Bentonite Backfill		
Unit Weight (ASTM C138)	Twice per shift	• ≥ slurry in trench plus 15 pcf
Slump (ASTM C143)	Twice per shift	• 3 - 6 inches
Gradation (ASTM D6913)	Once per shift	• Meeting Soil-Bentonite Backfill Gradation Requirements
Triaxial Permeability Test (ASTM D5084)	One per 500 lineal feet	• ≤ 1 x 10^{-7} cm/sec.
Backfill Profile and Trench Bottom Profile Soundings	One per 10 linear feet at the beginning and end of each shift	

B. The Contractor shall provide test equipment and a testing trailer with electricity and water. The Contractor shall make the testing trailer available for Engineer's use.

C. Final acceptance of all materials and placement methods will be based on a review of quality control tests and on visual observations made by the Engineer during construction. The Contractor shall submit testing results daily to the Engineer.

D. If a test fails to meet the specified criteria, another test shall be performed after Contractor has completed the necessary corrective work. Contractor shall bear the expense of all the necessary corrective action and re-tests performed.

E. The Contractor shall be responsible for demonstrating to the satisfaction of the Engineer that the trench is continuous and keyed the minimum specified depth into the designated stratum. Trench continuity shall be assured by the action of movement of the trench excavation equipment such that the digging tools can be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering unexcavated material. Penetration of the bottom of the trench into the designated stratum shall be demonstrated at 10-foot centers by observation of the excavation spoils from the trench and by direct measurement of the top of the designated stratum and the final excavated trench depth to the satisfaction of the Engineer. Obtain a sample of the confining stratum with the excavator for each set at approximately 10-foot intervals along the trench bottom. Obtain additional bottom samples as requested by Engineer at intermediate locations.

F. Quality Control Testing Equipment

1. The field laboratory shall be provided and equipped by the Contractor with the following equipment, at a minimum:

    a. Marsh funnel and cup
    b. Mud balance
    c. Sounding cable
    d. Slump cone with rod and scoop
    e. Sand content kit
    f. Standard 3 inch, 3/8 inch, #20 and #200 sieve with hot plate (or microwave oven) and balance
    g. Filter Press
    h. Standard Concrete air pot for backfill density
    i. Atterberg Limits Test apparatus
    j. pH test strips

G. Soundings shall be taken by the Contractor every 10 feet along the trench centerline using a weighted tape, cable, or other device. Soundings shall be recorded to the nearest 0.5 foot. Soundings shall be performed by the Contractor and observed by the Engineer. Soundings shall record the following:

1. Top of Key: The top elevation of the key stratum shall be determined based on an examination of cuttings taken during excavation in the presence of the Engineer.
2. Bottom of Excavation: The depth and elevation of the trench shall be determined subject to approval by the Engineer.
3. Bottom of Excavation Prior to Backfilling: Soundings shall be used to monitor for sidewall collapse and accumulation of sediments.
4. Profile of Backfill Slope: The SB backfill slope and trench bottom shall be sounded at the beginning and end of each shift and converted to an as-built drawing. This drawing shall be reviewed daily as an indication of trench collapse, excessive settlement, or sloughing. If profiling prior to the next backfill placement shift indicates sedimentation or cave-in has occurred on the slurry trench bottom or the backfill slope, the material shall be removed by backhoe, clamshell, airlift pump, or other suitable equipment. This equipment shall be

operated in a manner that prevents removal of material from the walls of the Slurry Trench.

H. A qualified off-site laboratory shall be engaged by the Contractor to perform flexible wall permeability tests in accordance with ASTM D5084 and particle size analysis in accordance with ASTM D6913 at the frequency specified in Table 31 56 13-1. Samples of the SB backfill shall be obtained from the mixing area and shall be sent to the off-site laboratory for testing. The permeability test parameters shall be as follows:

1. Average Effective Confining Stress = 10 psi.
2. Maximum Hydraulic Gradient = 10

I. Documentation

1. Results of all tests performed will be recorded by the Contractor. Copies of all quality control documents will be submitted daily to the Engineer.
2. Results of all Construction activities shall be recorded daily on a form acceptable to the Engineer. At a minimum, these forms are to include:
3. The project station both at the starting and ending location for each day for the following:

    a. Top of backfill.
    b. Toe of backfill.
    c. Last completed set.

        1) Verified area of excavated material.
        2) Contractor's start and stop work times.
        3) Contractor's activities.
        4) Set summaries that include:

    d. Start and Stop time for excavation of the set.
    e. Depth to top of confining stratum.
    f. Depth to bottom of key.
    g. Description of the confining stratum.

4. Whenever tests indicate material or workmanship not in accordance with the Specifications, work shall be halted, and the cause of the discrepancy shall be identified. Work not in accordance with the Specifications shall be removed, replaced, repaired, or otherwise corrected to comply with the specified requirements.
5. An as-built profile drawing of the trench bottom and backfill slope shall be continuously maintained by the Contractor. The profile shall indicate the extent and progression of excavation and backfill at the end of each working day. The daily profile shall be generated and provided in an acceptable electronic format.

3.12 TOLERANCES

A. The following tolerances shall apply to the slurry trench dimensions and construction.

B. The slurry trench alignment shall be constructed as shown on the Project Drawings and shall not deviate from centerline by more than one foot left or right.

C. The slurry trench shall be plumb within 3 percent of vertical.

D. The depth of the slurry trench shall be measured or surveyed to within 6 inches of the desired elevation.

E. The excavating tool shall be at least as wide as the design width of the slurry trench.

F. In cases where the trench must be re-excavated (for example, due to an extended shutdown, cave-in, rework, etc.) the overlap into acceptable backfill shall be at least 10 feet.

G. The bottom of the slurry wall excavation will be sloped to match changes in top of confining stratum elevation.

H. When the top of the confining stratum elevation decreases, the excavation shall be sloped down at a 1H:1V slope to maintain the required excavation depth into the confining stratum.

I. When the top of the confining stratum elevation increases, the excavation shall be sloped up at a 3H:1V slope to maintain the minimum required excavation key depth into the confining stratum.

END OF SECTION

SECTION 31 62 16
STEEL SHEET PILES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Furnishing and installing steel sheet piling system at the locations shown on the Drawings, including monitoring of adjacent structures, pipelines, and utilities during sheet pile installation, and maintaining records of sheet pile installation.

1.2 REFERENCES

A. American Welding Society (AWS)

1.	AWS D1.1	Structural Welding Code - Steel

B. American Society for Testing and Materials (ASTM)

1.	ASTM A6	Specifications for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
2.	ASTM A36	Specifications for Carbon Structural Steel.
3.	ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium - Vanadium Structural Steel

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Sheet Pile Subcontractor: Name of proposed sheet pile subcontractor.

C. Resumes and References: Key sheet pile subcontractor field personnel, including superintendent, foreman, engineers, equipment operators, and quality control engineers.

D. Shop Drawings: Detail drawings for sheet piling, including fabricated sections, showing complete piling dimensions and details, driving sequence and location of installed piling.

E. Installation Plan: Proposed procedures to be used to locate, set, align, and drive the sheet piles. Include details for top protection, special reinforcing tips, lagging, cut-off method, dimensions of templates and other temporary guide structures for installing piling, and methods to maintain sheet pile spacing during concrete placement.

F. Quality Control: Proposed quality control methods which the Contractor intends to use to install the system, and the forms used to record quality control inspections. The quality control methods shall include all procedures, tests, and measures the Contractor intends to employ to assure that the system is installed in accordance with the Specifications and Drawings. Proposed quality control methods shall include, but not be limited to, material test procedures, survey control for horizontal and vertical alignment, and measurements to be taken during and after installation.

G. Installation Report Form: Proposed form for compiling sheet pile driving records.

H. Monitoring Instrumentation: Proposed location and equipment for monitoring the movement of adjacent structures, pipelines, and utilities.

I. Equipment: Type and operating details of the pile hammers and related equipment to be used to install and extract sheet piles, including type and thickness of the cushion block (where applicable) for driving.

J. Pulling and Redriving: The proposed equipment and method for pulling sheet piling.

K. Storage and Handling Procedures: Methods to handle and store piling to prevent permanent deflection, distortion, or damage to piling interlocks.

L. Material Test Reports: Reports of certified materials tests meeting the requirements of ASTM A 6 and A572 clearly showing that sheet piling meets the specified requirements. Provide reports for each shipment identified with specific lots prior to installing materials. Identification data shall include piling type, dimensions, chemical composition, mechanical properties, section properties, heat number, and mill identification mark.

M. Interlocked Joint Strength in Tension Test: The procedure for testing sheet piling interlocked joint strength in tension, prior to testing piling.

N. Interlock Tension Strength Test: Procedure for testing at least two 3 inch long coupons taken randomly from different as-produced pilings of each heat. Test shall conform to the piling manufacturer's standard and will be approved by the Engineer.

O. Construction Records.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to the site in new and undamaged condition accompanied by certificates of conformance. Provide the manufacturer's logo and mill identification mark on the sheet piling.

B. Store and handle sheet piling in the manner recommended by the manufacturer to prevent permanent deflection, distortion, or damage to the interlocks; as a minimum, support on level blocks or racks spaced not more than 10 feet apart and not more than 2 feet from the ends.

C. Storage of sheet piling should also facilitate required inspection activities and prevent damage to coatings and damage from corrosion prior to installation.

1.5 QUALIFICATIONS

A. Work specified in this Section shall be performed by an individual or firm of established reputation (or, if newly organized, whose personnel have previously established a reputation in the same field), which is regularly engaged in, has the required equipment, and which maintains a regular force of experienced field personnel skilled in installation of sheet piles.

B. Contractor specializing in the installation of sheet piles must be prequalified and be approved by the Engineer.

C. The sheet pile subcontractor shall provide a full-time, on-site project manager with at least 10 years' experience installing sheet piles, as approved by the Engineer. The sheet pile subcontractor shall also provide an on-site superintendent, foreman, engineers, equipment operators, and quality control engineers who are experienced installing sheet piles, as approved by the Engineer.

PART 2 PRODUCTS

2.1 STEEL SHEET PILES

A. Conforming to ASTM A6 and A572 with a minimum yield strength of 50,000 psi.

B. Supply in PZ22 shape unless otherwise shown on the Drawings.

C. Straight, and free from any defects, cutouts, corrosion, and interlock damage.

D. Equipped with free-sliding interlocks, providing a swing angle suitable for the intended installation but not less than 5 degrees when interlocked, and maintaining continuous interlocking when installed.

E. Provide sheet piling continuous for the full length of the pile. No splicing of piles will be permitted.

F. Fitted with an approved driving shoe capable of protecting the pile tip from damage during hard driving.

G. Provide sheets with handling holes at the top end only, above the final top elevation.

H. Nelson Studs (if required): ASTM A36 Carbon Steel.

PART 3 EXECUTION

3.1 PREPARATION

A. Prior to installation of sheet piles, remove all debris and material that interfere with pile installation.

B. Before installing sheet piles, establish temporary monitoring points at the dam, spillway, and US Highway 40. Record the horizontal coordinates and elevation of each point prior to sheet pile driving activities.

C. Provide 48-hour notice to the Engineer before sheet pile driving.

3.2 SHEET PILE INSTALLATION

A. Determine and mark locations of the sheet piles in the field.

B. Complete any excavations in areas where sheet piles will be installed.

C. Determine the appropriate size and type of hammer to be used for the project based on the following data/criteria:

1. Size hammer to drive the size and type of sheets described herein to the depths shown on the Drawings, based on geotechnical data obtained from geotechnical investigations.
2. Hammer type and size must not cause adverse impacts to the adjacent dam or spillway during driving per the specified requirements for monitoring.

D. Protect piles from damage during driving. Protection includes but is not limited to the use of suitable caps, rings, heads, blocks, and mandrels. A driving cap shall be used at all times, with the heads of the sheet piles cut square to accept this cap. It is the Contractor's

responsibility to provide those items (driving heads, mandrels, etc.) necessary to drive special types of piles per pile manufacturer's recommendations.

E. Drive sheet piles in plumb position such that each pile is installed continuously and interlocked with adjacent piles over its entire length. Hold piles in proper alignment during driving by means of assembling frames or other suitable temporary guide structures.

F. Jetting is not permitted. Pre-excavation or trenching may be undertaken to remove near-surface cobbles and small boulders that interfere with initial sheet pile alignment and driving. Such excavations shall be backfilled with compacted, granular fill.

G. Drive sheet piles to the depth(s) shown or specified unless directed by the Engineer in the field. If a sheet pile encounters refusal prior to reaching the required depth and can no longer be driven without damage to the sheet pile, or if continued driving causes the sheet pile to be out of alignment, driving shall cease. Refusal will be determined by inability of driving equipment to drive a pile more than one inch with four blows of the driving hammer operating at normal capacity. If a sheet pile starts to deform or move out of alignment prior to refusal, then driving shall also cease.

H. If it appears that a sheet pile has encountered a boulder or some other obstruction within the first five feet of driving, pull the sheet pile and excavate to remove the obstruction if possible. Backfill the excavation with compacted fill prior to re-driving of the sheet pile. If the obstruction cannot be removed, then the excavation shall be backfilled and re-compacted, with the pile re-driven to the depth of the obstruction unless the Engineer directs otherwise. In all cases of refusal, the undriven portion of sheet pile shall be cut at shown or specified elevations and saved on site for inspection and measurement by the Engineer prior to removal from the site by the Contractor.

I. Sheet Pile Cut-offs

1. The Contractor shall cut off the sheet piles at the elevations shown or specified on the plans. The cutoff length shall be sufficient to permit the removal of all damaged material.
2. Unless otherwise approved, install sheet piles such that the top elevation at the end of driving extends a minimum of 1-foot above the final top elevation or as necessary to ensure the head of each pile, after cutoff, is sound, undamaged material.
3. After all sheet piles along a continuous line are driven and accepted, cut the sheet piles to the final top elevations shown on the Drawings.
4. Perform cutting in a neat and workmanlike manner. Use a straight edge in cuts made by burning to avoid abrupt nicks or deviations from the cut line.
5. Piling cut-offs become the property of the Contractor and shall be removed from the site.

J. Drill or burn holes in steel piling and ream by approved methods which will not damage the surrounding metal and create reasonably smooth and proper size holes for rods and other items to be inserted.

K. Tolerances:

1. Horizontal alignment of the top of sheet pile centerline: Within 3 inches of plan location.
2. Vertical alignment: No more than 2 percent of the pile length from vertical.

L. Repair or replace to the satisfaction of Engineer any sheet piles damaged during installation.

3.3 STRUCTURAL MONITORING DURING SHEET PILE INSTALLATION

A. Perform structural monitoring of the dam, spillway and US Highway 40 during sheet pile driving. Structural monitoring shall include performing survey monitoring of temporary monitoring points in proximity to the sheets that are being installed each day. Structural monitoring shall be performed continuously during the first full day of production pile driving and may be reduced to a minimum of once daily thereafter based on Engineer's approval after reviewing the results of the first days' monitoring.

B. Contractor may be required to employ different work techniques, change hammer type or size, temporarily move work locations, or alter work sequence if the results of the structural monitoring indicate settlement, deformation, damage, or other adverse impacts to the adjacent dam or spillway structure during sheet pile installation. The Engineer will be the sole determiner if the dam structure is being adversely impacted by the sheet pile installation and will consult with Subcontractor to identify appropriate adjustments needed to maintain integrity of the existing dam during the work.

3.4 DEFECTIVE PILES

A. Any pile damaged, driven out of its design location, driven below the specified cutoff elevation, or inaccurately cut off shall be corrected by one of the following methods, whichever is approved by the Engineer.

B. Pull, replace, or redrive defective pile.

C. Drive a new pile adjacent to the defective pile.

D. Piles pushed up due to the driving of adjacent piles or by any other cause shall be re-driven to their specified elevation(s). Pull and replace any sheet pile ruptured in the interlock, or otherwise damaged during driving.

3.5 REMOVAL

A. Pulling and Redriving: Where damage is suspected, pull as directed selected sheet piling after driving to determine the condition of the underground portion of piling. Any piling so pulled and found to be damaged, to the extent that its usefulness in the structure is impaired, shall be removed and replaced at the Contractor expense. Sheet piling pulled and found to be in satisfactory condition may be re-driven.

B. Provide pulling holes in sheet piling as required. Extractors shall be of suitable type and size. Exercise care during pulling of sheet piling to avoid damaging piling interlocks and adjacent construction. If the Engineer determines that adjacent permanent construction has been damaged during pulling, the Contractor will be required to repair this construction at no cost to the Owner. Pull sheet piles one sheet at a time. Separate sheets that were fused together before pulling, unless the Contractor can demonstrate to the satisfaction of the Engineer, that the pilings cannot be separated. The Contractor will not be paid for the removal of sheet piling damaged beyond structural use due to proper care not being exercised during pulling.

C. Sort, clean, inventory and store pulled sheet piles by type into groups as:

1. Piling usable without reconditioning.
2. Piling requiring reconditioning.
3. Piling damaged beyond structural use.

3.6 QUALITY CONTROL

A. Perform continuous observation and inspections to confirm installation of sheet piles systems in accordance with the Drawings and Specifications.

B. Maintain sheet pile installation quality control records during sheet pile driving.

C. Inspect sheet pile for compliance with tolerance requirements.

D. Inspect the interlocks of the portion of driven piles that extend above ground.

E. Notify the Engineer immediately of any defects, deviations from the Specifications or Drawings. Correct defects as directed by the Engineer.

F. Remove and replace sheet piles that are out of interlock or alignment, as directed by the Engineer, using the same materials, procedures, and testing, and materials as for permanent sheet piles.

G. Use welders qualified in accordance with AWS D1.1. Perform welding, welding inspection, and corrective welding in accordance with AWS D1.1. Use continuous welds on all connections. Grind visible welds smooth in the finished installation.

H. Construction Records: Maintain quality control installation records of each sheet pile installation in approved format. Submit records at the end of each day that sheet piles are driven. At a minimum include the following information:

1. Installation date and time.
2. Sheet pile reference number.
3. Type of sheet pile including rate of operation, total driving time, blows required per foot for each foot of penetration, and final driving resistance in blows for the final 6 inches of penetration.
4. Dimensions of driving helmet and cap used,
5. Detailed driving record.
6. Final tip and top elevations.
7. Deviations from design location and alignment.
8. Lateral deflection and other appropriate deflection measurements.
9. Re-heading or cutting of sheet piles.
10. Records of occurrence of any gaps between sheet piles created during pile driving.
11. Unusual problems during driving
12. Other data pertaining to the sheet pile installation and performance.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes furnishing and placing Hot Mix Asphalt (HMA) for bridge paving.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1.	ASTM C 110	Standard Test Method for Physical Testing of Quicklime, Hydrated Lime, and Limestone
2.	ASTM C 207	Standard Specification for Hydrated Lime for Masonry Purposes
3.	ASTM D 2950	Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods
4.	ASTM D 4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregates
5.	ASTM D 5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

B. American Association of State Highway and Transportation Officials (AASHTO)

1.	AASHTO M 17	Standard Specification for Mineral Filler for Bituminous Paving Mixtures
2.	AASHTO M 140	Standard Specification for Emulsified Asphalt
3.	AASHTO M 156	Standard Specification for Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures
4.	AASHTO M208	Standard Specification for Cationic Emulsified Asphalt
5.	AASHTO T 27	Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
6.	AASHTO T 44	Standard Method of Test for Solubility of Bituminous Materials
7.	AASHTO T 59	Standard Method of Test for Emulsified Asphalts
8.	AASHTO T 78	Standard Method of Test for Distillation of Cutback Asphaltic (Bituminous) Products
9.	AASHTO T 90	Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils
10.	AASHTO T 96	Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
11.	AASHTO T 104	Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
12.	AASHTO T 165	Standard Method of Test for Effect of Water on Compressive Strength of Compacted Bituminous Mixtures
13.	AASHTO T 167	Standard Method of Test for Compressive Strength of Hot Mix Asphalt

14. AASHTO T 168 Standard Method of Test for Sampling Bituminous Paving Mixtures
15. AASHTO T 176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
16. AASHTO T 195 Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures
17. AASHTO T 202 Standard Method of Test for Viscosity of Asphalts by Vacuum Capillary Viscometer
18. AASHTO T 209 Standard Method of Test for Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
19. AASHTO T 245 Standard Method of Test for Plastic Flow of Asphalt Mixtures Using Marshall Apparatus
20. AASHTO T 283 Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage
21. AASHTO T 304 Standard Method of Test for Uncompacted Void content of fine Aggregate
22. AASHTO T 308 Standard Method of Test for Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method

C. Colorado Department of Transportation (CDOT)

1. Standard Specifications for Road and Bridge Construction, most recent revision. These references are abbreviated as CDOT Specifications in this Section. Where CDOT Specifications indicate terms such as “Project Manager”, “Engineer”, or other similar terms of authority, they shall be replaced with “Owner” or “Engineer” as applicable.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Job mix design formula (JMF) to the Engineer for his review and approval at least 14 days prior to the beginning of paving operations. The mix design to be used on the project shall be approved prior to the start of any paving operation. The mix design shall be developed using approved mix design procedures and shall be stamped by an engineer licensed in the State of Colorado practicing in this field. Submit as part of the mixture design the following items:

1. Source of materials.
2. Aggregate gradation, specific gravity, source and description of individual aggregates and the final mixture blend.
3. Aggregate physical properties.
4. Source and grade of Performance Graded binder along with certification of binder.
5. Proposed JMF: aggregate and additive blending, final gradation shown on a 0.45 power graph, optimum binder content.
6. Mixing and compaction temperatures.
7. N_{ini} and N_{des}

8. Mixture properties determined at the minimum of four binder contents and interpolated at optimum and graphs showing mixture properties versus binder content.
9. Anti-stripping agent - product name and manufacturer.
10. Percent of RAP if used in the mixture.

C. Certification tests for all materials.

D. HMA placement, compaction equipment and procedures.

E. Proposed Prime and Tack Coat.

F. Original load tickets for bituminous and HMA materials delivered and placed.

G. Quality Control:

1. QC testing plan.
2. Testing personnel qualifications.
3. Laboratory qualifications.
4. Test results.

1.4 QUALITY REQUIREMENTS

A. All work and materials shall be in accordance with the requirements specified by CDOT Specifications for HMA and these specifications. Any conflicts between requirements shall be resolved by the Engineer.

PART 2 PRODUCTS

2.1 GENERAL

A. The HMA shall be composed of a mixture of aggregate, approved filler or additives, asphalt binder and reclaimed asphalt pavement (RAP), when permitted. The materials used in the manufacture of HMA shall meet the following requirements.

2.2 MATERIALS

A. Aggregates shall be of uniform quality, clean, hard, durable particles of crushed stone, crushed gravel, natural gravel, or crushed slag free from clay balls, vegetable matter or other deleterious materials meeting the requirements in Table 32 12 16-1.

Table 32 12 16-1
Aggregate Properties

Property	Test Procedure	Coarse Retained on #4 Sieve	Fine Passing the #4 Sieve
Uncompacted Void Content of Fine Aggregate (Fine Aggregate Angularity)	AASHTO T 304 Method A		40% Minimum
Fractured Faces (minimum of 2)	ASTM D 5821	70% Minimum	
LA Abrasion	AASHTO T 96	45% Maximum	
Flat and Elongated Pieces	ASTM D 4791	10% Maximum	
Sodium Sulfate Soundness	AASHTO T 104	12% Maximum Combined Coarse and Fine	
Sand Equivalent	AASHTO T 176		45% Minimum

B. Aggregates meeting the requirements in Table 32 12 16-1 shall be used to develop the Job Mix Formula (JMF) for the HMA mixture. The aggregate should be composed of angular, coarse textured, cube shaped particles. Natural sand may be used to obtain gradation of the blended aggregate mixture but should not exceed more than 25%. If the percent of aggregate passing the #4 sieve is greater than 10% by weight of the individual aggregate sample, Plasticity will be determined in accordance with AASHTO T 90. The gradation of the aggregates used in the mixture shall meet the criteria shown in the Aggregate Master Range Table 32 12 16-2 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be well graded from coarse to fine. The nominal size aggregate used in the HMA mixture shall not be more than one-third the thickness of the uncompacted HMA lift being constructed.

Table 32 12 16-2
Aggregate Master Range Table for Hot Mix Asphalt Mixtures

Sieve Size	Percent by Weight Passing Square Mesh Sieves		
	Grading S	Grading SG	Grading SX
1 ½"		100	
1"	100	90-100	
¾"	90-100		100
½"			90-100
3/8"			
#4			
#8	23-49	19-45	28-58
#30			
#200	2-8	1-7	2-10

C. If mineral filler is required to meet the JMF it shall conform to the requirements of AASHTO M 17. It shall consist of rock dust, slag dust, hydrated lime, hydraulic cement, fly ash or other suitable mineral matter. Mineral filler shall have a plasticity index not greater than four (4) excluding hydrated lime and hydraulic cement. Mineral filler shall meet the grading limits shown in Table 32 12 16-3. The maximum amount of allowable Hydrated lime or Hydraulic Cement shall not exceed 3% by weight of mix.

Table 32 12 16-3
Mineral Filler Grading Limits

Sieve Size	Mass Percent Passing
#30 (600: µ m)	100
#50 (300: µm)	95-100
#200 (75: µm)	70-100

D. Additives. Additives to the mineral aggregate shall be added if the asphalt binder will not coat or stick to the aggregates. Additives shall be either Hydrated Lime or Anti-stripping Agents as approved by CDOT. The Contractor will provide an anti-strip (liquid or mineral) agent as necessary to meet an Index of Retained Strength (AASHTO T 165, T 167, or Lottman Procedure T 283) of 80% minimum for the mix design and 70% minimum for production.

Hydrated Lime. Hydrated lime shall conform to ASTM C 207 Type N. The residue retained on a #200(75:m) sieve shall not exceed 10% when determined in accordance with ASTM C 110.

E. Reclaimed Asphalt Pavement. Reclaimed Asphalt Pavement (RAP) shall be allowed in the HMA mixture. It shall be of uniform quality and gradation with a maximum size particle no greater than the maximum size allowed in the HMA mixture. HMA mixtures containing RAP shall meet the same gradation requirements as a virgin HMA mix. HMA mixtures containing less than 15% RAP need only to take into account the gradation of the RAP so that the final mixture meets the requirements of the JMF. HMA mixtures containing more than 15% but less than 25% RAP, need to take into account the gradation of the RAP but also the asphalt binder grade. If the Contractor desires to increase the use of RAP, the request must be made and approved by the Engineer/ Owner in writing specifying the amount of RAP to be used in the mixture, prior to submitting the mixture for preliminary approval.

F. Asphalt Binder. Superpave Performance Graded Binder shall conform to the requirements listed in CDOT Specifications Table 702-1 for PG 58-34 unless otherwise approved. Any asphalt binder supplied must be from an approved source. The approved source for asphalt binders must be certified by CDOT.

1. Provide to the Owner acceptable "Certification of Compliance" of each applicable asphalt binder grade that will be used on the project. Binder grades other than the grade specified shall not be used unless the proposed binder and the m ix design are approved by the Engineer.

G. Prime coat material shall either be an Emulsified Asphalt Prime Coat or a Penetrating Priming Stabilizer. Emulsified Asphalt Prime Coat and Penetrating Priming Stabilizer shall conform to the requirements in Table 32 12 16-4 Requirements for Prime Coat Materials.

Table 32 12 16-4
Requirements for Prime Coat Materials
Penetrating Priming Stabilizer

Asphalt Emulsion Prime			**Penetrating Priming Stabilizer**			
Property	**Requirement**	**AASHTO Test #**	**Property**	**Requirement**		**AASHTO Test #**
				Max.	**Min.**	
Saybolt Furol Viscosity at 50 °C (122 °F), s	15 -150	T 59	*Flash (T.O.C.). °C (°F)*	*38 (100)*		*T 79*
Settlement	1% Max.	T 59	*Saybolt Furol Viscosity at 50 °C)122 °F), s*	*30*	*100*	*T72*
% Residue	65% Min.	T 59 to 260 °C (500 °F)	Kinematic Viscosity at 60 °C, mm/s (140 °F, centistokes)	60	*212*	*T201*

Asphalt Emulsion Prime			Penetrating Priming Stabilizer			
Property	**Requirement**	**AASHTO Test #**	**Property**	**Requirement**		**AASHTO Test #**
				Max.	**Min.**	
Oil Distillate by Volume %	7% Max.	T 78	Residue by evaporation, %	*55*		T 59
Test on Residue from Distillation:			Tests on Residue:			
Solubility in Trichloroethylene, %	97.5 Min.	T 44	Penetration, 25 °C (77 °F), 5 sec, mm	*25*		T 49
Tests on Residue from Cutback Distillation to 360 °C (680 °F):			Softening Point Ring & Ball, °C (°F)		71 (160)	7 53
Viscosity, 60 °C, mm/s (140 °F, centistokes)	3000 (3000) Min.	T 202				

H. Tack coat material shall be an Emulsified asphalt conforming to AASHTO M 140 or M 208 for the designated grades.

I. Prior to the delivery of materials to the job site, submit certification tests to the Engineer, for his approval, showing all materials to be used on the project meet the appropriate specification. The certification shall show the appropriate test(s) for each material, the test results, and a statement that the materials meet the appropriate specification. If the Engineer request samples of the materials for verification testing prior to and/or during the production of the HMA mixture, deliver the requested materials to the Engineer within 2 days of receiving the request.

2.3 HOT MIX ASPHALT MIXTURE COMPOSITION.

A. The HMA mix shall be composed of well-graded aggregate, mineral filler, anti-stripping agent (if required and approved) and asphalt binder.

B. Submit the mix design (JMF) to the Engineer for his approval 7 days prior to the beginning of paving operations. The laboratory performing the mix design shall be AASHTO Accredited in the test methods used to develop the mix design. The mix design(s) of each mixture(s) to be used on the project shall be approved prior to the start of any paving operation. The mix design(s) shall be developed using the Marshall mix design procedures outlined in the Asphalt Institute's Manual Series No. 2 (MS-2) Marshall Method of Mix Design, in accordance with AASHTO T 245, using 50 blows per side Compactive effort, and shall be stamped by an engineer licensed in the State of Colorado practicing in this field.

C. Submit as part of the mixture design the following items:

1. Source(s) of materials.
2. Aggregate gradation, specific gravity, source and description of individual aggregates and the final mixture blend.
3. Aggregate physical properties.
4. Source and grade of Performance Graded binder along with certification of binder.

5. Proposed JMF: aggregate and additive blending, final gradation shown on a 0.45 power graph, optimum binder content.
6. Mixing and compaction temperatures.
7. Mixture properties determined at the minimum of four binder contents and interpolated at optimum and graphs showing mixture properties versus binder content.
8. Anti-stripping agent - product name and manufacturer.
9. Percent of RAP if used in the mixture.

D. The mix design(s) shall meet the requirements of Table 32 12 16-2, the specified binder Grade, Table 32 12 16-5, and Table 32 12 16-6. The HMA mixture(s) will be designed for the nominal aggregate size and binder grade designated.

Table 32 12 16-5
Marshall Design Volumetric Mixture Properties

Test Property	**Required Value**
Number of Blows	50
Air voids (%)	3 - 5
Stability, pounds minimum	1200
Flow, 0.01 in.	8 - 16
Voids Filled w/Asphalt, VFA, MS-2	65 - 78
Percent Voids in Mineral Aggregate	See Table 32 12 16-6

Table 32 12 16-6
Voids in Mineral Aggregate

Nominal Maximum Particle Size1	**Minimum VMA - %**		
	Design Air Voids - %		
	3.0	4.0	5.0
½"	13	14	15
¾"	12	13	14
1"	11	12	13
1The nominal maximum particle size is one sieve size larger than the first sieve to retain more than 10 percent			

E. If the Contractor proposes to use RAP in the HMA mixture(s), the resulting mixture(s) must meet the same requirements as a mixture(s) that do not contain RAP. The RAP shall be of uniform quality. The maximum size of the RAP shall be 95% passing the 1½" sieve prior to the introduction into the mixer.

F. Mixture(s) being produced by the plant shall be verified prior to the start of the placement of the mixture(s). Verification shall be performed by engineering technicians with qualifications in the appropriate field equivalent to a NICET Level II or higher construction materials technician or highway construction technician, or LabCAT Level C and shall have a minimum 2 years of experience testing hot mix asphalt. If the mixture(s) has been produced for another project within the last 90 days, verification results from that project can be submitted for this verification. Marshall mix design

volumetric tolerances for the approved HMA mixture(s) shall be within the limits shown in Table 32 12 16-7.

Table 32 12 16-7
HMA Mixture Design Verification Tolerances

Property	Tolerance
Air Voids	3 - 5%
VMA	See Table 32 12 16-6
Asphalt binder content	± 0.4%
Stability	1200 lb. minimum

PART 3 EXECUTION

3.1 HOT MIX ASPHALT PAVEMENT CONSTRUCTION.

A. Pre-paving Meeting. Prior to the start of the paving operation, all key parties involved in the supply, haul, placement, compaction, inspection and quality control and quality acceptance (QC/QA) of the HMA pavement shall attend a pre-paving meeting to go over procedures and acceptance of the HMA pavement. The meeting may be scheduled by the Engineer. Areas of responsibility and contact names and phone numbers will be shared.

B. Paving Schedule. Plan the work in such a manner as to cause a minimum of inconvenience to the project. Submit to the Engineer a plan of this operation.

C. Weather Restrictions. The HMA mixture shall be place only on properly constructed surfaces that are dry, unfrozen surfaces and only when weather conditions allow for proper handling and compacting of the mixture. The HMA shall be placed in accordance with the temperature limits shown in Table 32 12 16-8 and only when weather conditions permit the pavement to be properly placed and compacted as determined by the Engineer. Placement and compaction of the HMA may be accomplished at temperatures less that shown in Table 32 12 16-8 when meeting the compaction requirements stated herein can be obtained. Temperature requirements may be reviewed on a project by project basis by the Engineer / Owner at the request of the Contractor, to facilitate placement of Hot Mix Asphalt.

Table 32 12 16-8
HMA Pavement Placement Temperature Limitations

Paving Course	Thickness	Minimum Surface and Air Temperature °F
Surface	All	40*
Subsurface	< 3"	40
Subsurface	> 3"	32
* - denotes modified asphalt binder HMA surface mixes shall be placed at a minimum of 50 °F air temperature.		

D. HMA Production Facilities. The HMA plant used to produce the asphalt aggregate mixture shall meet the requirements of AASHTO M 156 and shall have adequate capacity and be maintained in good mechanical condition. The plant shall control dust, smoke, or other contaminants such that it meets the Colorado Air Quality Control Act, Title 25, Article 7, CRS, and all regulations promulgated thereunder.

1. Truck Scales. When necessary and paid for by the ton, the HMA mixture shall be weighed on approved scales furnished by the Contractor or on public scales at the Contractor's expense. Such scales shall be inspected and sealed as required by local laws or requirements as often as necessary to assure their accuracy. No load shall be above the legal limit.
2. Inspection of Plant. The Engineer or his authorized representative shall have access, at all times, to all areas of the plant for checking the adequacy of the equipment; inspecting the operation of the plant; verifying weights, proportions and material properties and checking the temperatures maintained in the preparation of the mixtures.
3. Storage. HMA mix may be stored provided that the characteristics of the mixture are not altered by such storage. If storing or holding of the mixture causes segregation, excessive heat loss, or adversely affects the quality of the finished product, corrective action shall be taken. Unsuitable mixture, as determined by laboratory testing and inspection to determine the mixture does not meet the project requirements, shall be disposed of at the Contractors expense. Use of surge bins or storage bins for temporary storage of hot HMA mixtures will be permitted as follows:

    a. The HMA mixture may be stored in surge bins for period not to exceed 3 hours.
    b. The HMA mixture may be stored in insulated storage bins for a period not to exceed 45 hours, unless approved.

4. The mix drawn from the bins shall meet the same requirements as the mix loaded directly into trucks. If the Engineer determines by laboratory testing and inspection to determine the mixture does not meet the project requirements, that there is an adverse effect on the quality of the finished product due to the temporary storage, corrective action shall be taken. Unsuitable mixture, as determined by laboratory testing and inspection to determine the mixture does not meet the project requirements, shall be disposed of at the Contractor's expense.

E. Hauling Equipment. Trucks used for hauling HMA mixtures shall have tight, clean, and smooth metal beds. To prevent the mixture from adhering to them, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution or other approved release agent material. Each truck shall have a suitable cover to protect the mixture from adverse weather and to maintain temperature of the mixture when required by project specifications, state or local requirements, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds may be insulated or heated and covers shall be securely fastened when required and used.

F. Placement Equipment. Pavers shall be self-propelled, with activated screed assemblies, heated as necessary, to spread and finish the HMA mixture to the specified width, thickness, smoothness, and grade shown. The pavers shall have sufficient power to propel themselves and the hauling equipment without adversely affecting the finished pavement surface. The receiving hopper of the paver shall have sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. The paver shall be capable of operating at consistent speeds to apply the mixture in an even, continuous layer avoiding stop and go operations whenever possible. If an automatic grade and slope control device is used, the

paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from a reference line or through a system of mechanical sensors or sensor directed mechanisms which will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The controls shall be capable of maintaining the screed at the desired transverse slope within ±0.1 percent. If the Contractor fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

G. Compaction Equipment. The hot mix asphalt shall be compacted by rolling. Both steel wheel and pneumatic tire rollers may be required. The number and type, and weight of rollers furnished shall be sufficient to obtain the required density while the mixture is in a workable condition. The use of equipment which causes excessive crushing of the aggregate will not be permitted.

H. Hot Mix Asphalt Mixture Production. The HMA mixture shall be produced in a plant meeting the requirements specified herein. The dried aggregates and asphalt binder shall be combined in the plant in the quantities required to meet the job mix formula.

1. Preparation of the Asphalt Binder. The asphalt binder shall be the heated in a manner that will avoid local overheating and provide a continuous supply of the HMA material to the plant at a uniform temperature. The temperature of the asphalt binder delivered to the mixer shall be sufficient to provide a suitable viscosity for adequate coating of the aggregate particles but shall not exceed the maximum temperature prescribed by the asphalt refiner.
2. Preparation of the Aggregate. The aggregate for the mixture shall be dried and heated prior to introduction into the mixer or mixing area of the drum. The temperature of the aggregate and mineral filler shall not exceed 350 °F when the asphalt is added. The temperature shall not be lower than is required to obtain complete coating and uniform distribution on the aggregate particles and to provide a mixture of satisfactory workability. When hydrated lime is required to achieve complete and uniform coating of the aggregate by the asphalt binder it shall be added to the aggregate in the form of either a slurry or a dry form and then thoroughly mixed in an approved pug mill. The slurry shall contain a minimum of 70% water by weight. If dry hydrated lime is used, it shall be added to the wet aggregate at a minimum of 2% above saturated surface dry and then m ix thoroughly in an approved pug m ill. Care should be taken to not add more moisture to the aggregate than required to insure proper coating.
3. Preparation Hot Mix Asphalt Mixture. The heated and dried aggregates and the asphalt binder shall be combined by weight in the mixer in the amount specified by the job mix formula. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt cement is uniformly distributed throughout the aggregate. If allowed, baghouse fines shall be fed back to the mixing plant in a uniform and continuous manner to maintain uniformity in the mixture. The baghouse, fines feeder, auger, and related equipment, shall be in good working condition and operated in accordance with manufacturer's recommendation. If visual inspection and testing determines that non-uniform operation of the equipment is producing a mixture which does not meet the project specification paving operations may be suspended until the Contractor takes appropriate action. The temperature of the HMA mixture, for different asphalt binder grades, when discharged from the plant shall be within the

maximum and minimum limits allowed by CDOT. The HMA mixture shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95 percent minimum in accordance with AASHTO T 195) and allows the required compaction to be achieved.

4. The temperature of the mixture delivered to the paver hopper shall be in accordance with the asphalt binder supplier and mix design engineer's recommendations. All loads shall be delivered continuously in covered vehicles as required by state, or local regulations or by project requirements.

I. Preparation of the Underlying Surface. The HMA mixture shall be place on a prepared surface. Prior to the placing of the mixture, irregularities in the underlying surface shall be brought to uniform grade and cross section. The surface shall be cleaned of all dust and debris. A prime coat shall be applied to the subgrade

J. Contact surfaces of structures coming in contact with the HMA mixture shall be coated with a uniform coating of asphaltic material prior to the placement of the HMA mixture against them.

K. Tack Coat.

1. This work consists of preparing and treating the surface that will be receiving the HMA mixture in accordance with these specifications and in conformity with the lines shown on the plans or established by the Engineer. Before applying the tack coat, surfaces shall be thoroughly cleaned of all dirt and other debris to insure adequate bond between tack surface and HMA mat. The surface shall be allowed to cure to permit drying and setting of the tack coat prior to the paving operation.
2. The emulsified asphalt shall be diluted 1:1 with water and applied at 0.20± 0.01 gallons per squared yard of diluted material.
3. Tack coats shall not be applied (1) when the surface to receive the tack coat is wet or when weather conditions would prevent the proper construction of the tack coat.
4. Provide equipment for heating and uniformly applying the tack coat material. The distributor or equipment for applying the tack coat shall be capable of uniformly spraying the material at even temperature and uniform pressure on variable widths of surface up to 15 feet in width at readily determined and controlled rates from 0.05 to 0.1 gallons per square yard. The amount of tack to be placed will vary depending on the condition of the surface on which the tack will be applied. A dry, cracked surface will require a greater amount of tack coat compared to a flushed or bleeding surface. The coating should be similar for all surfaces.
5. The prime coat shall be applied in a uniform and continuous spread. When traffic is maintained, not more that ½ of the width of the section shall be treated in one application, or sufficient width shall be left to adequately handle traffic. Care shall be taken so the application of the tack coat materials at the junctions of spreads is not more than the specified quantity. Excess material shall be removed or distributed. Tack coat should not be place on any surface where traffic will travel on the freshly applied material.
6. The rate of application, temperatures, and areas to be treated shall be as directed by the Engineer and shall be approved prior to the application of the prime coat.

3.2 HAULING

A. Maintain an adequate number of vehicles so delivery of the HMA mixture can be continuous with a minimum of interruptions of material to the paving equipment in order for a continued non-stop paving operation and before the temperature of the HMA material falls below the specified placement temperature or satisfactory compaction temperature. Deliveries shall be planned so the placing and compaction of all the mixture prepared for one day<s operation can be completed during daylight, or unless adequate artificial lighting is provided by the Contractor and approved by the Engineer. Hauling over newly placed mixture shall not be permitted until the mixture has been compacted as specified and allowed to cool sufficiently so vehicular traffic does not damage or deform the final lift.

3.3 PLACING HMA MIXTURE.

A. The HMA mixture shall be placed using equipment meeting the requirements specified herein to the established grade and required thickness over the entire width or partial width as practicable.

B. The mixture shall be laid upon an approved surface, spread, and struck off to obtain the required grade and elevation after compaction. The Thickness of the mixture being placed should be such that after compaction is achieved, the finished mat will be even with the existing adjacent mat. Raking is discouraged and should not be allowed if it is causing segregation in the mat. Casting or raking that causes any segregation will not be permitted.

C. On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to achieve the required compacted thickness. Carefully move or minimally work the HMA mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt cement require more rapid completion of handwork areas than for normal mixtures. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Excessive starting and stopping should be avoided. If stopping and starting of the paving operation cannot be avoided, it should be done as rapidly as possible within reason. A construction joint shall be placed any time the paver completes a day’s production or for breaks in the paving operation, if the screed drops enough to cause a surface dip exceeding the specified maximum or the mat temperature falls enough that the compaction ca not be obtained as specified.

D. The mixture shall be laid upon the approved base surface, spread, and struck off to the grade and elevation required. Pavers shall be used to distribute the mixture over the entire surface except where hand placing is necessary.

E. On areas where the use of mechanical pavers cannot be used, the mixture shall be spread, raked, and luted by hand tools. When materials are shoveled, no "slinging" of the shovel will be permitted. The hand placed material shall be smoothed and placed in a manner to achieve the required compacted thickness. If the machine laid mixture has been rolled, then the hand laid mixture shall be smoothed and placed in a manner to achieve the required compacted thickness. The majority of the raker’s work shall be done with a lute rather than a tined rake.

3.4 LIFT THICKNESS.

A. Each lift of uncompacted Hot Mix Asphalt pavement shall be of uniform thickness. The minimum compacted lift thickness shall be three times the nominal maximum aggregate size of the mixture. The maximum lift thickness shall be 3 inches unless the Contractor can demonstrate his ability to achieve required compaction of thicker lifts.

B. The final lift, when placed adjacent to guttering, shall extend ¼ to ½ inch above the lip of the gutter when compacted for a catch curb and gutter and shall be even with a spill curb and gutter at the time of construction.

3.5 JOINT CONSTRUCTION.

A. The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses. All joints shall have the same texture, and smoothness as other sections of the mat and meet the requirements for smoothness and grade.

B. The roller shall not pass over the unprotected end of the freshly laid mixture except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course.

C. The free edge of the paved pass shall be laid as straight as possible and to the satisfaction of the Engineer. This joint, if cold, shall be tack coated prior to placement of adjacent paving.

D. The new compacted mat shall overlap the adjacent previous placed mat no more than 1.5 inches. Excess overlap or thickness shall not be raked or cast onto the new mat but shall be wasted by pulling back and removing. The hot edge shall be blocked or bumped in a smooth line consistent with the previous longitudinal edge. Minor raking will only be allowed to correct major grade problems or provide mix around manholes and meter covers.

E. Longitudinal Joints.

1. The longitudinal joint in both a new pavement and an overlay pavement layer shall offset the joint in the layer immediately below by 6 inches. In multiple lift (3 lifts or more) construction the joint in any succeeding lift shall not be placed in line of any of the previous lifts. The joints in any pavement layer shall not fall in a wheel path. When required by the Engineer, submit a longitudinal joint and pavement marking plan three days prior to the Pre-Paving Conference. The plan shall show the location and configuration of the proposed longitudinal joints and pavement markings and shall detail the methods to be used in the field to establish a control line. When required by the Engineer for alignment control purposes, use a l continuous string line to delineate every longitudinal joint during paving operations. All exposed string line shall be picked up and disposed of at the end of each day's paving. Paving shall not commence until the plan has been approved in writing by the Engineer. The joints in the top layer of pavement shall be located as follows unless otherwise approved in writing by the Engineer:

   a. For two lane roadways, offset 6 to 12 inches from the center of pavement and from the outside edge of the travel lanes.
   b. For roadways of more than 2 lanes, offset 6 to 12 inches from lane lines and outside edge of travel lanes.

c. If exposed to traffic, a full height taper no steeper than 2:1 is permissible. Longitudinal joints shall not cross the centerline, lane lines or edge line unless approved by the Engineer.

F. Transverse Joints

1. When required by the Engineer for alignment control purposes, submit a transverse joint plan showing the locations and the methods to be used to construct transverse joints. The Engineer must approve such plans prior to paving. Placing of the HMA mixture shall be continuous with a minimum of transverse joints.
2. Rollers should not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Construction of a transverse joint will be the responsibility of the Contractor and can be accomplished by many different methods. Tack coat material should be applied to contact surfaces of all joints just before additional mixture is placed against the previously compacted material.
3. The end of transverse joints should be located so they will be constructed with a full head of mix in front of the screed. W hen butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted.
4. When a tapered joint is required for traffic access, the ramp shall be removed back to a full depth before paving is restarted.
5. When restarting paving operations, the paver screed should be placed on starter blocks on the completed side of the transverse joint. The starter blocks should be of such height that the thickness of the mixture being placed after compaction is achieved, the finished mat will be even with the existing adjacent mat. Raking of this joint should be minimized.

3.6 COMPACTION.

A. When the surface temperature of the mixture falls below 185°F, further compactive effort should not be applied unless approved.

B. Compaction shall begin immediately after the mixture is placed and be continuous until the required density is obtained.

C. Prevent the HMA mixture from adhering to the rollers by using detergent or other approved material.

D. The speed of the roller shall, at all times, be suitable to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller or from any other cause shall be corrected as quickly as possible.

E. In areas not accessible to the roller, the mixture shall be thoroughly compacted with hand tampers or small mechanical hand compactors.

F. Any mixture that becomes loose and broken, mixed with dirt, contains extensive check-cracking or in any way is defective shall be removed and replaced with fresh HMA mixture and immediately compacted to conform to the surrounding area at the

Contractor's expense. Skin patching should be discouraged and used only with the approval of the Engineer.

G. All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted during the final rolling of the surface course.

H. Pavement shall be compacted to a density of 94 ± 2% of the maximum theoretical density determined in accordance with AASHTO T 209. Percent compaction of the pavement shall be determined from cores taken from the completed lift. Percent compaction shall be determined in accordance with AASHTO T 269. Eight percent air voids is 92% compaction and 4% air voids is 96% compaction.

3.7 MATERIAL TESTING, ACCEPTANCE, AND INSPECTION.

A. Acceptance of the work can be based on all or part of the following characteristics of the Hot Mix Asphalt mixture and completed pavement as well as Contractor's quality control test results and specified in the project specific documents.

1. Binder grade certification.
2. Binder Content.
3. Aggregate gradation.
4. Mat density.
5. Mat smoothness.

B. The Contractor is responsible for acceptance testing for asphalt content, gradation, and mat density.

C. Quality control testing of plant produced materials for material gradation and asphalt content shall be performed by the Contractor. All failing test shall be immediately reported to the Engineer. Test results from each day's production shall be completed and submitted to the Engineer within one day. Personnel performing sampling and testing of Hot Mix Asphalt mixtures in the lab and field shall possess the appropriate LabCat Certification or combination of certifications for all sampling and testing performed issued by the Rocky Mountain Asphalt Education Center.

D. Acceptance testing frequency and tolerance limits are shown in Table 32 12 16-9. Quality Control (QC) testing shall be done by the Contractor. Engineering technicians performing the testing shall have qualifications in the appropriate field equivalent to a NICET Level II or higher construction materials technician or highway construction technician, or LabCAT Level C and shall have a minimum 2 years of experience testing hot mix asphalt. Quality Assurance (QA) testing may be done by the Owner at their discretion. The Contractor's testing agency shall have a fully and properly equipped asphalt laboratory or shall hire an independent testing laboratory for acceptance testing. Laboratories performing the testing shall be AASHTO Accredited in the procedures being performed.

Table 32 12 16-9
Acceptance Testing

Test	Procedure	Specification Tolerance Limits	Frequency
Asphalt Content	AASHTO T 308-01 (CP-L 5120)	Per Table 32 12 16-6	1 per 1000 Tons or 1 per day min.
Gradation	AASHTO T 27-99 (CP	Per Table 32 12 16-11	1 per 2000 Tons or 1

	31A)		per day min.
Percent Compaction	AASHTO T 269	94% ± 2% of AASHTO T 209, 4 to 8% air voids in place	1/500 tons

E. Sufficient material for preparation of test specimens shall be obtained by the Contractor in accordance with AASHTO T 168. Samples shall be split with the Owner's materials laboratory. Each set of laboratory compacted specimens will consist of three test portions prepared from the same sample increment. The sample of HMA mixture may be placed in an oven in a covered metal container for not more than 30 minutes to maintain heat. The material shall be compacted at the temperature as specified in the job mix formula. Testing of plant produced material for Air Voids and VMA shall be determined in accordance with the procedures shown in Table 32 12 16-9. For air voids determination, the theoretical maximum specific gravity of the mixture shall be determined in accordance with AASHTO T 209. Gradation and asphalt content testing shall be the responsibility of the Contractor and shall be part of the Contractor's quality control testing. Acceptance of the plant produced material for air voids and VMA shall be if the materials are within the specification limits. One or more or the tested elements outside of the acceptable limits shall be subject to an engineering review and possible corrective action. For projects where less than three samples are required, acceptance of the material shall be based on the individual tests meeting the tolerances shown in Table 32 12 16-10 along with adherence to the job mix formula.

Table 32 12 16-10
Acceptance Limits for Air Voids, VMA and Density

Test	Lower Specification Tolerance Limit	Upper Specification Tolerance Limit
Air Voids total mixture1	3	5
VMA1	Table 32 12 16-6	NA
In-Place Density (percent theoretical maximum density)	92	96

F. Acceptance of the plant produced material for gradation shall be accepted if the gradation of the aggregate falls within the limits specified. Two consecutive gradations falling outside the limits or one gradation falling outside the Suspension Limits will warrant corrective action and shall be subject to engineering review. Acceptance of the plant produced material for binder content, shall be accepted if the binder meets the specification in Table 32 12 16-9 for the binder grade specified.

Table 32 12 16-11
Control Limits for Individual Measurements

Sieve	Action Limit	Suspension Limit
1 in.	0 %	0 %
¾ in.	± 6 %	± 8 %
½ in.	± 6 %	± 8%
d in.	± 6 %	± 8 %
No. 4	± 5 %	± 6.5 %
No. 8	± 5 %	± 6.5 %
No. 30	± 4 %	± 5.5 %

No. 200	± 2%	± 3 %

G. Field Placed Material.

1. Hot mix asphalt pavement shall be tested for in-place density. Acceptance testing will consist of one core per 500 tons of hot mix asphalt as outlined in Table 32 12 16-9. Percent compaction shall be determined from cores. If nuclear density measurements are allowed for acceptance of field placed material, nuclear densities shall be taken in accordance with ASTM D 2950. The nuclear density gauge shall be calibrated to a minimum of seven cores taken from the same material in accordance with paragraph 3.5 of ASTM D 2950.***C***ore samples shall be neatly cut with a core drill or other approved equipment. The minimum diameter of the sample shall be four inches. Samples that are clearly defective, as a result of sampling, shall be discarded and another sample taken. Cores or nuclear densities shall not be taken closer than one foot from a transverse or longitudinal joint. Furnish all tools, labor, and materials for cutting samples and filling the cored pavement. The Contractor is responsible for supplying the Owner's materials laboratory with the core samples. Cored holes shall be filled in a manner acceptable to the Agency and within one day after sampling.

H. Test results of the percent compaction shall be determined by dividing the density reading of the nuclear density gauge or core by the theoretical maximum density of the product as determined by AASHTO T 209. Testing frequency shall be in accordance with Table 32 12 16-9. The required compacted HMA mat thickness shall be as specified on the construction plans and/or specified in the Special Conditions. Final mat thickness shall be determined by coring the compacted HMA mat. No individual core thickness shall be greater than ½" less than specified and the average of all core thicknesses shall be at least 95% of the specified thickness on the construction plans and/or Special Conditions. When core thickness is less than ninety percent (<90%) of that specified the Contractor is required correct the situation at his expense. Surface Smoothness of the final riding surface of all pavements are subject to testing by the 10-foot straightedge method. Furnish an approved 10-foot straightedge and depth gauge and provide an operator to aid the Engineer in testing the finished pavement surface. Areas to be tested shall be determined by the Engineer or the Construction Inspector. The variation between any two contacts with the surface shall not exceed 3/8 inch in 10 feet. Areas showing deviation of more that 3/8 inch shall be marked and corrected at the Contractor's expense.

3.8 CONTRACTOR QUALITY CONTROL.

A. Control all elements which affect the quality of the pavement including, but not limited to:

1. Mix Design
2. Aggregate Grading
3. Quality of Materials
4. Stockpile Management
5. Proportioning
6. Mixing and Transportation
7. Placing and Finishing
8. Asphalt Content
9. Compaction
10. Surface Smoothness

B. Provide a fully and properly equipped asphalt laboratory or shall hire an independent testing laboratory for quality control testing. Laboratory facilities shall be kept clean and all equipment shall be maintained in proper working condition. The Owner's designated representative shall be permitted unrestricted access to inspect the Contractor's laboratory facility and witness quality control activities. The Owner's representative will advise the Contractor in writing of any noted deficiencies concerning the laboratory facility, equipment, supplies, testing personnel and testing procedures. When the deficiencies are serious enough to be adversely affecting test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

C. Perform all quality control tests necessary to control the production and construction processes applicable to these specifications. Quality control test results shall be submitted to the Engineer within 24 hours of sampling. Engineering technicians performing the testing shall have qualifications in the appropriate field equivalent to a NICET Level II or higher construction materials technician or highway construction technician, or LabCAT Level C and shall have a minimum 2 years of experience testing hot mix asphalt. The quality control testing generally includes the following tests:

1. Asphalt Content: One asphalt binder content test shall be performed per sublot for determination of asphalt content and shall be sampled at the same time as the VMA and air voids samples are obtained.
2. Gradation: Aggregate gradations shall be determined from mechanical analysis of extracted aggregate. When asphalt content is determined by a nuclear method, aggregate gradation shall be determined from the cold feed on drum mix or continuous mix plants or from hot bin samples on batch plants. The samples shall use actual batch weights to determine the combined aggregate gradation of the mixture.
3. Temperatures: Temperatures shall be checked, at least twice per day, at necessary locations to determine the temperatures of the dryer, the binder in the storage tank, the mixture at the plant and the mixture at the job site.
4. In-Place Density Monitoring: It is recommended that the Contractor conduct testing to ensure that the specified density is being achieved during the construction of the HMA pavement. A nuclear gauge shall be used to monitor the pavement density in accordance with ASTM D 2950.
5. Additional Testing: Any additional testing that the Contractor deems necessary to control the process may be performed at the Contractor's option.
6. Monitoring: The Engineer and/or the Owner reserve the right to monitor any of the quality control tests listed above and to perform verification sampling and testing of all materials.
7. Sampling: When directed by the Engineer, sample and test any material that appears inconsistent with similar material being sampled, unless such material is voluntarily removed and replaced, or deficiencies corrected by the Contractor. All sampling shall be in accordance with standard procedures specified.

END OF SECTION

SECTION 32 34 23
FABRICATED ROADWAY BRIDGE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes designing, furnishing, and installing a shop assembled, fabricated weathering steel bridge as shown on the Drawings.

1.2 REFERENCES

A. American Society of Testing and Materials International (ASTM)

1.	ASTM A 242	Specification for High Strength Low-Alloy Structural Steel
2.	ASTM A 307	Specification for Carbon Steel Bolts and Studs, Latest Edition
3.	ASTM A 325	Specification for High Strength Bolts for Structural Steel Joints, Latest Edition
4.	ASTM A 588	Specification for High-Strength Low-Alloy Structural Steel with 50 ksi Minimum Yield Point to 4-inch thick
5.	ASTM A 847	Specification for Cold-Formed Welded and Seamless High Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance

B. American Association of State Transportation Highway Officials (AASHTO)

1. Standard Specifications for Highway Bridges, most recent Edition with current Interims
2. LRFD Bridge Design Specifications - Ninth Edition; Incorporating Errata: 2020 or most recent edition.

C. American Institute of Steel Construction (AISC)

1.	AISC 303	Code of Standard Practice for Steel Buildings and Bridges, Latest Edition
2.	AISC MSC	Manual of Steel Construction, Latest Edition
3.	Highway Structures Handbook	

D. American National Standards Institute (ANSI)

1.	ANSI Z49.1	Safety in Welding and Cutting, Latest Edition

E. American Welding Society (AWS)

1.	AWS B2.1-05	Welding Procedure and Performance Qualification
2.	ANSI/AWS D1.1	Structural Welding Code, Latest Edition
3.	AWS D1.5	Bridge Welding Code – Steel

F. Steel Structures Painting Council (SSPC)

1.	SSPC SP-6	Commercial Blast Cleaning
2.	SSPC SP-7	Brush-Off Blast Cleaning

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Bridge Manufacturer Qualifications:

1. Copy of AISC Certification.
2. Name and resume of design engineer.
3. List of 5 successful bridge projects, each of which has been in service for at least 3 years.
4. Welder's certifications.

C. Shop drawings and bridge manufacturer's standard schematic drawings and diagrams:

1. Unique drawings prepared to illustrate the specific portion of the work to be done.
2. All relative design information such as member sizes, bridge reactions, and general notes shall be clearly specified on the Shop Drawings. Service load reactions exceeding the loads in the shop drawings or specified herein require approval by the Engineer.
3. Shop Drawings shall be accurately prepared by skilled draftsmen to be complete in every respect. Shop Drawings shall have cross-referenced details and sheet numbers. All Shop Drawings shall be signed and sealed by a Professional Engineer licensed in the state of Colorado responsible for the design of the bridge superstructure, and design of the abutments for the Spillway Bridge.
4. Calculations to demonstrate the bridge can support the design load. All calculations must be signed and sealed by a Professional Engineer licensed in the state of Colorado responsible for the design of the bridge superstructure.

D. Certifications:

1. Certified Mill test results for all structural and bridge deck steel. Charpy V-notch impact test results for main steel members.

E. Installation and Rigging Plan:

1. Accompany delivered units with a comprehensive Installation and Rigging Plan stamped by a Professional Engineer experienced with installing long span bridges that provides manufacturer's installation sequence, recommended handling, placement, fit-up, bolting, and securing to the abutment system.
2. Include a sequential description of the installation of the bridge, number and types of equipment to be used for the bridge installation, and Site Plan Drawing showing installation equipment locations during installation such as bridge staging, cranes, and other support equipment.
3. Laminate the Installation and Rigging Plan in a manner suitable for review and use in a field environment.

F. Manufacturer's Written Warranty.

1.4 QUALITY ASSURANCE

A. A list of approved bridge manufacturers which are certified as AISC Major Steel Bridge (CBR) fabricators are provided below. These manufacturers have a quality management system that supports fabrication practices necessary to meet the contract requirements,

including a welding quality assurance system in accordance with AASHTO/AWS D1.5 - Bridge Welding Code, and have experience in fabricating girders that have bolted splices.

B. The materials and workmanship shall be in accordance with the best standard practices of modern bridge construction. All materials used in fabrication of the superstructure shall conform to the applicable Specifications. Bridge fabrication must be conducted in an AISC (American Institute of Steel Construction) shop approved for Major Bridge fabrication.

C. The bridge manufacturer shall be a qualified fabricator who participates in the AISC Certification Program and is designated an AISC Certified Plant, Category Major Steel Bridge (CBR) at time of bid.

D. The bridge manufacturer shall provide a Professional Engineer licensed in the State of Colorado with a minimum of 5 years of bridge design experience to perform all engineering related design. Calculations and details shall be checked by a qualified engineer.

E. The bridge manufacturer shall have at least 5 years of experience fabricating these types of structures and have at least 5 successful bridge projects, each of which has been in service for at least 3 years. The bridge manufacturer shall provide a list of the location, bridge size, owner, and a contact for reference for each of the 5 projects.

F. Approved Bridge Manufacturers, certified as AISC Major Steel Bridge (CBR) fabricators at the time of preparation of this document:

1. BigR Manufacturing, LLC
   P.O. Box 1290
   Greeley, CO 80632
   Telephone: 800-234-0734
2. Contech Bridge Solutions, Inc.
   9025 Center Pointe Drive, Suite 400
   West Chester, OH 45069
   Telephone: 800-338-1122
3. Excel Bridge Manufacturing
   12001 Shoemaker Ave.
   Santa Fe Springs, CA 90670
   Telephone: 800-548-0054

G. All materials used in the fabrication of the superstructure, frame, deck, and guardrails shall be new and conform to the standards and quality for this type of fabrication and best engineering practices.

H. Acceptance of the structure will occur after it has been fabricated and delivered in accordance with these Specifications, and after all required certifications have been furnished.

I. Welding: All welding shall be completed to AWS D1.5 specifications by certified welders meeting requirements and qualifications tests of the American Welding Society. Welding operators shall be certified for the 6G position in accordance with AWS D1.5. All welds shall conform to specifications of the American Welding Society.

1.5 DELIVERY, HANDLING, AND STORAGE

A. Deliver the bridge, complete with guard rails.

B. The bridge manufacturer shall provide notice of delivery 14 days prior to the anticipated delivery date, and 7 days prior to the firm delivery date. Do not make deliveries on a weekend or holiday.

C. Design and supply each bridge module with a minimum of 4 or more integral lifting lugs to facilitate safe handling and placement of the bridge module.

D. The Contractor is responsible for unloading the bridge and gate from the truck at the time of arrival. The bridge supplier/manufacturer shall have a representative on Site during placing of the bridge on the abutments to assure that damage to the bridge does not occur during handling.

E. Lift and support units only at designated lifting and supporting points.

1.6 WARRANTY

A. Submit manufacturer warranty covering the structure and appurtenances from design, material and workmanship defects for a period of 10 years from the date of delivery. The manufacturer warranty may exempt wood attachments or to defects in the bridge caused by abuse, misuse, overloading, accident, improper maintenance, alteration or any other cause not the result of defective materials or workmanship. Repair or replacement is the exclusive remedy for defects under this warranty.

PART 2 PRODUCTS

2.1 GENERAL

A. Domestic (USA) site-specific modular bridge manufacture with full material traceability provided upon customer request.

B. Unpainted, self-weathering bridge fabricated from high-strength, self-weathering, low alloy, atmospheric corrosion resistant ASTM A847 cold-formed welded square and rectangular tubing and ASTM A588 or ASTM A242 plate and structural steel shapes.

C. Field splices fully bolted with ASTM A-325 Type 3 high-strength bolts in accordance with the AISC Manual of Steel Construction. No field welded structural connections will be permitted.

D. Blast clean exposed surfaces of self-weathering steel in general accordance with SSPC SP-6 or SSPC SP-7 prior to shipment in a manner that will remove mill scale and rust and provide uniform weathering appearance.

2.2 BRIDGE DESIGN

A. Verify span length, substructure clearance, and elevation of bearing supports required by the bridge manufacturer, and clearance between the ends of the bridge and the abutments.

B. Design bridges with a full bolt-together design that eliminates the need or requirement for field-welding on the bridge or its anchoring system. Provide field splices fully bolted with ASTM A-325 Type 3 high-strength bolts in accordance with the AISC Manual of Steel Construction. Each bridge module shall incorporate more than one main support

beam to maximize safety and eliminate a “fracture critical” designation. No field welded structural connections will be permitted.

C. Load Ratings:

1. Dead load: Weight of bridge structure and decking.
2. Uniform design live load: HL-93 Design Vehicle.
3. Point design load: 1,000 pounds distributed over a 2.5-foot by 2.5-foot area at any point of the bridge deck.
4. Seismic design load: AASHTO LRFD Bridge Design Specifications Site Class D.
5. Bridge Deck: Designed for loads specified herein and designed to carry the imposed deck loads at the stringer or floor beam spacing as determined by the bridge manufacturer.
6. Deflection, wind load and wind uplift: Based on AASHTO LRFD Bridge Design Specifications.

D. Approximate Dimensions:

1. Total Length: 80 feet. Width: 18 feet clear between rails.
2. The approximate length of the bridge does not include the clearance between the end of bridge and the structures at each end, as determined by the bridge manufacturer. Provide allowance for temperature expansion between the ends of the bridge and the supporting structures.
3. Bridge widths are from the inside face of structural elements at deck level.

2.3 DECKING

A. Furnish bridge with a stay-in-place galvanized steel form deck suitable for pouring a reinforced concrete slab of normal weight concrete. Design form deck to carry the dead load of the wet concrete, weight of the form decking, asphalt wearing surface and construction load of 20 PSF uniform load or a 150 pound concentrated load on a 1′-0″ wide section of deck.

2.4 SAFETY RAILS

A. Horizontal safety rails placed on the structure up to a minimum height of 42 inches above the deck surface. Safety rails may be placed on the inside or outside of the structure at the bridge fabricator's option. Safety rails placed on the inside of the truss shall have their ends sealed and ground smooth so as to produce no sharp edges.

B. Fabricated in a manner to prevent a 4 inch sphere from passing through the truss.

C. Designed for an infill loading of 200 pounds, applied horizontally at right angles, to a one square foot area at any point in the system.

2.5 ACCESSORIES

A. Assembly and anchor bolts.

B. Manufacturer’s recommended bearing plates and electrometric bearing pads.

C. Expansion joints compatible with the superstructure and abutment as recommended and supplied by the bridge manufacturer.

PART 3 EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

A. Deliver bridge by truck to a location nearest the Site accessible by roads. Hauling permits and freight charges are the responsibility of the manufacturer or Contractor.

B. The bridge manufacturer shall coordinate with the Contractor regarding the delivery and erection schedule for the bridge and security gate.

3.2 ERECTION

A. Follow manufacturers written instructions for the proper lifting procedure for unloading and erecting the bridge. Care must be taken to prevent damage to the finish of the bridge.

B. The Professional Engineer who prepared and stamped the rigging plan shall be present during the installation of the bridges.

C. Provide a licensed representative of the bridge supplier/manufacturer at the site to supervise placement of the bridge on the abutments.

D. No bolting, drilling or welding of final structure will be permitted without prior approval of the manufacturer.

E. Do not proceed with erection of the bridge structure until substructure concrete has reached 100% of the design strength in accordance with Section 03 30 00: Cast-in-Place Concrete.

END OF SECTION

SECTION 32 92 19
NATIVE SEEDING

PART 1 GENERAL

1.1 SUMMARY

A. This section includes preparing topsoil as seedbed and seeding disturbed areas in the zones identified on the Drawings.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Seeding plan including:

1. Qualifying experience for personnel responsible for supervision of seeding, hydraulic mulching, and seedling planting, for approval. Qualifying experience to include names, addresses, and telephone numbers of references for proposed individuals. Qualifications may be waived for pre-qualitied contractors.
2. Proposed seedbed preparation, seeding, amendment/fertilizer incorporation, and mulching equipment.

C. Statements of guarantee and/or certifications from vendors who supply seed, mulches, and tackifiers.

D. Seed

1. Name and address of proposed seed suppliers before ordering.
2. Origin of seed.
3. Percent purity and germination.
4. Signed statement from supplier certifying that the seed furnished is from a lot that has been tested by a recognized laboratory for seed testing within 6 months prior to the date of delivery.
5. Seed tag from each mix ordered, at completion of work or more frequently if requested by Engineer.
6. Seed source weed content test results to Engineer prior to completing seed order.

E. Hydraulic mulch and tackifier product data and installation instructions.

F. Erosion control blanket product data and installation instructions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be furnished in original manufacturers shipping bags or containers and remain in these bags or containers until they are used.

B. All materials shall be stored in a manner that will prevent them from contact with precipitation, surface water, or any other contaminating substance.

C. Deliver each type of seed in separate sealed containers and fully tagged with Zone designation. All seed shall be tagged as “Certified” and presented to Engineer for approval.

1.4 QUALITY ASSURANCE

A. The seeding and planting contractor shall have experience seeding and planting in Colorado (at about elevation 7000 to 8000 feet) on at least 5 projects of similar size and scope.

B. Perform work in this section with personnel thoroughly familiar with proper and accepted methods for soil preparation, fertilizing, seeding, and mulching and under the direct supervision of a qualified superintendent.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials furnished shall be free of noxious weeds including, but not limited to Russian knapweed, diffuse knapweed, Canada thistle, field bindweed, Johnson grass, leafy spurge, kochia, curly dock or any state-listed noxious weed species.

B. Any materials that have become wet, moldy, or otherwise damaged in transit or in storage shall not be used.

2.2 SEED MIXTURES

A. Seed Mixtures and application rates are as shown on the Drawings.

B. Minimum germination shall be aligned with typical standards by species. Germination amounts will be reviewed by the Engineer. Substitutions will be allowed only when the designated material is not available and as authorized by the Engineer. Except for named varieties, all seed shall be from sources native to Colorado and adapted to the site.

C. Furnish seed in bags or containers clearly labeled and tagged as certified seed to show the name and address of the supplier, the seed name, the lot number, net mass (weight), origin, the percent of weed seed content, the guaranteed percentage of purity and germination, pounds of (PLS) of each seed species, and total pounds of PLS in the container.

D. Seed shall be free from all listed noxious weeds for the State of Colorado, including but not limited to Canadian thistle, musk thistle, dalmation toadflax, knapweed, leafy spurge, and other species listed by the Colorado Department of Agriculture and/or County. Seed which has become wet, moldy, or damaged in transit or in storage will not be accepted.

E. Seed and seed labels shall conform to all current State and Federal regulations and will be subject to the testing provisions of the Association of Official Seed Analysis. If seed available on the market does not meet the minimum purity and germination percentages specified, the Contractor must compensate for a lesser percentage of purity or germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of PLS in pounds.

2.3 AMENDEMENTS AND FERTILIZER

A. Provide products for amending topsoil before seeding in accordance with Section 31 14 13: Topsoil Stripping, Stockpiling, and Placement.

2.4 HYDRAULIC MULCH MATERIAL

A. Hydraulically applied mulch product with incorporated adhesive binder (tackifier), that does not contain any mineral filler, recycled cellulose fibers, clays, or other substances which may inhibit germination or growth of plants, and be non-toxic and non-injurious to plants, wildlife, or personnel.

B. Product: Flexterra Extended Term-Flexible Growth Medium (ET-FGM) with Cocoflex addition, fully bio-degradable with a functional longevity of up to 24 months for slopes greater than 4:1. Tack-30 by Rantec, Plantago based mulch tackifier with wood fiber mulch or equivalent for slopes less than 4:1.

C. ET-FGM shall consist of wood and coconut fibers and manufacturer's proprietary biodegradable fibers bound together by adhesive and premixed at the factory. The wood fibers shall be manufactured expressly from clean whole wood chips and contain a range of fiber lengths. The adhesive binder shall be formulated to form a water resistant bond. The fibers shall be colored yellow or green with a water-soluble, non-toxic dye to help the operator apply the material uniformly. The mixture shall also contain a copolymer gel. A sample of the ET-FGM shall be submitted for approval at least two weeks in advance of its use on the project. Tack 30 by Rantec with wood fiber mulch or equivalent shall be applied per manufacturer recommendations.

D. Mix Water: Clean, fresh and free of substances which could inhibit vigorous growth of plant material.

2.5 EROSION CONTROL BLANKET

A. North American Green C125BN coconut fiber blanket with biodegradable netting on both sides, or approved equivalent.

PART 3 EXECUTION

3.1 GENERAL

A. Notify Engineer 48 hours in advance and obtain approval before proceeding with work in this section. Each seeding zone per the plan shall be clearly delineated in the and approved by Engineer prior to seeding.

B. Present seed tags to Engineer and obtain approval before using any seed.

C. Complete seeding as soon as practical after the completion of final grading. Coordinate the actual start of the seeding operation with Engineer. Seeding shall occur between September 1 and June 1, unless otherwise permitted by the Engineer. Do not drill or sow seed during windy, rainy weather or when ground is frozen or otherwise unable to be tilled.

3.2 SOIL/SEEDBED PREPARATION, SOILAMENDMENTS

A. Prepare subgrade and place topsoil in accordance with Section 31 14 13: Topsoil Stripping, Stockpiling, and Placement.

B. In areas where equipment cannot be operated, prepare the seedbed by hand with raking or other approved methods.

C. If the topsoil is compacted, use a spring tooth harrow equipped with utility or seedbed teeth, or similar equipment, to loosen and smooth the soil surface.

D. If the topsoil is loose, compact with a culti-packer or similar implement to provide a firm seedbed.

E. Ripping and tilling operations shall be done in a direction which follows the natural contour of the land on slopes of 3H:1V or flatter. Prepare soils on slopes steeper than 3H:1V with track walking or other method approved by the Engineer. Any irregularities in the ground surface resulting from soil preparation operations shall be corrected and sloped to drain unless otherwise directed by the Engineer.

F. Apply soil amendments and/or fertilizers on surface of spread topsoil and till thoroughly into top 4 inches before seeding. pH and nutrient amendments shall be based on soil and nutrient testing recommendations.

3.3 SEEDING

A. Drill Seeding:

1. All seed is to be drilled ¼-inch to ½-inch into the soil at the specified pure live seed (PLS) per acre rate with a mechanical grass drill with depth bands and an agitator in the seed box. Rows shall be spaced not more than 7 inches apart. Contractor shall drill 1/2 of the required PLS per acre in one compass direction, and then drill the remaining half of the required PLS per acre in a direction 90° to the first half.

B. Broadcast Seeding:

1. Some areas may be inaccessible to a drill. In these areas, which shall be agreed upon by Contractor and Engineer, seed shall be uniformly broadcast at the specified PLS per acre and covered with soil to a depth of ¼-inch to ½-inch by hand raking or harrowing by some other means acceptable to Engineer.
2. Broadcast seeding shall be accomplished using hand-operated “cyclone-type” seeders or rotary broadcast equipment attached to construction or revegetation machinery. All machinery shall be equipped with metering devices. Broadcasting by hand shall be acceptable on small, isolated sites and steep slopes. Prior to hand broadcast seeding, divide the seed required into two portions. Apply the first half of the seed and then follow up by applying the second portion to ensure complete coverage by seed. When broadcast seeding, passes shall be made over each site to be seeded in a manner to ensure an even distribution of seed. When using hopper type equipment, seed shall be frequently mixed within the hopper to discourage seed settling and uneven planting distribution of species.
3. Broadcast seeding shall take place immediately following the completion of final seedbed preparation techniques and upon inspection and approval of Engineer. Broadcast seeding should not be conducted when wind velocities could prohibit even seed distribution.

3.4 HYDRAULIC MULCH

A. Hydromulch is to be applied as mulch in all areas not otherwise to be covered with coir mat or coconut blanket as shown on the Drawings. Hydromulch shall consist of mechanically de-fibrated virgin wood fiber hydromulch applied at a rate of no less than

2500 pounds/acre plus 150 pounds/acre approved organic tackifier. Hydromulch shall be applied from the ground by hose from two directions to minimize the ‘shadow’ effect.

B. Apply ET-FGM or Tack-30 with wood fiber mulch over all seeded areas after broadcast seeding is completed. Do not mix seed.

C. Do not apply when rain is imminent, and manufacturer’s minimum cure time cannot be met. Replace damaged ET-FGM or Tack-30 with wood fiber mulch.

D. Apply ET-FGM and Tack-30 with wood fiber mulch mixture at the manufacturer’s recommended rate of application for site-specific conditions and slopes.

E. Apply mixture in even layers, working back and forth between top and bottom of the slope, to uniformly cover soil with the mixture. Spray the product through a fan or slit-type nozzle (22 to 50 degree tip). The nozzle shall create a fine, uniformly dispersed spray that "rains down" on the soil. Unless otherwise approved, apply in opposing directions to ensure complete coverage with no “shadowing” in accordance with the manufacturers written instructions.

F. Do not apply hydraulic mulch in ditches or other areas of concentrated flow.

G. If mulching fails to prevent gullying or other seed and seedbed loss, restore the seedbed to the finished grade, reseed and mulch at no additional cost to the Owner.

3.5 EROSION CONTROL BLANKETS

A. Areas to be covered with erosion control blankets shall be properly prepared, seeded, and mulched before blankets are placed. The soil shall be free of clods, rocks, wood, and other obstructions over one inch in diameter so that the blankets are in direct contact with soil. No gaps or voids shall exist under the blankets.

B. Blankets shall be installed starting at the upstream end and unrolled in the direction of the flow of water. Blankets shall be placed smoothly but loosely on the soil surface without stretching. Blankets shall be staked and anchored according to the details shown on the Drawings. On uncut coir edges, a minimum edge distance of 4-inches from the edge of blanket to the edge of the stake shall be maintained. To reduce unraveling of edges, all cut edges of coir shall be folded under 6-inches and staked a minimum of 4-inches from the edge of blanket. Any blanket adjacent to hard surfaces shall be fully blanketed to the edge of the hard surface, leaving no soil exposed. The starting edge of the blanket installation shall wrap soil to the hard surface and be secured in a trench as shown on the Drawings. Any downstream edge of blanket ending at a hard surface shall be lapped (12-inches overlap with cut end folded under 6-inches) over an additional short section of coir mat as shown on the Drawings to cover all soil to the edge of the hard surface (shingle lap downstream).

C. Initial anchor trenches shall be used at the upstream end of all installations. Terminal anchor trenches shall be installed at the downstream ends of all installations. Longitudinal trenches shall be installed at the toe and top of slopes.

D. When blankets/mats need to be spliced at ends, place upstream blanket/mat over the downstream blanket/mat with an overlap of 12-inches and stake using wood stakes at one-foot transverse spacing. Intermediate staking (in addition to the staking details shown on

the Drawings) shall be completed using stakes at one-foot transverse spacing at 50-foot intervals along the length of the blankets.

3.6 PROTECTION/MAINTENANCE

A. Maintain all seeded areas in good condition until final acceptance. Seeded areas will be reviewed by the Engineer for bare soils caused by surface or wind erosion. Bare areas caused by surface or gully erosion, blown away mulch, displaced erosion control blankets etc. shall be regraded, seeded, and have mulch (or erosion control blanket) applied as necessary.

B. Protect seeded areas subject to vehicular traffic with warning signs and barricades.

END OF SECTION

SECTION 32 96 10
NATIVE PLANTING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for accepting, transporting and transplanting planting Owner-Furnished containerized plants in the types, quantities, and planting zones shown on the Drawings.

1.2 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Planting Plan including:

1. Qualifying experience for personnel responsible for supervision of planting, for approval. Qualifying experience to include names, addresses, and telephone numbers of references for proposed individuals. Qualifications may be waived for pre-qualitied contractors.
2. Plan to sequence and schedule planting work with seeding to preserve viability of both planting and seeding.
3. Proposed fertilizers, backfill, planting mix, seed, mulches, and soil amendments.
4. Methods to maintain plant viability from acceptance through delivery and transplanting.
5. Methods to maintain plant viability after planting.

C. Signed statement from the Contractor for each load of plants picked up from the Contract Grow Nursery indicating the number and type of plants transported to the site and a statement indicating the contractor has inspected the plants and accepts responsibility for maintaining plant health viability until final acceptance.

D. Documentation of planting accessories as required by the Engineer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. The Contractor is responsible for transporting Owner-Furnished plants from the Owner's Contract Grow Nursery to the site.

B. Plant Protection During Transport:

1. Plants shall be packed, shipped, and handled so that they are adequately protected from excessive heat, desiccation, and other injury. All plants shall be thoroughly watered prior to during packing prior to transport.
2. Plants shall be securely tarped covered or enclosed during transportation to prevent wind burn.
3. Plants shall be kept under cover and/or in the shade whenever possible.
4. Plants shall be watered as soon as they arrive on the site and placed into the holding facility and when the plants are planted.

C. On-Site Plant Storage: Contractor shall be responsible for constructing a holding facility on-site prior to receiving any live plant material. This holding area shall be inspected and approved by the Engineer before use. The facility shall provide protection from excessive

sun and wind; browsing by deer, rodents, or other animals; and adequate irrigation to maintain plant health.

1. Protection from the sun shall be in the form of shade cloth or other similar material that still allows passage of adequate sunlight.
2. Protection from the wind shall be such that proper ventilation and air exchange are maintained.
3. Irrigation shall be adequate to keep the root balls of all plants consistently moist. Water application rates shall be easily modified to account for different plant species and sizes, and weather conditions.
4. If overhead irrigation is used, droplet size shall be small enough to not cause mechanical damage to the plants (including dislodging or eroding soil from their containers).
5. Plants shall not be so tightly arranged as to prevent irrigation from penetrating the root balls/containers.
6. Plants shall be monitored daily to ensure proper watering and sun/wind protection. If stressed, wilted, or dying plants are observed, corrective action shall be taken immediately.
7. No plants shall be stored on-site (including in the holding facility) for more than 21 days, unless pre-approved by the Engineer.

D. Protect all materials used for construction from damage, deterioration, or loss of any kind while in storage and construction.

E. All plant cones and trays at the completion of planting must be returned to the respective contract grow nursery.

1.4 COORDINATION

A. Coordinate work in this Section with other site work including topsoil placement and seeding to ensure proper sequencing of construction.

B. Coordinate with Engineer before plant pick-up and delivery so the Engineer can review nursery provided materials for species correctness, plant health, size including height, form, and root dimension, and vigor.

C. Planting operations shall be performed only during periods when beneficial results can be obtained. When drought, excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped when directed. When special conditions warrant a variance to the planting operations, proposed planting times shall be submitted for Engineer for approval.

1.5 QUALITY ASSURANCE

A. Contractor shall appoint a competent resident superintendent. The superintendent shall be experienced in the specified techniques of woody plant installation and be on-site whenever this work is in progress. The superintendent shall not be replaced without notice to Engineer.

B. Workers shall be competent in performance of the work they are assigned.

PART 2 PRODUCTS

2.1 GENERAL

A. Planting zones, plant types, and planting quantities are shown on the Drawings. Deviations or adjustments to the Drawings require Engineer approval.

2.2 WATER

A. Water for planting during the construction period and supplemental watering as required: clean, fresh and free of substances which could inhibit vigorous growth of plant material.

2.3 PLANTING MIX

A. Planting mix approved by the Engineer suitable for establishing vegetative growth. Planting mix to be unamended topsoil as defined in Section: 31 14 13 Topsoil Stripping and Stockpiling and shall meet the criteria in Table 31 14 13-1 unless otherwise approved by the Engineer.

2.4 WOOD CHIP MULCH

A. Coordinate with Owner and Engineer for sourcing wood chip mulch. Wood chip mulch to be from a site approved by the Engineer. The mulch shall be between ½ to ¾ inches in diameter and 1 ½ to 5 inches long or as approved by the Engineer.

2.5 PLANTS

A. Plants in the size and types shown on the Drawings will be Owner-Furnished from the Contract Grow Nursery.

B. The Contractor and Engineer will jointly inspect the plants at the Contract Grow Nursery to confirm the health and viability of the plants before transport to the site.

C. Contractor's responsibility for maintaining the health and viability of the plants starts from the time the plants are picked up from the Contract Grow Nursery and extends until final acceptance.

D. The owner has contracted for approximately 5% additional plants than are included on the plans. The additional plant locations will be determined by the Engineer in the field.

PART 3 EXECUTION

3.1 GENERAL

A. All sites designated for native plantings shall be planted in accordance with the planting details on the plans. Comply with the Planting details for specific spacing requirements including dimension and layout as indicated on the planting details to determine the spacing between each plant.

B. Stake out each individual planting pit is not required. However, upon planting a typical 1,000 square feet area within each planting zone, notify the Engineer to inspect and approve plant spacing and planting techniques prior to proceeding. Any extra native plantings above that specified in the plans shall be planted at the direction of the Engineer.

3.2 PREPARATION

A. Pre-planting Observation and Approval:

1. Obtain Engineer approval of plant material before planting. This observation may be either at the site, nursery, or holding area, at the option of Engineer. Materials planted prior to approval are subject to rejection. Observation of materials may be sequenced by major planting areas to accommodate efficient planting operations. Acceptance of plant material at the nursery or holding area does not preclude rejection at the site. All rejected materials shall be removed from the site, replaced in kind, and reinspected before planting.
2. All fertilizers, backfill, seed, mulches, and soil amendments shall be reviewed at the site by Engineer before they are used in planting operations.

B. Obtain Engineer approval of site preparation in each area before beginning any planting work.

C. Contaminated Soil: Do not perform any soil preparation work in areas where soil is contaminated with cement, plaster, paint or other construction debris. Bring such areas to the attention of the Engineer.

D. Planting Pits:

1. Dig planting pits minimum 2 times the size of the soil ball and the depth of the soil ball.

E. Existing Tree Roots:

1. When the cutting of tree roots is necessary, each final cut shall be made as cleanly as possible for all roots over 3 inches in diameter using the following method:

    a. The line of excavation shall be drawn out and appropriate excavation equipment used to clear the area at least 6 inches in front of the actual finished excavation line. Roots can then be cut using tools such as axes, stump grinders, or trenchers.
    b. Each root over 3 inches in diameter shall then be cut cleanly back to the final excavation line using a stump grinder. A sharp hand or bow saw is acceptable for roots under 3 inches in diameter. Axes and trenchers do not cut roots cleanly and shall not be used for final root cuts.

2. All branches shall be cut with a sharp pruner or saw. All cuts shall be cleanly made back to the next crotch or tree, leaving the bark collar intact at the base of the cut.

F. Backfill Material: Planting pits shall be backfilled with the specified improved planting mix.

3.3 CONTAINER STOCK PLANTING

A. The Contractor is responsible to ensuring quality and species correctness before planting. Any dead, dying, stresses, or badly “root-bound” plants will be rejected before planting.

B. Planting holes shall be hand dug or drilled with an auger where necessary to allow deep root penetration and to minimize “j-rooting”. Holes shall be dug twice the width and equal to the depth of the root ball of the plant. Holes will be watered before planting, then filled, tamping down the soil to remove air pockets, and watered again immediately.

C. Place mulch 2 inches deep in a 1-foot diameter around the base of planted container stock.

3.4 CLEANING

A. Remove excess soil and materials resulting from planting operations.

3.5 SUPPPLEMENTAL WATERING

A. Supplemental watering (3 to 5 gallons of water per plant per supplemental watering event) is required for all planted trees and shrubs. Supplemental watering events shall be as approved by the Engineer.

END OF SECTION

SECTION 33 29 00
PIEZOMETER ABANDONMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Abandoning existing open-well piezometers.

1.2 REFERENCES

A. Colorado Code Regulations (CCR): Section 2 CCR 402-2-16 - Standards for Plugging, Sealing, and Abandoning Wells and Boreholes.

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Qualifications of the licensed drilling contractor to perform abandonment and qualifications of geologist or geotechnical engineer hired by the Contractor and approved by the Engineer to inspect and approve the abandonment.

C. Permits, Licenses, and Certificates: Copies of permits, licenses, certifications, inspection reports, records, and similar documents established in conjunction with compliance with standards and regulations bearing upon performance of the Work.

D. Abandonment Plan:

1. Proposed equipment, and methods.
2. Grouting plan:

    a. Grouting mixing and pumping equipment including pumps, lines, gauges, and associated equipment.
    b. Product data for cement and bentonite.

E. Quality Control Records

1. Abandonment Report including measured depth of piezometer and water, and quantities of abandonment materials used for abandonment of each piezometer including neatline versus actual quantities for backfill grout
2. Final top of casing survey data.

1.4 QUALITY ASSURANCE

A. Driller Qualifications: Well driller licensed in the State of Colorado.

B. Geologist or Geotechnical Engineer: Competent individual provided by the Contractor with minimum 5 years' experience in oversight of piezometer well casing drilling, installation, and abandonment.

1.5 ABANDONMENT REPORT

A. The licensed well driller shall complete and file Form GWS 9: Well Abandonment Report with the Colorado Division of Water Resources within ninety days after completion of abandonment.

PART 2 PRODUCTS

2.1 GROUT MATERIALS

A. Cement: ASTM C Type II furnished in 94-lb sacks. Stored and protected to prevent contamination, exposure, and formation of lumps.

B. Bentonite: Natural Wyoming sodium bentonite containing no additives, ground to pass a 200-mesh sieve. Furnished in sacks and free of lumps and foreign matter.

C. Mixing Water: Clean and free from injurious amounts of oil, acid, organic matter, salt, or other deleterious substances.

PART 3 EXECUTION

3.1 PREPARATION

A. Inform the Engineer a minimum of 48 hours in advance of abandoning any piezometer.

B. Document and record the condition, depth, and size of piezometers before abandonment.

3.2 ABANDONMENT

A. Comply with CCR requirements applicable to abandonment.

B. Unless otherwise required by CCR, grout the piezometers with cement-bentonite grout using tremie grouting methods that completely fill the casing or bore hole with grout.

C. Measure and record top of hardened grout at least 48 hours after plugging and top off the hole with additional grout after any shrinkage occurs.

3.3 QUALITY CONTROL

A. Monitor the volume of grout placed. Track and record actual volume used against the calculated neat line volume and submit with abandonment report documentation.

END OF SECTION

SECTION 35 22 10
HYDRAULICALLY OPERATED HINGED CREST GATE AND SLIDE GATE

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Design, manufacture, quality control, shop assembly and testing, delivery, supervision of site installation and testing, warranty and all other services and materials specified and necessary for the following:

1. One hydraulically-operated, hinged crest gate, as shown on the Drawings, complete with:

   a. Gate leaf, hinges, bearings, seals, and other associated parts.
   b. Embedded parts, including bottom seal members, side seal plates, bearing base plates and anchors, operator base plates and anchors, aeration piping ducts, nappe breakers, and other embedded and non-embedded parts.
   c. Two hydraulic cylinder actuators each complete with all mechanical and hydraulic connections.
   d. Erection and maintenance supports.
   e. Electrical heating systems for end plates.
   f. Spare parts for the gates and hydraulic operators.

2. One hydraulically-operated, slide gate, as shown on the Drawings, complete with all parts required for operation.

B. The Contractor has full responsibility with respect to the gate purchasing and installation including coordination of cast-in-place concrete embedments with the gate manufacturer.

C. The crest and slide gates shall be designed and manufactured by a single well-established gate system supplier. The gate system supplier shall have at least ten years' experience designing, manufacturing, and installing gates of the type and general sizes specified herein. The gate system supplier shall also have demonstrated experience within the past five years furnishing complete gate systems, hydraulicoperating systems, and PLC-based control systems on three or more installations in the United States.

D. The gate systems supplier shall furnish, coordinate, integrate, and be responsible for proper functional operation of the gate systems. The gate systems shall include all components required for a fully operational system including but not limited to the gates, hydraulic operating systems, and complete PLC-based control systems designed for integration into the Owner's SCADA system. The control building for housing the PLC and hydraulic power unit and hydraulic fluid storage; hydraulic lines and encasements, conduits, and structural concrete for the gate structure are by others.

1.2 REFERENCES

A. American Institute of Steel Construction (AISC):

1. Steel Construction Manual, 9th Edition - Specification for Structural Steel for Buildings

B. American Society for Testing and Materials (ASTM):

1.	ASTM A 36	Standard Specification for Carbon Structural Steel
2.	ASTM A 325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
3.	ASTM A 516	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
4.	ASTM A 564	Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless and Heat-Resisting Steel Bars, Wire, and Shapes

C. Association of Iron and Steel Engineers (AISE):

1.	Technical Report No. 7	Specification for Ladle Hooks.

D. American Welding Society (AWS):

1.	AWS D1.1	Structural Welding Code – Steel
2.	AWS D1.4	Structural Welding Code – Reinforcing Steel
3.	AWS D1.6	Structural Welding Code – Stainless Steel

E. American Concrete Institute (ACI):

1.	ACI 350	Code Requirements for Environmental Engineering Concrete Structures.

F. American Water Works Association (AWWA)

1.	AWWA C541	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
2.	AWWA C561	Fabricated Stainless-Steel Slide Gates

G. The Society for Protective Coatings/National Association of Corrosion Engineers (SSPC/NACE):

1.	SSPC SP 3	Power Tool Cleaning
2.	SSPC SP 6/NACE No. 3	Commercial Blast Cleaning
3.	SSPC SP 10/NACE No. 2	Near-White Blast Cleaning

1.3 PURPOSE OF EQUIPMENT

A. Hinged Crest Gate:

1. Provide for regulation of the reservoir pool level.
2. The gate will normally be in the raised position.

B. Slide Gate:

1. Regulate flow through the fish bypass system.

1.4 HINGED CREST GATE DESIGN REQUIREMENTS

A. General:

1. The gate and embedded parts shall be designed to meet the requirements specified herein. A corrosion allowance of 1/16 inch (total) shall be made on the thickness of all gate leaf members.
2. The gate system supplier is responsible for the design of the gate equipment and its design for safe and reliable operation. The design requirements specified in this Section are only intended to be minimum requirements. The gate system supplier shall apply more restrictive or more stringent design methods, design loads, codes, and standards consistent with normal accepted engineering practices, as deemed necessary to provide function in accordance with design criteria.

B. Stresses:

1. General:

a. The gate leaf shall be designed as an integral torsion member subjected to fatigue loading.
b. For normal loading conditions, the allowable stresses shall not exceed 75 percent of those permitted by the AISC Specification for Structural Steel for Buildings. For extreme loading conditions, the allowable stresses shall not exceed the lower of those permitted by AISC or 80 percent of the elastic limit of the material.

2. Biaxial Stress Conditions:

a. Biaxial stresses shall be in accordance with the Hencky von Mises criterion of failure:

Where:

$$\frac{F_y}{n} = \sqrt{F_X^2 F_Y^2 - F_X - F_Y + 3T_{XY}^2}$$

F_y	=	minimum specified yield strength of the material
n	=	factor of safety which shall be equal to or greater than 2.5 for normal conditions, and 2 for overloading conditions when considering elastic instability of the gate structure.
F_X	=	normal stress in x-direction
F_Y	=	normal stress in y-direction
T_{XY}	=	shear stress

C. Connection Design:

1. Welded Connections:

a. Allowable stresses for normal loading conditions in welded connections shall not be greater than 75 percent of the values permitted by AWS D1.1. For extreme conditions, the stresses shall not exceed 133 percent of the values permitted by AWS D1.1 provided they do not exceed 80 percent of the elastic limit of the material. Welded field connections on major structural components will not be permitted.
b. The gate leaf shall be continuously welded. The welds connecting the upstream and the downstream skinplates to each other and to the vertical

ribs shall develop the full strength of the plates. The weld joint shall be designed to consider fatigue.

2. Bolted Connections:

   a. All field connections for structural steel shall be designed using high strength bolts in slip critical connections in accordance with AISC Standards. For normal loading conditions, the loads shall not exceed 75 percent of those permitted by AISC Standards. For extreme conditions, the stresses shall not exceed 133 percent of the loads permitted by AISC Standards.

3. Mechanical Components:

   a. For normal loading conditions, the allowable stresses shall not exceed 20 percent of the ultimate strength or 33 percent of the yield strength of the material, whichever is lower. Stresses in welded connections shall not exceed 50 percent of the values permitted by AWS D1.1. For extreme loading conditions, stresses shall not exceed 80 percent of the elastic limit of the material.

4. Bearings:

   a. For self-lubricating bronze bearings, the stresses shall not exceed 5,000 psi for normal loading and 8,000 psi for extreme loading.

D. Design Loads:

1. The gate operating systems shall be designed to maintain a constant upstream normal headwater pool water level elevation as shown on the Drawings, plus or minus 0.1 foot.
2. The gate hoisting system shall have sufficient thrust capacity to raise the leaf from the fully lowered position to the fully raised position when the upstream water level is at elevation 7841.
3. The gates shall be structurally designed to withstand the worst combination of all axial, bending, shear, torsion, thermal fatigue loads from the following loading condition cases:

   a. Hinged crest gate in raised position and 2-year flood water surface at elevation 7836.3 feet with a horizontal ice load of 1,500 pounds per lineal foot of gate applied horizontally at the top of the water surface.
   b. Hinged crest gate in raised position and 10-year flood water surface at elevation 7839.2 feet.
   c. Hinged crest gate in lowered position and flood passing to water surface elevation of 7837.8 feet.
   d. Hinged crest gate in raised position and 100-year flood water surface at elevation 7841.0 feet with a horizontal special debris load of 500 pounds per lineal foot of gate applied horizontally at the top of the water surface.
   e. Hinged crest gate in lowered position and flood passing to water surface elevation of 7841.7 feet.
   f. Hinged crest gate in raised position and 2-year flood water surface at elevation 7836.3 feet with earthquake loads applied. Earthquake loads following seismic coefficient approach with seismic coefficient kh equal to 0.22g. Hydrodynamics force based on Westergaard method.

4. In the event of a power loss, it shall be possible to lower the gate leafs from the fully raised position to the fully lowered position by manually opening a bypass valve at the hydraulic power unit.
5. The gate manufacturer shall also detail, as needed, any special modifications to the concrete crest gate structure to assure the overall structural adequacy of the gate system.
6. Each gate shall take no more than 10 minutes to move from a fully open position to a fully closed position and no more than 10 minutes to move from a fully closed position to a fully open position.
7. The load due to negative air pressure on downstream face of the gate when discharging water shall be accounted for in the gate design.

E. Frictional Forces:

1. The following minimum friction coefficients shall be used in the calculations of hoisting and resisting loads acting on the gates:

Materials	Static Friction	Moving Friction
Anti-friction bearings using average diameter of bearing and including seal and rolling friction	0.02	0.01
Self-lubricating "Lubron," or equal, bearings	0.15	0.10
Rubber seals on steel	1.5	0.80
Rubber seals with fluorocarbon sealing surfaces on steel	0.20	0.10
Steel on steel (unlubricated)	0.50	0.25

1.5 HINGED CREST GATE OPERATING REQUIREMENTS

A. Design and manufacture hinged crest gate equipment to be safely operated under the conditions specified below.

B. Dimensions and Features

1. The following dimensions and features shall be incorporated in the work:

a. Gate Leaf Assemblies:

1)	Location:	Windy Gap Reservoir.
2)	Type of hinged crest gate	Hydraulically operated
3)	Width of gate opening:	75 feet
4)	Top of gate (max raised position):	EL. 7841 feet
5)	Spillway	EL. 7834 feet
6)	Effective height of gate:	7 feet

b. Hydraulic Conditions:

1) The gate equipment shall be designed and manufactured so the gate can be operated under varying differential head conditions and in any position, without objectionable or detrimental vibration of the gate, under the following hydraulic conditions:

Condition	Elevation
Maximum headwater level for gate operation	El. 7841 feet
Normal headwater level (gate raised)	El. 7839.2 feet

C. Hinged crest gates shall be supplied for the spillway sections shown on the drawings. The top edge of the gates will be fitted with nappe breakers to eliminate flow induced vibrations. When in fully raised position, the gate leafs shall lean downstream approximately 20 degrees. The gates will rotate approximately 70 degrees from the fully raised to fully lowered position as shown on the drawings. The gates shall be capable of extended use in any position without vibration.

D. Curve upstream surface of the leaf to a constant radius such that when the leaf is in the fully lowered position, the combined shape of the leaf and the spillway structure shall approximate that of the lower nappe resulting from a total energy head of 4 feet. This shape shall be sufficiently close to provide at the design head a minimum coefficient of discharge of C = 3.2 in the weir equation $Q = CWH^{3/2}$ where Q is the flow in cfs; W is the length of the weir in feet; and H is the total energy head above the fixed crest in feet. The radius shall be sufficiently great to prevent negative pressure on the gate surfaces for any head up to WSEL 7844.0 feet.

E. Climatic Conditions:

1. The operating system shall be operational with an ambient temperature from 10 degrees Fahrenheit to 100 degrees Fahrenheit.

F. Erection and Maintenance Supports

1. Erection struts and associated brackets provided to support the leaf in the full up position with the operator detached from the leaf. Each strut and bracket shall be manufactured from A36 Steel and strong enough to support the leaf in the full up position with a normal water surface elevation to facilitate future maintenance work.

G. Floatation:

1. Gates shall be designed to prevent floatation. Gate system supplier to provide calculations to document buoyancy of gate and design to prevent floatation from occurring.

H. Gate Operation:

1. As agreed during the gate vendor procurement process.

1.6 SLIDE GATE DESIGN

A. Design the slide gate in accordance with AWWA C561 and the following:

1. Total and Seating Head: 10 feet.

1.7 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Experience qualifications meeting the specified requirements.

C. Drawings, calculations, catalog cuts, and material specifications for the equipment proposed.

D. Schedule for the manufacture and delivery of the gate.

E. Schedule for shop fabrication procedures for coordination of in-plant quality control review.

F. Gate manufacturer's hydraulic cylinder and gate hinge loads. The loads shall be presented in vectored quantities in the X and Y components (vertical and horizontal direction). Loads more than those schematically indicated on the Drawings will require the Engineer to reevaluate the stability of the dam structures and may require authorized revisions to the dam substructures.

G. Shop Drawings for all electrical and hydraulic piping and controls and any other equipment which is required for the successful installation and operation of the gate systems.

H. Operating and Maintenance Instructions:

1. Detailed operating and maintenance instructions, including reduced size copies of applicable drawings, applicable parts lists, and catalogs covering all equipment furnished and which may be needed or useful in the operation, maintenance, repairs, dismantling or assembling, and for repair and identification of parts for ordering replacements.
2. The operating instructions shall include all required liquid levels, flows, and pressure settings and settings of all auxiliary protective devices.
3. All catalog pages shall be marked to show the model number selected for each item of equipment.
4. The salient features of the equipment supplied shall be clearly stated and the operation of the hydraulic and electrical controls fully explained.
5. A troubleshooting chart, maintenance timetable, lubrication diagrams, and disassembly, re-assembly and adjustment procedures shall also be provided.
6. Two sets of the operating and maintenance manual shall be supplied in three-ring binders. One set shall have all sheets double contact clear plastic coated.

I. Paint Swatches – Provide paint swatches showing colors of all painted surfaces.

J. Nappe Breaker Arrangement – Nappe breaker arrangement and aesthetic effect shall be submitted for approval by Engineer and/or Architect.

K. Owner Training Plan – Training plan including anticipated hours and training topics.

L. Warranty.

M. Installation Certificate.

1.8 SUBSTITUTIONS

A. The Contractor shall submit to the Engineer for review, a complete list of all materials and equipment which differ in any respect from materials and equipment specified herein or shown or noted on the Drawings.

B. Whenever the name, brand, or model of a manufacturer's article, product item of equipment, or system is specified, it is used as a measure of quality and utility or as a standard. No intent to limit competition is inferred or implied.

1.9 QUALITY ASSURANCE

A. The gates, attachments, and supports including anchors, bearings, and operating mechanisms shall be the product of one manufacturer who has been regularly engaged in the design and manufacture of the types of gates specified for a minimum of 10 years.

B. Detail design shall be under the direct supervision of a professional engineer registered in the State of Colorado and who is under the permanent employ of the gate manufacturer. The engineer shall sign and seal the resultant drawings and calculations.

C. The gate manufacturer shall furnish the services of an experienced erection advisor of the manufacturer during installation, final adjustment and testing of the gates.

D. The manufacturer shall have in effect at all times a QA program which clearly establishes the authority and responsibility of those responsible for the QA program. Persons performing quality functions shall have sufficient and well defined responsibility and authority to enforce quality requirements, to identify, initiate, recommend and provide solutions to quality problems to verify the effectiveness of the solutions.

1.10 WARRANTY

A. A two-year written warranty from the date of acceptance of the Project shall be provided by the gate system supplier to guarantee that the equipment and all accessories will perform as stated in these Specifications.

B. There shall be no defects in material or workmanship in any items supplied.

C. The gate system supplier shall replace, at no cost to the Owner, any item the gate system supplier furnished which fails to perform as specified during the warranty period.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

A. Steel-Fab Inc., Fitchburg MA, Telephone 978-345-1112.

2.2 FABRICATION AND WORKMANSHIP

A. The fabrication of all structural steel parts shall conform to the requirements of the latest revision of the AISC and AWS specifications. Surface finishes shall be indicated on the manufacturer's shop drawings in accordance with ANSI requirements.

B. The gate and associated components shall be fabricated in sections that are convenient for shipment and field erection. All major components shall have lifting ears, eye and/or lugs arranged to facilitate handling during site off-loading and erection.

2.3 CERTIFICATION OF MATERIALS

A. All materials shall be new. Certified material test reports shall be available in the manufacturer's project file for all steel materials. All materials shall be certified to the appropriate American Standards such as ASTM, AISI, ANSI, and AWS or any other standards fully acceptable to the Owner that equal or exceed the American Standards.

2.4 HINGED CREST GATE LEAF CONSTRUCTION

A. Description:

1. Each gate leaf shall be hinged at the bottom and fitted with suitable seals along the bottom and ends. The top edge shall be fitted with nappe breakers.
2. A stub shaft shall be attached to the top of the gates at each end for attaching the hydraulic cylinder operators.
3. Pivoting operating cylinders shall be located above the gates on the side walls of the concrete gate support structure.
4. Cylinders and steel supports shall be mounted on the concrete side walls of the gate support structure.
5. The gates shall be designed to withstand the loading conditions defined in these Specifications.

B. Construction of Gate Leaf:

1. The gate leaf shall be of welded construction.
2. The space between the upstream and downstream skin plates shall be made airtight by welding hermetically and the welds checked for air tightness. The leaf side seals shall be mounted so as not to penetrate the gate leaf thereby eliminating any access ports in the downstream skin compartments that would compromise water tightness.
3. The gate leaf shall transmit the forces from the hydraulic cylinders to the skin plates and bearings and turn, to the embedded anchors through the bearings.
4. The upstream skin plate shall have a minimum thickness of ½ inch and shall be designed to withstand the loading conditions defined in this Section. The skin plate profile shall comply with the channel invert profile shown on the Drawings.
5. The hinge brackets shall be adjustable and accurately aligned and machined to maintain proper location, alignment, and tolerances.
6. The bearing sleeves shall be adjustable and accurately aligned and machined to maintain proper location, alignment, and tolerances.
7. Provision shall be made to dog the gates in the raised position at two locations to provide for maintenance of the hydraulic operators. The arrangement shall permit removal of the hydraulic cylinders in the dogged position.
8. The gate leaf shall consist of curved upstream and downstream skinplates and flat vertical diaphragm plates arranged to form an integral torsion member that will avoid negative pressure zones. The curved plates shall be pressure vessel quality conforming to ASTM A 572 Grade 50. The remainder of the leaf structure will be ASTM A 36 steel.
9. A curved Type 304 stainless steel surface shall be provided directly above the gate hinges to mate with the horizontal double-stem fluorocarbon seal. The end of the leaf shall have a Type 304 stainless steel surface to mate with the end double-stem seals. The top edge of the upstream skinplate shall form a discharge lip of a design to eliminate flow induced vibrations.

10. The vertical diaphragm plates shall assist with stiffening the leaf diaphragm and distribution of loads to the hinge and bearings.
11. Provide drain holes in the downstream skinplate to prevent the accumulation of water inside the gates. Access ports shall be provided in the downstream skinplate for maintenance and inspection.
12. When it is necessary, because of excess length, to manufacture and ship each gate leaf in multiple sections, the joint between the sections shall be machine flanged and bolted using high strength ASTM A 325 Type 3 fasteners then field welded along the seams to avoid leakage.

C. Gate Seals:

1. The gate side seals shall be of rubber, mounted on the base ends of the gate and held in position with clamping bars and stainless steel fasteners. The end seals shall continue to seal with a gate movement of 6 inches from the fully raised position. The seals shall be Huntington Brand, by Seals Unlimited, or engineered equal.
2. The horizontal seal shall be mounted to fabricated steel support members. The support members shall be anchor bolted to the concrete structure in a manner to allow adjustment during erection. The seals shall be attached with stainless steel retainer bars and bronze or stainless steel fasteners. Stainless steel cover plates shall be provided to protect the seal from debris.
3. Side seal plates gates shall be manufactured from Type 304 Stainless Steel and allow for sealing in all gate positions. Leaf side seals shall be fluorocarbon clad neoprene and attached to the sealing ends of each leaf with Type 304 Stainless Steel retainers and fasteners. The seal attachment shall allow for replacement of the seal without removal of the leaf. Embedded side seal plates shall consist of the stainless steel seal plate surfaces with steel reinforcing on the backside. Type 304 Stainless Steel Drill-In Epoxy anchors shall be provided for alignment of the embedded seal plates. The sealing surface of the side seal plates shall have a surface finish smoother than 125 micro-inch RMS.

D. Hinges:

1. The gate leaf shall rotate on pin type hinges. The hinge pins shall be A564 Type 630 Grade H1150high strength stainless steel and fixed to the gate leaf. The pins will rotate in permanently lubricated bronze bearings which shall be retained in fabricated A572 Grade 50 steel bearing brackets. The brackets shall be anchored to the concrete structure in a manner to allow adjustment in all three planes during erection of the leaf sections. The hinge bracket anchor bolts shall be A193 Grade B7 Galvanized.

E. Bearings:

1. The main bearing shall be of sufficient size and strength to transmit the loads from the gate to the embedded bearing plates. Self-lubricating bearings and washers shall be “Lubron”, or equal, and shall be mounted on corrosion resistant surfaces. Bearings shall be replaceable with the gates in place, and the area upstream of the gates unwatered. All press fits and running clearances shall be in accordance with the recommendations of the bearing manufacturer. The bearings shall fully retain the gates in position and shall prevent uplift.
2. The main bearing anchor bolts embedded in primary concrete shall have a minimum diameter of 1 inch.

F. Nappe Breakers:

1. Gates shall be equipped with nappe breakers to prevent negative pressure under the water curtain.

G. Stops:

1. When the leaf is in the fully lowered position the weight of the leaf shall be supported by adjustable gate stops contacting pads on the downstream surface of the channels. The pads shall be manufactured from A36 steel and anchored in place using Type 304 Stainless Steel anchor bolts.

H. Heating:

1. Include provisions for heating embedded side seal plates in the design of the side seal plates and furnish suitable immersion type heaters for the seal plates with the gate.

I. Aeration Piping:

1. It shall be the responsibility of the gate manufacturer to determine the necessity of air vent piping and to determine the size, location, and shape of the air vent piping system. The air vent piping shall be galvanized steel and have protective screens on both the inlet and outlet.
2. Aeration piping shall be sized to prevent negative pressure under the gate with reasonable velocities in the aeration pipes. The gate system supplier shall provide all aeration piping, ducts, frames, and gratings.

2.5 HINGED CREST GATE EMBEDDED PARTS CONSTRUCTION

A. Description:

1. The gate embedded parts shall consist of the following:

   a. Embedded anchors to be installed in primary concrete for installing the bearing base plates and hydraulic operator base plates. Anchors shall be headed with end plates and shall not be of the L- or J-type construction. See specifications and drawings for requirements for structural concrete layout and minimum strength.
   b. Vertical seal plates and horizontal embedded seal members.
   c. Bearing base plates and hydraulic operator base plates.
   d. Aeration piping and grating.

2. Unless otherwise stated, the minimum anchor bolt diameter shall be ¾ inch.

B. Construction of Vertical Seal Plates:

1. The seal plate shall be of welded construction.
2. The seal plate shall be of substantial construction with stiffeners to maintain flatness during field installation.
3. Anchors embedded in primary concrete shall be provided to withstand all possible loads tending to separate the seal plate from the pier.
4. Adjusting bolts shall be provided to facilitate field positioning of the seal plate prior to secondary concreting. The number of adjusting bolts shall be kept to a

minimum and shall be substantial enough to transmit all loads to the anchors embedded in primary concrete.

2.6 HYDRAULIC CYLINDERS

A. The hydraulic cylinders shall be of the heavy-duty industrial type, suitable for immersion service and designed in accordance with ANSI/AWWA C541. Seals and glands shall be compatible with the hydraulic fluid used.

B. The hydraulic cylinders shall be as follows:

- Rated pressure: 3,000 psi minimum
- Type: single-acting*

C. Hydraulic cylinder rods shall be stainless steel with chrome plating conforming to ASTM A 564 or A 705, Type 630, or Type XM-12. Rods shall be heat treated to a condition of H-1150 before final machining.

D. The cylinder head, cap, body, and tie rods shall be of steel. The piston shall be equipped with lip type seals.

E. The cylinder trunnions and piston rod ends shall incorporate spherical self-aligning bearings. The bearings shall be sized to withstand the force exerted by the cylinder when pressurized to 3,000 psi.

F. The rod end of the cylinders shall have rod wipers and ice scrapers. The cylinders shall incorporate lifting lugs.

G. Orifices or other means shall be provided in the cylinder ports to control the rate of descent in the event of a hydraulic rupture. A velocity fuse shall be provided on the lower cylinder port to prevent inadvertent gate loweringand loss of hydraulic fluid upon sudden breach of the interconnecting hydraulic lines.

H. A set of 4 stainless steel ball valves and 2 flexible hoses shall be installed at each gate cylinder to allow the removal of the cylinder without requiring the cylinder or the interconnecting lines to be drained. One ball valve shall be installed at each end of the cylinder; one ball valve shall be installed at the end of the field interconnecting hard piping and the other ball valve shall be installed at the cylinder port.

I. Air release and drain cocks shall be provided to allow filling and draining of each cylinder.

J. Provide hydraulic cylinders with all necessary mounting and support brackets and bearings for installation on the concrete gate piers and concrete walls, as applicable. All necessary embedded parts and anchor bolts shall also be provided for mounting of the cylinders. The cylinder support shall be of structural steel, accurately fabricated and machined on bearing surfaces to assure a uniform bearing load.

K. The support brackets shall be fabricated from A572 Grade 50 steel with A193B7 Galvanized anchor bolts provided for mounting each cylinder.

L. Port cylinder for inflow and outflow tap for pressure gauge.

2.7 HINGED CREST GATE POSITION TRANSMITTER AND LIMIT SWITCH MECHANISM

A. The crest gates shall be provided with a gate position transmitter. The position transmitter shall be Rittmeyer Rivert mounted on the gate. The limit switches shall be integral to the position transmitter. The position transmitter shall have a 4 mA to 20 mA output proportional to gate inclination. The transmitter shall have zero and span adjustments.

B. All the components shall be heavy-duty type, adjustable to operate with gate in any position.

C. Components shall be housed in a waterproof enclosure.

2.8 SLIDE GATE

A. Materials

1. Frame, Frame Extensions, Guide Rails. Slide, Flush Bottom Retainer Bar, Wall Thimble, Yoke: Stainless Steel, ASTM A240 or A276, Type 304 or 304L.
2. Guides: Ultra High Molecular Weight Polyurethane (UHMW): ASTM D4020.
3. Thrust Nuts: Bronze, ASTM B584.
4. Anchor Bolts and Nuts: ASTM F593 and ASTM F594, Group 1 or 2 sized by gate manufacturer.
5. Assembly Hardware and Fasteners: Series 300 Stainless Steel, ASTM A193 and A194.
6. Flush Bottom Seal: Neoprene, ASTM D2000

B. Gate Frame and Guides

1. Stainless steel, designed for maximum head specified herein, and with minimum safety factor of five with regard to tensile, compressive and shear strengths.
2. The self-contained gate frame shall be a rigid, welded unit, composed of guide rails and cross bars with a clear opening, as specified, and suitable for flush-bottom closure.
3. Suitable reinforcement to resist all operating loads.
4. The stainless steel guides shall be of formed plates, standard structural or extruded shapes, conforming to the safety factors stated under AWWA C561 with a minimum thickness of 1/4 inch.
5. Design and fabricate guides to withstand the total thrust of the hydraulic cylinder, and the anticipated water loads. The guides shall be of sufficient length to fully support the height of the slide when the gate is fully open.
6. The frame shall positively retain the polymer (UHMW) guide/seal strip. Non loosening (prevailing torque) fasteners shall be used on the guide assembly. The guide/seal assembly shall be replaceable.

C. Slide

1. Stainless steel plate reinforced with structural shapes welded to the plate. Safety factors as stated under AWWA C561, with a minimum plate and member thickness of 1/4 inch, and designed so that deflection under maximum reservoir head does not exceed 1/16 inch.
2. Designed with a flush bottom for positive sealing against a sill plate.
3. The stem connections shall be threaded and bolted (or keyed) thrust nuts supported in welded nut pockets. The clevis or nut pocket of the gate shall be capable of withstanding the maximum thrust of the hydraulic cylinder.

D. Yoke

1. Provide a yoke at the top of the extended gate frame and guide rails to support the hydraulic cylinder capable of withstanding all operating and thrust loads from the hydraulic cylinder.

E. Thrust Nuts

1. Thrust Nut: Designed to resist thrust developed during gate operation at maximum operating head, threaded and keyed, pinned or threaded and set screwed to stem.

F. Gate Seals

1. The gate sealing arrangement for the side and top seals may consist of a combination of UHMW guides and neoprene J-seals, or a self-adjusting UHMW guide/seal arrangement.
2. Attach neoprene seals with stainless steel retainer bars.
3. J-seals shall be field replaceable without removing the gate frame from the wall thimble.
4. The top and side seals shall remain in full contact with the slide for positive sealing at any gate position.
5. The bottom seal shall be a neoprene seal attached to either the bottom of the gate slide or the flush bottom retainer bar.

2.9 HYDRAULIC OPERATING SYSTEM

A. The hydraulic operating system for the gates shall be in accordance with Section 35 22 11: Hydraulic Operating Systems.

2.10 WELDING

A. All welding, welding procedures and qualifications, and welder qualifications shall be in accordance with the most recent revision of AWS . All welding shall be in strict accordance with applicable AWS procedures and shall be made only by qualified welders. Procedures and qualifications shall be maintained in the manufacturer's project file.

2.11 INSPECTION OF WELDS

A. All welds shall be visually inspected to the requirements in AWS using AWS certified welding inspectors.

B. The welds joining the curved upstream and downstream skinplates to each other and to the vertical rib plates; and lifting lugs shall receive 100% visual and magnetic particle inspection.

2.12 SHOP ASSEMBLY AND TESTING

A. The hinged crest gate leaf shall be completely assembled in the shop. The gate pivot bores shall be sighted to ensure correct alignment of the centers. Each hinge bracket shall be assembled to the leaf at its respective location and the bracket rotated through its full range of operating swing.

B. All mating parts shall be trial fitted to determine if their planes are true, parallel, and in uniform contact with opposing surfaces.

C. During shop assembly, the gate shall be checked for dimensions, tolerances, accuracy of alignment and squareness.

D. The manufacturer shall make a record of the shop measurements of all critical dimensions which may affect the field erection and alignment or the operation and maintenance of the equipment. This record shall be included as part of the operation and service manual.

E. The gate system supplier shall permit and make available to the Engineer, free access to all works necessary for complete and satisfactory inspections and checking of manufacture and construction procedures.

F. All lubricating grease and oil required for performance of the tests shall be furnished by the gate system supplier.

G. Before disassembly, each part shall be match-marked and identified in accordance with the erection drawings; such marking shall be done to retain its legibility until field erection is complete.

H. Hydraulic cylinder leakage tests shall be performed under a minimum pressure of 3,000 psi for 15 minute periods: repairs shall be made, if necessary, and the tests repeated until zero leakage is achieved. Leakage past the piston shall also be measured when the cylinder is pressurized to 18 psi and shall not exceed 0.01 ounce per hour. (Note that the low pressure test is required for piston seals that seal under pressure.)

I. The operational test of the hydraulic and electrical control system shall be made to demonstrate proper functioning of the system including the functioning and sequencing of all control and alarm devices.

2.13 SPARE PARTS

A. The gate system supplier shall, at the option of Owner, provide spare parts for the crest gate equipment. The list of spare parts shall be mutually agreed upon. Delivery of the spare parts shall be made with the shipment to site location of the respective equipment.

B. Spare parts shall be adequately labeled and securely packaged for long-term storage at each site. All spare parts shall be interchangeable with, and of the same materials and workmanship as, the corresponding parts of the equipment covered by these Specifications.

2.14 WRENCHES AND TOOLS

A. The gate system supplier shall provide 2 complete sets of case-hardened wrenches in metal toolboxes and 2 sets of special tools and devices required for dismantling and assembling the work, together with 2 plate steel panels suitable for wall mounting these tools and devices. The wrenches shall be new and unused and shall be delivered to Owner with the gate equipment.

2.15 PAINTING

A. Steel Surfaces Subject to Immersion:

1. All exposed steel surfaces of the crest gate equipment shall be blast cleaned to the requirements of SSPC-10 then coated with 14-16 mils of Tnemec N69F Epoxy Coating. Additionally, the downstream face of each gate and hydraulic cylinder mounting brackets will be top coated with 2- 5 mils of Tnemec Enduroshield 1074 for UV protection.

B. Steel Surfaces Exposed to Air

1. Non-immersed steel surfaces shall be blast cleaned to the requirements of SSPC SP 6/NACE No. 3 “commercial blast cleaning,” coated with the manufacturer’s standard primer, and finish coated with two coats of the manufacturer’s alkyd paint system.
2. All steel surfaces that cannot be blast cleaned shall be surface cleaned in accordance with the requirements of SSPC SP 3 “power tool cleaning,” coated with the manufacturer’s standard primer, and finish coated with two coats of the manufacturer’s standard alkyd paint system. Paint color shall be pre-approved by Owner.

C. Surfaces Not Painted:

1. Steel surfaces embedded in concrete, stainless steel, bronze and other corrosion resistant materials, and machined surfaces for field assembly shall not be painted. Machined steel surfaces shall receive a rust inhibiting grease coating.

PART 3 EXECUTION

3.1 ERECTION AND INSTALLATION PROCEDURES

A. The gate manufacturer will provide a written, detailed procedure for the erection and installation of the gate and equipment that will be furnished to the Contractor after award of Contract. The installation procedure will include the sequence of steps necessary for installation, precautions to be taken, description of adjustments to be made and tolerances to be maintained.

B. The Contractor shall install the gates and associated parts in accordance with the gate manufacturer’s procedures, the erection advisor’s recommendations, and the requirements of these Specifications.

3.2 ERECTION ADVISOR

A. The gate manufacturer will provide an erection advisor to advise the Contractor in matters of methods, procedures, and precautions to be followed in the erection of the gate and gate equipment. The erection advisor will be available on-site as a minimum for the following events:

1. Construction planning meeting, to be held prior to shipment of the equipment.
2. After placement of the embedment in the primary placed concrete and prior to assembly of the hinge brackets and leaves.
3. During erection of the gate leaf.
4. During trial "dry operation" of the assembled gate; and prior to final "grouting in" of the fixed parts of the gate.
5. Start-up of the hydraulic power unit.
6. For the final operational "wet" testing of the gates and control systems.

B. The erection advisor shall furnish a signed statement to the Owner stating that the final installation and start-up of the gate has been inspected, witnessed, and complies fully with the manufacturer's warranty requirements.

C. The erection advisor shall also instruct the Owner's operating staff members in the operation and maintenance of the equipment. Instruction will be a minimum of one day with classroom and field training included.

3.3 FIELD OPERATIONAL TESTS

A. After the installation is complete, the gates shall be tested under the direction of the erection advisor.

B. The gates shall be operated through all modes of operation and testing, and all necessary adjustments made.

C. The workmanship in the installation of the gate shall be such that the gate in the closed position will form a watertight barrier across the opening.

D. The Contractor shall make all necessary adjustments, repairs, or replacements to correct defects, as directed by the Engineer.

END OF SECTION

SECTION 35 22 11
HYDRAULIC OPERATING SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Designing, furnishing, and installing a hydraulic operating system to provide complete and reliable control for the hinged crest gate and slide gate.

B. The gate system supplier qualified in Section 35 22 10: Hydraulically Operated Hinged Crest Gate and Slide Gate shall furnish, coordinate, integrate, and be responsible for proper functional operation of the entire crest gate and slide gate systems. The crest gate and slide gate systems include the gates, hydraulic operating systems, and complete PLC-based monitoring and control system.

1.2 REFERENCES

A. American National Standards Institute [in association with the National Fluid Power Association and the Joint Industry Conference] (ANSI NFPA/JIC):

1. ANSI (NFPA/JIC) T2.24.1 Hydraulic Fluid Power – Systems Standard for Stationary Industrial Machinery.

B. American Society of Mechanical Engineers (ASME International):

1. ASME Y32.10 Graphic Symbols for Fluid Power Diagrams.
2. ASME BPV VIII Div. 1 Boiler and Pressure Vessel Code, Section VIII, Pressure Vessels Division 1 – Base Coverage.

C. American Society for Testing and Materials (ASTM):

1. ASTM A312 Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
2. ASTM A564 Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
3. ASTM A705 Standard Specification for Age-Hardening Stainless Steel Forgings.

D. Society of Automotive Engineers (SAE):

1. SAE J517 Hydraulic Hose.
2. SAE J524 Low-Carbon Stainless Steel Tubing, Annealed for Bending and Flaring.

E. International Standards Organization (ISO):

1. ISI 4406 Hydraulic fluid power. Fluids. Method for coding the level of contamination by solid particles

1.3 DEFINITIONS

A. Hydraulic Power Unit (HPU): A skid-mounted system to provide hydraulic power for the hydraulic cylinders to control the operation of the gate. Includes, but is not limited to

hydraulic pumps and motors, manual pumps, hydraulic reservoirs, valves, accumulators, hydraulic fluid, and other components necessary to provide and control hydraulic power.

B. HPU Control Panel: A control panel furnished with and factory-installed on the HPU containing motor starters and other components required for control and protection of the hydraulic pump motors.

C. Gate Control Panel: A control panel furnished with the HPU but mounted separately containing the Programmable Logic Controller (PLC) hardware and other control components as submitted and approved during the procurement process.

1.4 SYSTEMS DESCRIPTION AND REQUIREMENTS

A. General:

1. Furnish the detailed design in conformity with ANSI (NFPA/JIC) T2.24.1, and the requirements of these Specifications and furnish detailed calculations for all components of the operating equipment for review as specified.
2. The systems must be designed and configured to operate the hinged crest gate and slide gates
3. The systems shall be designed to operate the gates smoothly and uniformly and hold the gates in the desired position.
4. Flow controls and pressure relief valves shall be included to provide uniform gate travel on both sides as applicable, and to avoid pressure more than design values.
5. The operating systems shall be capable of operating the gates under the head conditions specified, and in accordance with the operating requirements specified.
6. The Contractor shall coordinate all concrete embedments with the gate manufacturer.
7. The hydraulic lines and electrical cables to operate and monitor the gate shall be installed in the block outs in the concrete structures, trenches, cableways, under bridges, ducts, and vaults as generally shown on the Drawings and as directed by Engineer.
8. The environmental conditions for operation of the equipment shall be as specified.
9. The HPU and HPU control panel will be installed in a heated control building located on the US Highway 40 Access Road near the diversion structure as shown on the Drawings.

B. The hydraulic operating systems controls shall be based on the specified PLC system.

C. Hydraulic Fluid: The systems shall be designed to use a premium grade, hydraulic fluid that is nontoxic, environmentally acceptable with applicable local, state, and federal laws and meeting the requirements in Part 2 of the Section.

D. HPU Alarms to PLC

1. Provide dry contacts for wiring the following hydraulic system signals to the PLC:

a. AC voltage failure
b. Motor Overload/Failure.
c. Low Oil Warning.
d. High Temperature Warning.

e. Dirty Filter Warning.
f. Low Oil Shutdown.

E. Gate Controls:

1. PLC system and manual controls for the gate shall be housed in the Gate Control Panel.
2. Control devices for HPU operation will be as submitted and approved during the procurement process.
3. One NEMA 4 local control panel shall be provided with and located at the hydraulic power unit. Solenoid valves shall be controlled by Open or Close pushbuttons. Solenoids shall be de-energized by the gate open/close limit switches when the corresponding gate reaches the fully open or fully closed position. It shall be possible to stop the gate at any intermediate position. Continuous position indication using a gate mounted Rittmeyer Rivert transducer shall be displayed at the local control panel.
4. All switches, solenoids, transmitters, and other devices that require connection to the Gate Control Panel shall be wired to terminal boards in a junction box mounted on the HPU to facilitate the connection of field wiring. Low-voltage devices whose function does not require it shall not be routed through or terminated in the HPU Control Panel.

F. Hydraulic Pump Controls:

1. Each hydraulic pump shall have a corresponding MANUAL-OFF-AUTO selector switch on the front of the HPU Control Panel.
2. When both pumps are in AUTO mode, they shall automatically alternate with each call for pumping.
3. The pump controls shall be arranged so that in the event of failure of one pump to generate its rated flow and pressure, the other pump will automatically start.
4. One pump shall be able to provide for any single gate operation function.
5. Pumps shall be controlled to maintain accumulator pressure within the operating range.
6. Accumulator pressure shall be monitored by a pressure indicating transmitter with an integral digital indicator, calibrated in engineering units.
7. Provide one “Pressure Normal” dry contacts to the PLC, to allow for safety and operational interlocks. The contacts shall be closed when the accumulator pressure is within the operating range.
8. Hand pumps shall be provided for maintenance or repair operations in the event of electrical power outages for fine adjustments.

G. Position Indication:

1. Limit travel indication shall be provided via limit switches integral to the position transmitter.
2. Continuous position indication shall be provided for gates.

H. Field Piping:

1. Field hydraulic lines and hoses shall be supplied and installed by the Contractor.
2. Interconnecting lines shall be installed between the hydraulic power unit and the hydraulic cylinders, and between the hydraulic power unit and any accumulators.

3. The interconnecting lines shall be installed by a pre-approved installer fully experienced in similar systems and operating pressures.
4. All field lines shall be properly installed, supported, flushed, and pressure tested to 150% of the maximum system operating pressure prior to connection of the field lines to the hydraulic cylinders, the hydraulic power unit, and other devices comprising the hydraulic operating system.
5. A minimum of one air bleed valve shall be installed in each interconnected line at the high point of the run. If more than one high point exists, additional air bleed valves shall be installed at each high point.
6. A field installed pressure-rated flexible hose shall connect the ball valves. (The two ball valves located on the power unit shall be supplied by the systems manufacturer.)
7. Flexible hoses at the gate cylinders shall be furnished by the manufacturer as part of the hydraulic operating systems.
8. Field hard piping shall connect to ports provided by the manufacturer on the cylinder mounting bases.
9. Pressure-rated flexible hoses shall be installed between the interconnecting lines and the hydraulic power unit take-off ball valves.
10. All interconnecting lines shall be properly supported and clamped. All installation recommendations listed by the clamp manufacturer shall be followed.
11. All piping, pipe fittings, cored holes, or drilled holes shall be free of burrs or foreign matter that might cause damage to any hydraulic component or contamination to the hydraulic fluid before installation.

I. Additional Items Supplied by Contractor:

1. Hydraulic fluid; interconnecting wiring piping and supporting racks and clamps between the power systems,
2. Power supply and instrumentation and control wiring as indicated on the electrical and instrumentation drawings and as required for a complete and functional system.
3. The gate systems manufacturer shall provide information to the Contractor about the size of the power unit, installation details, piping sizes, interconnecting wiring details, and the approximate quantities of fluid required to flush and fill the systems during start-up.
4. Control Buildings:

    a. Locate controls and operating equipment in a dedicated structure properly sized for the specified equipment.
    b. Operating systems shall be specially designed and modular to allow for introduction assembly, operation, and maintenance within this space.
    c. The building shall also contain power supply, lighting, and air handling equipment.
    d. The control building shall be flood- proofed up to the 100-year flood event. However, where practicable, the control system shall be designed and configured to locate water sensitive equipment at elevations less likely to be inundated by flooding of the structure.

J. Accessibility: Design of the operating systems to provide accessibility to all parts of the systems for operating, inspection, lubrication, repairs, and painting.

1.5 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. Manufacturer's catalog data and descriptive literature for all standard equipment and products to be incorporated in the systems. This data shall include specifications and assembly drawings showing sizes, ratings, parts and material lists, overall dimensions, and mounting dimensions.

C. Design computations for all items which are designed by the Contractor.

D. Shop Drawings as follows:

1. Fabrication drawings for all mechanical and structural parts of components, except those of standard manufacture, showing complete details of materials, tolerances, machined surface finishes, connections, and proposed welding sequences.
2. Shop assembly drawings which provide details for connecting adjoining fabricated components in the shop to ensure satisfactory field installation.
3. Construction drawings for all electrical and hydraulic piping and controls and any other equipment which is required for the successful installation and operation of the gate. The detailed construction drawing submittal shall include, as a minimum, the following types of drawings and diagrams:

    a. Legend, Symbols, and Index.
    b. Power Distribution Diagrams.
    c. Construction Drawings and Details.
    d. Internal Panel Wiring Diagrams.
    e. Process and Instrumentation Diagram.

4. Hydraulic schematic in accordance with ASME Y32.10 showing all hydraulic components with set point and size parameters indicated for each component.
5. Delivery drawings which provide descriptions of methods of delivering components to the site including details for supporting fabricated components during shipping to prevent distortion or other damage.
6. Field installation procedure drawings which provide a detailed description of the field installation procedures, including the method of maintaining components in correct alignment; and detailed piping installation drawings showing piping details and locations of all pipe supports.

E. Two operation and maintenance manuals for each piece of equipment shall be submitted at the time the equipment is shipped. The manuals shall include, but not be limited to, the following:

1. A cross-section drawing of the hydraulic cylinders with parts list.
2. A system layout drawing showing the piping valves and controls.
3. A system hydraulic schematic.
4. Photos of each primary assembly with major components and controls labeled.
5. Electrical wiring and control diagrams.
6. Operating and maintenance instructions.
7. Manufacturer's bulletins, catalog cuts, and descriptive data.
8. Parts lists and recommended spare parts.

F. Quality Control

1. Manufacturer's Certificates of Proper Installation.
2. Checklists for shop and field testing.
3. Certified results of shop and field testing: including measured clearances and tolerances results of all tests, and adjustments, repairs, or replacements necessary to meet Specification requirements.

G. Warranty.

1.6 QUALITY ASSURANCE

A. The hydraulic operating systems shall be the product of a manufacturer with 10-years demonstrated successful experience with supplied gate operating and control equipment similar to the systems necessary for complete operation of the specified gate.

B. The hydraulic operating systems shall be of North American manufacture with components readily available in North America.

C. Inspection of hydraulic power unit manufacture/fabrication: Owner and Engineer reserve the right to inspect hydraulic power unit manufacture/fabrication facilities before and during manufacture/fabrication for inclusion in the Work.

1.7 SEQUENCING AND SCHEDULING

A. Notify Engineer in writing:

1. At least 14 days prior to start of manufacture/fabrication of the hydraulic power unit components.
2. At least 5 days prior to start of:

a. Shop coating.
b. Shop assembly, inspection, and testing.
c. Field testing.

1.8 DELIVERY HANDLING AND STORAGE

A. Each hydraulic power system or subassembly shall be shipped completely assembled. Subassemblies are defined as:

1. Hydraulic power units.
2. Piping assemblies.
3. Control assemblies.

B. The subassemblies shall be provided with adequate protective pads, supports, and blocking and shall be securely restrained to prevent distortion or damage in transit.

C. All accessories and spare parts shall be packed separately in containers plainly marked as such.

D. A packing list, listing the contents of each container, shall be placed in a moisture-proof envelope, and securely fastened to the outside of the container.

E. Equipment delivered and placed in storage shall be stored with protection from the weather, humidity, temperature variation, dirt, and dust.

1.9 WARRANTY

A. A two-year written warranty from the date of acceptance of the Project shall be provided by the Contractor to guarantee that the equipment and all accessories will perform as stated in these Specifications.

B. There shall be no defects in material or workmanship in any items supplied.

C. The Contractor shall replace, at no cost to the Owner, any item the Contractor furnished which fails to perform as specified during the warranty period.

PART 2 PRODUCTS

2.1 GENERAL

A. All materials and components shall be new and shall comply with the specified standards.

B. All hydraulic components shall be compatible with the fluid used, suitable for the systems cycling rate and design pressure and shall be used and installed in accordance with manufacturer's recommendations.

2.2 HYDRAULIC CONTROL SYSTEMS

A. The hydraulic system for control of gate hydraulic operating cylinders shall be designed with the following features as a minimum:

1. The system design pressure shall be not less than 2,000 psi operating pressure and not greater than 3,000 psi rated pressure.
2. It shall also be possible to operate the gate by manually operating the solenoid control valves.
3. Components shall be selected based on minimum leakage.
4. Gate operating time shall be as described in these Specifications but shall be adjustable by means of temperature and pressure compensated flow controllers for each gate.
5. The time for operating gate between limit points shall be as specified in these Specifications using one pump, the actual time being dependent on the pump selected and the temperature of operation. At low temperatures, when the hydraulic fluid has a greater viscosity, the operation time will be allowed to increase slightly subject to acceptance by the Engineer.
6. Electric motor driven pumps shall be provided. The pumps shall be rated for continuous operation at a discharge pressure equal to or greater than the system design pressure.
7. Bladder type accumulators, suitable for charging with nitrogen, shall be provided, if necessary, for "cushioning" the pumps. As a minimum, the accumulators shall be sized for 10 percent of the rated pump flow, and to prevent gate creep should the power be off for a period of ½ hour. Accumulators shall be equipped with a safety device to release excessive pressure before the burst pressure is reached. The accumulators shall be designed and fabricated in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII Division 1.
8. Manual lowering of the crest gate shall be possible during a power outage, by manually actuating the respective solenoid control valves.

9. A hydraulic restoring device shall be provided for the crest gate, such that when the gate drops by a preset angle (adjustable at the site), the hydraulic system shall restore the gate to the position called for in the control system logic. The gate position detector shall be used in conjunction with the restoring device.
10. All solenoid operated control valves shall be provided with manual override and rated for 120 VAC nominal (108-132 VAC range) service. Solenoids shall be de-energized in the neutral position.
11. Relief valves shall be tamperproof, showing settings given on the Contractor's drawings, and shall generally be sized for the maximum flow rates
12. Pumps and controls shall be designed to permit isolation and maintenance of any one item while the system is operational.
13. The hydraulic control systems shall be complete with all piping, fittings, valves, and controls necessary to satisfy the above requirements.

2.3 HYDRAULIC CYLINDERS AND POSITION INDICATORS

A. The hydraulic cylinders and appurtenances for the hinged crest gate are provided for in Section 35 22 10: Hydraulically Operated Hinged Crest Gate and Slide Gate.

B. Pressure relief valves shall be provided for each operating system to allow the gate to automatically lower when the load on the gate causes the cylinder pressure to exceed its design pressure. The relief valves are to be used to limit extreme loads on the gate.

C. Port each cylinder for inflow and outflow, tap for pressure gauge. Pressure gauges areto be provided during initial startup and testing to demonstrate operation and gauges are to be removed, plug installed, and gauge provided to Owner.

2.4 HYDRAULIC SYSTEM

A. General:

1. Design for water control gate loading conditions (including, but not limited to, gate operating and design loads) provided by water control gate manufacturer and detailed in Section 35 22 10: Hydraulically Operated Hinged Crest Gate and Slide Gate.
2. System shall be designed to operate smoothly and uniformly operate the gate and hold the gate in the desired position.
3. Safe, reliable, and smooth operation, without binding, vibration, noise, or heat.
4. Conforming to AWWA C540 and additional requirements of these Specifications.
5. Electrical controls shall be factory furnished in a NEMA 1 rated electrical enclosure, for mounting in the control panel or as approved.

B. Hydraulic Power Unit (HPU):

1. The Drawings indicate the general concept, arrangement, and requirements of the hydraulic power unit, and are not intended to define or represent detailed design of equipment to be furnished. The hydraulic power unit manufacturer/fabricator is responsible for complete design of the required hydraulic equipment.
2. The hydraulic power unit shall be a nominal 2000 psi hydraulic fluid system of sufficient size and capacity to operate the crest gate. The hydraulic operating system shall be sized to operate each gate through a full close (raise) stroke in 10 minutes.

3. The system shall include dual automatically alternating motor/pumps. Manually operated valves and interconnections between each gate's hydraulic hoses shall be provided to allow one of the motor/pumps to operate gate sequentially if the other motor/pump fails. An inlet filter of 74 micron (nominal) in-line indicating type shall be provided for each pump. The minimum size of inlet filter shall be one size larger than the suction port of the pump.
4. A hand pump shall be provided to allow manual operation of the gate in the event there is not electric power. No downward movement of the crest gate shall occur in the event of a power outage unless manually overridden through means of a hand pump or portable generator, or by opening bypass valving. The hydraulic power unit will be designed to be placed in a non-heated, weather-tight area. A 500 watt thermostatically operated immersion heater shall be provided in the oil reservoir. Trouble indicating lights and a single general alarm dry contact shall be provided to signal a power unit fault for at least the following: low oil level, low temperature, and motor/pump failure.
5. The hydraulic power unit shall be designed and manufactured in compliance with good engineering practice and shall include oil reservoir, two electric motor-driven hydraulic pumps, strainers, check valves, relief valves, shut-off valves, directional control valves, switches, filters, accumulators, and all appurtenances to provide a complete operating system. Stainless steel ball valve shut- offs shall be provided on each hydraulic line where it leaves the hydraulic power unit.
6. Skid-mounted and arranged to facilitate adjustment, operation, and maintenance of the unit. Provide permanently installed lifting eyes to facilitate the handling of the unit.
7. All hydraulic components including pumps, valves, gages, and pressure switches shall be mounted on the reservoirs where practicable. Care shall be taken in the arrangement of components mounted on the reservoirs to ensure accessibility after installation.
8. Reservoir:

    a. Design and fabricate the oil reservoir in accordance with National Fluid Power Association (NFPA) Standards. The capacity of the oil reservoir for the hydraulic pumping unit to be a minimum of 3 times the pump capacity of the unit provided plus the stem displacements. Fabricate the oil reservoir and any internal piping from stainless steel, type 304 or 304L. Include a drain, access for inspection and cleaning, a filter breather assembly, and an oil level sight gauge and temperature gauge.
    b. Equipped with a fluid level indicator with markings to show high and low levels and a float switch. The fluid level shall be visible in the sight gage throughout the normal operating cycle. The float switch shall be adjusted to detect the oil level at 80% of tank capacity.
    c. Stainless steel welded construction with all joints seal welded.
    d. Provide a baffle between the intake and return lines to facilitate separation of air and foreign matter from the hydraulic fluid.
    e. One suction filter and one pressure filter shall be provided for oil pump and control valve protection. The suction filter shall be equipped with a 25-micron filter element, with an internal bypass, clogging switch, and a visual servicing indicator. The pressure filter shall be equipped with a 10-micron filter element, with an internal bypass, clogging switch, and a visual servicing indicator. The oil filters shall use replaceable elements, and six spare elements shall be furnished for each filter. The clogging switches shall have one Form C contact rated 120 volts AC, 5 amperes.

f. The reservoir shall be complete with drain connections, removable cleanout plates, sight level gages, low-level alarm switches, pump shut off switches, fill connections, and filtered air breathers.
g. Oil temperature gages shall be provided for each reservoir.
h. The internal surfaces of the reservoirs shall be coated with a protective sealer compatible with the fluid used.
i. The base of the reservoir shall be located at floor level to facilitate access to motors, pumps, and electrical controls.

9. Electric Motor:

a. Sufficient capacity to open and close the gate against all anticipated operating conditions when the voltage is 10 percent above or below the nominal voltage.
b. Totally enclosed, and fan cooled, with cast iron frames, providing the necessary horsepower to operate the hydraulic pump at the maximum pressure required without exceeding the nameplate rating. The motors shall be operated on 240 volt, 60 hertz, single-phase alternating current

C. Instrumentation: Provide a low oil-level sensor and local indication of low oil level, a high oil temperature sensor and local indication of high oil temperature, and a low pressure sensor and local indication of oil pressure less than 500 psi when the hydraulic system is operating. Operation of any one or a combination of these indicators shall energize an alarm circuit with one Form C contact rated 120Vac, 5amps, for remote annunciation. Simultaneous with the low oil level alarm, an automatic switch shall shut-off power to the pump and motor. Power shall continue to be supplied to other parts of the hydraulic power unit such asthe heaters

D. A pressure switch shall be provided to shut off the hydraulic power unit at each end of travel of the gate. The pressure switch shall be set approximately 300 psi higher than the calculated operating pressure required for operation of the gate, to account for hydraulic losses in the power unit and piping. The pressure switch shall be set no higher than 1,800 psi. The pressure switch shall be integrated with the alarm circuit specified in Item 3.

E. A pressure relief valve shall be provided to limit the operating pressure in the control system to 2,000 psi.

F. Two counterbalanced valves or pilot-operated check valves shall be provided, one in each hydraulic line to the bottom port of each hydraulic cylinder, so that the gate will not close by gravity or flow-induced down-pull, unless hydraulic pressure is applied to the closing side of the cylinders.

G. Pressure Gage:

1. Accumulator pressure gage showing hydraulic power unit output pressure.

H. Electrical Controls:

1. Electrical power controls, operating devices, and monitoring devices required shall be factory wired in a NEMA 1-rated enclosure.

2.5 HYDRAULIC FLUID

A. Hydraulic Fluid shall be an all-weather type hydraulic oil which has a high viscosity index, low pour point, rust and oxidation inhibitors, and antifoam properties, and suitable for operation with fluid temperatures ranging from -20 °F to +200 °F. The fluid shall be Mobil EAL 224H, or engineered equal.

B. A minimum of 150 percent of the quantity of hydraulic fluid to make the systems operable shall be provided by the Contractor. Provide all hydraulic fluid at time of startup.

2.6 HYDRAULIC CONTROL SYSTEM PIPING AND VALVES

A. Provide all interconnecting tubing, piping, hoses and associated components, including, but not limited to, valves, connectors, flexible hose assemblies, drains, vents, pipe and tube supports, expansion joints, and specialty items shall be provided as required for a complete piping system for the hydraulic operating systems.

B. Hydraulic tubing shall be used at the hydraulic power unit and shall be cold drawn, low carbon seamless hydraulic tubing produce in accordance with SAE J 524. Tubing wall thickness shall be selected to provide a safety factor of six on the bursting pressure for the specified systems design pressure. Tube fittings shall be screwed cadmium-plated steel and provided with O-ring seals.

C. Hydraulic lines connecting the hydraulic power unit to the hinged crest gate hydraulic cylinders: seamless stainless steel tubing, ASTM A269 or A312, Type 304L. Pipe wall thickness shall be selected to provide a safety factor of six on the bursting pressure for the specified systems design pressure. Pipe fittings shall be stainless steel provided with O-ring seals. Make all piping connections using socket weld stainless steel fittings and couplings, orbital TIG welding, or other approved welding methods.

D. Hydraulic hoses shall be flexible, wire-reinforced, high-pressure type hose in accordance with SAE J517. The hose shall be selected to provide a safety factor of six on the bursting pressure for the systems design pressure.

E. The velocities of the hydraulic fluid in the lines shall not exceed the following:

1. Maximum velocity in suction lines: 4 FT per second.
2. Maximum velocity in pressure and return lines: 25 FT per second.

F. Use hydraulic O-ring type connections on all unions and removeable valves. Provide ball type shutoff valves and O-ring unions and flanges at the hydraulic line connections to the power unit and the hydraulic cylinder connections. Connect ball valves at the cylinders on the upstream side of the unions, such that the cylinders can be removed without draining the hydraulic lines.

G. Provide a fluid line connecting the two ports on each hydraulic cylinder with a ball valve in the line, to allow for flushing the hydraulic lines if desired.

H. Fittings and Valves: 3,000 psi minimum.

2.7 HPU CONTROL PANEL

A. The control panel for the HPU motors shall constitute a complete combination motor controller per the National Electrical Code and shall include disconnecting means, short circuit and ground fault protection and motor overload protection.

B. Panel short circuit rating shall equal or exceed that of the panelboard from which it is served.

C. Refer to the electrical drawings.

D. Design motors and control panel components for operation from a 208V, 3-phase power supply.

E. Provide wye-delta starting or other reduced-voltage starting method capable of safely stating the motors while limiting starting current to 300 percent of full load amperes.

F. Enclosure: NEMA 12.

G. Provide field wiring terminal boards for all connections to Gate Control Panel or other systems.

H. All control panels shall be UL-listed and labeled per Standard 508 – Industrial Control Equipment

2.8 SPARE PARTS

A. Provide spare parts as recommended by manufacturer for 5 years operation for each type and size equipment. Provide Owner with an itemized list of the spare parts.

2.9 SPECIAL TOOLS

A. Provide all special tools required for maintenance, disassembly, and assembly of the equipment. Provide Owner with an itemized list of all special tools.

2.10 SOURCE QUALITY CONTROL

A. Hydraulic Power Unit Shop Testing and Assembly:

1. Perform any adjustments and/or repair or replace any components necessary to conform to approved shop drawings and comply with Specification requirements.
2. Provide a completed, dated, and signed copy of the detailed test procedure shipped with the hydraulic power unit for verification of start-up settings.

PART 3 EXECUTION

3.1 GENERAL

A. The Contractor shall install the equipment specified and as shown on the approved drawings to complete the hydraulic operating systems for operation of the crest gate.

B. Installation of hydraulic components shall be in accordance with the manufacturer's instructions and under the direction of the manufacturer's representative.

C. Complete units or assemblies shall be installed without disassembly.

D. Necessary supports for all appurtenances, pumps, motors and other equipment or components shall be provided and installed.

E. Floor mounted equipment shall be anchored to concrete pads by anchor bolts or expansion anchors.

F. All low and high points of piping shall be provided with plugged valves for draining and venting.

G. Piping components shall be located to provide accessibility for operation and maintenance.

H. Extreme care shall be taken during assembly and installation of the systems to avoidthe entrance of abrasives, dirt, metal chips, and other foreign materials into the hydraulic systems through open ends of piping, tubing, hoses, and ports of the components.

I. The entire piping system shall be flushed after assembly and prior to pump installationin accordance with approved procedures using a separate flushing pump and filter.

J. Cut, prepare for welding, fit, thoroughly clean, and install the hydraulic piping so that all joints are oil-tight. For any threaded joints, place suitable thread compound on the third of the thread nearest the end of the pipe or fitting. Do not use tape on fittings.

K. Route and install the hydraulic lines as shown on the Drawings. Prior to connection to the hydraulic power unit and the gate hydraulic cylinders, and prior to any encasement in concrete, pressure test all the hydraulic lines and observe for leaks for at least 30 minutes at 3,000 psi. Locate and repair any leaks and retest the system until leak free.

3.2 FILLING, BLEEDING, FLUSHING, AND TESTING

A. Oil used to fill the systems shall be filtered through a 10 micron filter. Fill the oil reservoir and piping system while filtering the new oil, meeting the specifications, in accordance with ISO 4406 cleanliness level 18/16/13.

B. The complete hydraulic operating system shall be bled to remove all air from the systems. Care shall be taken to exclude as much air as possible during initial filling.

C. Where possible, the hydraulic cylinders shall be filled in the horizontal position with the piping connections up to allow air to escape, and the piping shall be filled in a manner that excludes as much air as possible.

D. The systems, once filled, shall be bled of air, operated, and periodically bled during the first week of operation to remove any air that might have been entrained in the systems.

E. With the hydraulic lines connected to the cylinders, but before connecting to the hydraulic power unit, flush the hydraulic lines using a temporary hydraulic pump. Close the ball valves at the ports of the cylinders and open the ball valve in the line connecting the cylinder ports. Provide a suitable flushing pump that provides enough velocity in the hydraulic lines to provide a minimum Reynolds number of 4,000 for removal of debris. Provide and monitor 10 micron filters during the flushing operation and continue flushing until the filter elements remain clean and complies with the requirements of ISO 4406 cleanliness level 18/16/13.

F. After flushing and filling the system is complete, final connections are made, and air is vented from the system, open the ball valves at the hydraulic cylinder ports and close the ball valve in the interconnecting line between cylinder ports.

G. Field hydraulic lines shall be properly supported, installed, flushed and pressure tested to 150% of the maximum system operating pressure prior to connection of the field piping to the hydraulic cylinders and power unit and prior to encasement in concrete.

3.3 PAINTING

A. All exposed exterior surfaces of assemblies and equipment, except stainless steel, synthetic rubber, and plastic, shall be surface cleaned in accordance with SSPC-SP3 and receive a primer and two finish coats of an alkyd paint system or shop primed and coated with the manufacturer's equal standard finish coating system.

B. Insofar as is practicable, the complete coating system shall be applied to individual components and items before assembly to ensure complete coverage and maximum protection against corrosion.

C. Equipment such as pumps and electric motors, which have a factory-finished coating, do not need to be recoated.

D. Chips, scratches, and other damage to shop-applied coatings shall be repainted in the field with color matching paint furnished by the manufacturer.

3.4 ERECTION ADVISOR

A. The hydraulic operating systems manufacturer shall provide an erection advisor to advise the Contractor in matters of methods, procedures, and precautions to be followed in the installation of the systems. The hydraulic operating systems erection advisor shall coordinate with the erection advisor specified in Section 35 22 10: Hydraulically Operated Hinged Crest Gate and Slide Gate, so that both erection advisor are on site for start-up, adjustment, and operation of the systems. The erection advisor shall be available on-site as a minimum for the following events:

1. Construction planning meeting, to be held prior to shipment of the systems equipment.
2. During installation, start-up, adjustment, and operation of the systems.
3. For the final testing of the gate and hydraulic operating systems.

B. The erection advisor shall furnish a signed statement stating that the final installation and start-up of the hydraulic operating systems has been inspected, witnessed, and complies fully with the manufacturer's warranty requirements.

C. The erection advisor shall also instruct the Owner's operating staff members in the operation and maintenance of the systems equipment.

3.5 FINAL ACCEPTANCE TESTS

A. Perform field testing in the presence of Engineer. Conform to approve test procedures and manufacturer's written instructions.

B. In preparation for the final acceptance tests, and after completion of the piping system testing, the Contractor shall operate the hydraulic operating systems to prove acceptability.

C. Preliminary tests shall be conducted at minimum pressures and velocities until initial adjustments have been proven safe for normal operation.

D. Details of all operations shall be constantly monitored for signs of impending trouble and corrections shall be made as necessary to prevent damage to the equipment.

E. The hydraulic reservoirs shall be inspected to ensure that the fluid is at the proper level.

F. The accumulator pre-charge pressure shall be inspected and adjusted to the specified value.

G. The hydraulic pumps shall be test started using the controls at the control console. The pumps shall be inspected for proper operation and discharge pressure. The discharge pressure of each pump shall be read and recorded.

H. The pressure relief valves shall be adjusted to limit the system pressure to the specified value.

I. The unloading valves shall be adjusted to unload the pumps to the reservoir when the accumulator has been charged to the specified pressure or if the control valves are not actuated.

J. The hydraulic lines and components which are under pressure shall be inspected for evidence of leakage.

K. Tests and inspections of the hydraulic operating systems shall be performed concurrently with the testing specified under other sections of these Specifications which test the gate operated by the hydraulic systems.

L. The hydraulic systems shall be tested by operating the gate through a minimum of four complete cycles.

M. Response of components to operation of applicable controls shall be inspected to ensure that all connections have been made properly.

N. Perform any adjustments and/or repair or replace any components necessary to conform to approved shop drawings and meet Specification requirements.

3.6 TEST REPORTS

A. The Contractor shall prepare and complete test reports showing in detail the results of the field tests.

B. The test reports shall include a detailed tabulation showing values of pressures, flowrates, and all adjustments recorded during the final tests.

C. During each test run, the following data and observations shall be recorded:

1. Control operation.
2. Voltages.
3. Currents.
4. Pressures.
5. Speeds and times.
6. Flow control valve settings.
7. Alignment and operating clearances.

8. Excessive vibration, by component.
9. Temperature of motors and hydraulic fluid.
10. Pertinent observations regarding such events as unusual sounds, malfunctions or difficulties encountered, and adjustments required.

END OF SECTION

SECTION 35 42 60
ARTICULATED CONCRETE BLOCKS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This section specifies requirements for furnishing and installing interlocking concrete revetment block systems at the locations shown on the Drawings.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1.	ASTM C33	Concrete Aggregates.
2.	ASTM C140	Sampling and Testing Concrete Masonry Units.
3.	ASTM C150	Portland Cement.

B. American Association of State Highway and Transportation Officials (AASHTO)

1.	T 88-93	Particle Size Analysis of Soils.
2.	T 194-87	Determination of Organic Materials in Soils by Wet Combustion.

C. Federal Highway Administration (FHWA)

1.	(FHWA)-RD-88-181	Minimizing Embankment Damage During Overtopping Flow

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittal Procedures.

B. ACB Mat System Installation Plan: Proposed equipment and methods to transport offload, stage, handle and install the ACB mats and system components including geotextile.

C. Manufacturer's performance research results and calculations in support of the ACB system(s) specific to this project.

D. Manufacturer's certificates of compliance and concrete compressive strength test results for batches of blocks delivered to this project.

E. Manufacturers written installation instructions for each application.

F. Manufacturer's product data for ACB system components including geotextile.

G. Manufacturer’s warranty

PART 2 PRODUCTS

2.1 ACB

A. Tri-Lock precast interlocking concrete blocks as manufactured by Tri-Lock, Midwest Construction Products Corporation with the nominal characteristics prescribed in Table 1 below:

Table 35 42 60-1
Trilock ACB Physical Properties

Class	Height (inches)	Approximate Weight (lbs./sqft)	Compressive Strength (psi)	Approx. Weight Block Pair (lbs.)	Open Area %
4015	6	45	4,000 Min	70	20

B. Visual Inspection

1. All units shall be sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction. Surface cracks incidental to the usual methods of manufacture, or surface chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.
2. Cracks exceeding 0.25 inches in width and/or 1.0 inch in depth shall be deemed grounds for rejection.
3. Chipping resulting in a weight loss exceeding 10% of the average weight of the blocks shall be deemed grounds for rejection.
4. Blocks rejected prior to delivery from the manufacture shall be replaced at the manufacturer's expense. Blocks rejected after receipt at the job site shall be repaired with structural grout at the expense of the Contractor.

2.2 ACB UNDERLAYMENT (WOVEN) GEOTEXTILE

A. The geotextile directly underlying the ACB shall be Winfab 2495 woven monofilament geotextile or approved equivalent.

B. During all periods of shipment and storage, protect the geotextile from direct sunlight, ultraviolet rays, and temperatures greater than 140 degrees Fahrenheit. Maintain the integrity of the protective covering on geotextile until it is ready to be installed.

C. At the time of installation, the geotextile shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation, or storage.

PART 3 EXECUTION

3.1 SYSTEM FOUNDATION PREPARATION

A. Prepare the subgrade foundation for the ACB mat system to the lines and grades shown on the Drawings and in accordance with Section 31 23 13: Subgrade Preparation.

B. Grade the soil foundation to a smooth plane surface to ensure that intimate contact will be achieved between the soil foundation and the geotextile. Remove or regrade deformities, roots, grade stakes, and stones that project from the foundation, moisture condition, compact and proof roll in accordance with Section 31 23 13: Subgrade Preparation.

C. The Engineer must inspect and approve the prepared soil foundation before geotextile installation.

3.2 ACB UNDERLAYMENT GEOTEXTILE PLACEMENT

A. Place geotextile in accordance with ACB manufacturers direction directly on the prepared subgrade under ACB at the locations shown on the Drawings.

B. Place geotextile to maintain intimate contact with the bedding, without stretching, and free of folds or wrinkles. Do not walk on or otherwise disturb the placed geotextile that would result in a loss of intimate contact between the bedding and the geotextile.

C. Seam geotextile with sewing or overlap as approved by the ACB manufacturer.

1. For overlap, place geotextile so that the upstream strip of geotextile overlaps the downstream strip. Unless otherwise recommended by the ACB manufacturer, overlap longitudinal and transverse joints at least 24 inches. Extend geotextile at least one foot beyond the top of the ACB termination points.
2. Where sewing is required, overlap a minimum of 4 inches and sew prayer seams with a suitable polymeric thread recommended by the geotextile manufacturer.

D. Secure the geotextile with pins, and anchor as shown on the Drawings and as recommended by the ACB manufacturer. Secure geotextile sufficiently to prevent it from being damaged or displaced by ACB installation. Remove ACB and repair damaged or reposition displaced geotextile if necessary.

3.3 ACB PLACEMENT

A. Place ACB at the locations and to the lines and grades shown on the Drawings.

B. Place ACB on the prepared subgrade in such a manner as to produce a smooth plane surface in intimate contact with the subgrade and geotextile and such that geotextile is not displaced or subgrade disturbed by the installation.

C. Place such that no individual block within the plane of placed concrete blocks is allowed to protrude more than one-quarter inch. Follow manufacturers instruction to ensure that the blocks are flush and develop intimate contact with the subgrade. Blocks may be "seated" by such means a smooth drum roller, vibrating plate compactor, or other means as approved by the manufacturer and Engineer.

D. Fill all open areas in the completed ACB with crushed rock or other suitable material recommended by the manufacturer and approved by the Engineer.

3.4 FIELD QUALITY CONTROL

A. Provide the services of the manufacturer’s Field Service Engineer to provide technical direction for installation crews. Include at least one site visit at the start of construction to assure conformance with manufacturer’s design intent.

END OF SECTION

SECTION 35 73 10
DAM EMBANKMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Embankment dam fill construction, including furnishing, placing, moisture conditioning, compacting, and grading.

1.2 REFERENCES

A. American Society for Testing and Materials International (ASTM)

1.	ASTM C 117	Standard Test Method for Materials finer than 7-μ (No. 200) Sieve in Mineral Aggregates by Washing
2.	ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3.	ASTM D 2216	Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
4.	ASTM D 4914	Standard Test Method for Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit
5.	ASTM D 5030	Standard Test Method for Density of Soil and Rock in Place by the Water Replacement Method in a Test Pit

1.3 DEFINITIONS

A. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

B. Completed Course: A course or layer that is ready for next layer or next phase of Work, free from irregularities with smooth, tight, even surface, true rolling, and cross section.

C. Coverage: One coverage is defined as the result of successive passes by a piece of compaction equipment, which by means of sufficient overlap, will ensure that all areas of the layer or lift being compacted have been subjected to one pass of the compaction equipment.

D. Fines: Materials passing the No. 200 sieve.

E. Imported Material: Materials obtained by Contractor from sources offsite, suitable for specified use.

F. Lift: Loose (uncompacted) layer of material.

G. Embankment: In this section, the term "embankment" is equivalent to Dam.

H. Prepared Subgrade: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil and reservoir sediments, excavation to grade, and scarification and compaction of subgrade. As defined in Section 31 23 13: Subgrade Preparation.

I. Subgrade: As defined in Section 31 23 13: Subgrade Preparation.

J. Suitable Material: Imported material, material from required excavations or from onsite borrow areas which meet the specification requirements for use in constructing fills and free of unsuitable materials.

K. Unsuitable Materials: Materials that contain waste, debris, roots, organic matter, frozen matter, or any other materials determined by the Engineer to not meet the specifications for any required fill.

L. Well-Graded: A mixture of particle sizes that has no specific concentration, or lack of particles, of one or more sizes.

1.4 SUBMITTALS

A. Submit in accordance with Section 01 33 00: Submittals.

B. Coordinate submittals in this Section with Section 31 23 16: Excavation to create a complete excavation and earthwork work plan for submittal. After acceptance of the Work plan, do not make changes to the work plan without the prior written approval of the Engineer.

C. Detailed Earthwork Plan describing the proposed methods and sequencing of the dam embankment and related construction.

1. Include in the Plan the following:

a. Proposed soil excavation, transport, processing, sorting/screening, placement, compaction, and moisture control equipment. Include the number of each type of equipment, operating weights, key dimensions, etc.
b. For the compaction equipment proposed, provide sufficient manufacturer data and drawings to verify the requirements specified in this section.
c. Number and length of shifts, and production rates and progress.
d. Proposed plan and sequencing for excavation including the extent and quantity of excavation, and an excavation schedule.
e. A detailed description of the sequencing and operations necessary for construction the dam embankment, including a description of the methods to be used to place materials and ensure the specified compaction is achieved. Clearly indicate interrelationships among other operations, including construction of cofferdams, preparation of Dam foundations, import and stockpiling materials, and operation of a diversion system.
f. Site plan or map indicating locations and sizes of temporary stockpile areas for each material type, and identifying which stockpiles are designated for imported materials and which stockpiles are designated for onsite excavated materials.
g. Proposed plan to obtain, convey, and store construction water, including proposed water source.
h. Special procedures to process and moisture condition materials in advance of placement.
i. Special procedures to handle, stockpile, transport, and place Dam Fill materials to create well graded fill mixtures without unacceptable segregation and rock pockets.
j. Proposed method of protecting Work, to include temporary dewatering, drainage, moisture conditioning, and frost protection measures.
k. Diagram showing all proposed haul routes and access ramps from required excavations, borrow area and stockpile areas to, from, and across the Dam embankment and zoned material crossings. Described and show estimates of construction traffic flows on proposed haul routes and ramping schemes onto and off the Dam embankment.

D. Detailed Test Fill Plan describing the proposed methods and sequencing for implementing the test fill. Include in the Plan the following:

1. Proposed location.
2. Proposed density measurement standard, fabricated ring or frame apparatus size and description, density standard measuring materials and measurement methods including field scales and accuracy, field support equipment and facilities.
3. Schematic maps that will be used to document settlement surveys.
4. Example plots to show settlement vs compactor passes.

E. Samples: Submit samples of onsite excavated materials and offsite materials for Engineer's approval. For imported material, submit samples and laboratory test results prior to shipment of the material to Site.

F. Proposed borrow source(s) for offsite materials and proposed method(s) of sampling on-site and offsite source(s) for acceptance.

G. Test Fill documentation.

H. Independent laboratory test results.

1.5 QUALITY ASSURANCE

A. The Contractor is responsible for all quality control testing using an independent commercial laboratory as specified in Section 01 40 00: Quality Requirements. The Engineer may conduct separate quality assurance testing at their discretion to check conformance with these specifications. Where any non-conformance is revealed, further testing by the approved independent laboratory will be required. The Contractor is responsible for corrective measures, to the extent of complete replacement of material, and retesting, until conformance is achieved.

PART 2 PRODUCTS

2.1 MATERIALS

A. General:

1. Obtain materials for Dam fill from required excavations and onsite borrow. This specification is intended to specify a method compaction specification for onsite borrow materials that are predominantly sandy and/or gravelly with gradations that prevent establishing moisture density or relative density relationships. Other materials if proposed may require different specifications.
2. Unless otherwise noted, gradations specified herein apply to the material after placing, spreading, moisture conditioning, and compacting. The Contractor is responsible to determine the gradation that the material must have before transportation to the Dam to ensure that the specified gradation is met in place in the Dam after placing, spreading, moisture conditioning and compacting. Materials represented by samples that do not meet the specified requirements, whether stockpiled or in place, will be rejected.
3. Transport, handle and stockpile materials to avoid segregation and contamination. Materials that are segregated or contaminated, either in stockpile or in-place in the Dam, will be rejected by the Engineer.
4. Remove all rejected materials that have been placed in stockpiles or in the embankments and replace them with material meeting the specified requirements for the Dam, at no cost to the Owner.

5. Adjust water content of embankment materials in the borrow areas, stockpiles, and required excavations to the fullest extent possible. The Contractor is cautioned that onsite material from required excavations and borrow areas will require additional processing and pre-moistening.
6. All embankment fill materials shall be free of unsuitable material.

B. Dam Fill

1. Description: Suitable, well graded material from approved borrow areas, and required excavations complying with the gradation in Table 35 73 10-1

Table 35 73 10-1
Dam Fill Material Gradation Requirements

Sieve Size	Percent Passing by Weight
3-inch	100
2-inch	80-100
1-inch	55 – 100
½-inch”	40 - 100
No. 4	30 – 75
No. 40	0 – 30
No. 200	0 – 20

2.2 COMPACTION EQUIPMENT

A. Maintain compaction equipment in good working condition at all times.

B. Compaction equipment for compaction of Dam embankment fill materials

1. Self-propelled single drum vibratory soil compactor with pads equivalent to a Caterpillar CS56B in terms of drum diameter and width, total weight, and weight on the drums or as provided in Contractor submittals and approved by the Engineer.
2. Equipped with cleaning devices to prevent accumulation of material between the tamping feet.
3. Pad height of 5-inches-minimum maintained to within manufacturer's wear limits and replaced as necessary during the course of the work. The weight of the roller drum during compaction of fill materials shall be maintained uniform and with the weight per foot of drum length not less than 2,000 pounds.
4. Do not use blades during compaction operations.
5. Operate rollers at speeds of 3 miles per hour or less.

C. In restricted spaces and in any location where other compactors specified in this section do not operate effectively, and in areas closer than 3 feet from structures or 2 feet from pipes (for special compaction) use hand-held power tampers, power tampers on wheels, walk-behind rollers, vibrating plates, or other compaction equipment, as approved by the Engineer appropriate for the material types and sufficiently sized to obtain the specified densities.

D. Provide equipment for applying water of a type and quality adequate for the work, free of leaks.

E. Provide suitable equipment for mixing, and moisture conditioning fill materials.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

A. Foundation Acceptance:

1. Do not place Dam Fill or other fill materials on any portion of the Dam foundation or prepared surface until the foundation or surface has been inspected and accepted by the Engineer. Provide the Engineer with 3 days advance notice of the intended foundation cleaning and preparation before placement of all embankment materials. Delays due to the Contractor's failure to adequately coordinate with the Engineer will not be a basis for a claim or request for a time extension.
2. Prepare foundations in accordance with Section 31 23 13: Subgrade Preparation.

B. Fill Elevations:

1. Place fill to the lines, grades and cross-sections shown on the Drawings and written field clarifications by the Engineer.
2. Maintain fill areas at approximately the same level, both parallel and perpendicular to the Dam axis.
3. Temporary construction slopes required by normal sequences of construction activities may be permitted. If temporary construction slopes are necessary, submit proposed plan for the temporary slope(s) that details the proposed location and configuration of the temporary slope(s), maximum height, schedule for placing adjacent embankment, and proposed procedures for bonding new embankment to previously placed embankment. Provide all additional work required to construct temporary slopes and bond new embankment to previously placed embankment at no additional cost to the Owner.

C. Tolerances:

1. Place and compact embankment materials in horizontal lifts to the lines and grades shown on the Drawings and written field clarifications by the Engineer within the tolerances specified below:

    a. Dam Fill and Crest Elevations: 0 to 0.15 feet from the elevations indicated on the Drawings.

D. Control of Drainage and Runoff:

1. Grade fill so that water does not pond on the top of embankment lifts. Prevent runoff from contaminating the embankment dam zones.

E. Haul Routes:

1. Except where otherwise specified, disperse hauling routes across the embankment to avoid heavy concentrations of loads in any one area. Remove and replace any material whose gradation is altered from that specified herein because of routing of traffic over the zone, or is contaminated, at no cost to the Owner.
2. Rework lift surfaces that have been sealed by smooth drum rolling, have been used as haul routes, are rutted, or otherwise determined by the Engineer to be too smooth to properly bond with the succeeding layer. Roughen surfaces by scarifying, plowing or discing to a minimum depth of 6 inches and moisture conditioning and re-compacting.

F. Placement and Compaction Orientation:

1. Dump, spread, and compact material for fill areas parallel to the Dam axis in that part of the Dam, unless otherwise specified. Except in restricted areas, spreading and compaction equipment travel in the transverse direction to the embankment axis will not be allowed.
2. Dump and spread fill in level, continuous, approximately horizontal lifts that do not exceed the specified loose lift thickness before compaction.

G. Coverages of Compaction Equipment:

1. Compact fill lifts only after moisture conditioning, blending, and leveling.
2. Carry out coverages of the compaction equipment, where accessible, so that the compactive effort is uniformly distributed in a systematic manner over the entire lift.
3. Complete compaction of individual lanes of a lift before beginning compaction of adjacent portions of the lift.
4. Overlap individual compaction lanes by at least 12 inches.

H. Control and Conduct of Operations:

1. Conduct all operations, including processing, stockpiling, loading, transporting, dumping, spreading, moisture conditioning and compacting materials, to prevent contamination and segregation of embankment material. Do not use handling methods that increase segregation such as conveyors or hoppers for stockpiling or loading, and excessive drop heights. Maintain moisture in fill materials.
2. The distribution and gradation of materials throughout the fill shall be such that the material will be free from lenses, pockets, streaks, or layers of material differing substantially in texture, gradation, and moisture from the surrounding material. The combined excavation, handling, and placing operations shall be such that the fill shall be mixed and blended sufficiently to provide a relatively homogeneous section without segregation and rock pockets.
3. Remove all contaminated, segregated, or non-conforming fill material, replace with fill material conforming to the specified requirement, and dispose of contaminated material in approved areas on site or offsite, at no cost to the Owner.
4. Immediately prior to periods of shutdown of the fill placement operations, including periods when rain or frost is forecast, slope to drain and roll the exposed surface of the fill with two passes of a smooth-drum roller (without vibration). Prior to recommencing placement, scarify rolled surfaces to meet the requirements of this Section.

I. Moisture Conditioning:

1. Thoroughly moisture condition fill materials as necessary to prevent segregation and achieve complete compaction.

J. Freezing Conditions:

1. Do not place Frozen Fill material, and do not place fill below water or on frozen ground. Stop fill placement temporarily during unsuitable weather conditions, if determined by the Engineer.

K. Re-working to Attain Specified Limits:

1. When the quality control test results indicate that the materials are not within specified limits make immediate adjustments in procedures as necessary to conform to the

specified limits. Re-working may include removal, re-handling, reconditioning, re-compacting, or combinations of these procedures. The Engineer will determine the area of re-work. Perform all re-work required to achieve the specified requirements.

L. Placing Fill Against Structures

1. Do not place fill adjacent to structures before the concrete has attained sufficient strength to withstand the applied construction loads. Do not place fill material structure walls until the concrete has attained at least 100% of the design compressive strength.
2. Where possible, place fill against structures in uniform lifts on both sides of the structure such that no unbalanced loading will occur against the structure.

M. Placing Fill Against Existing Dam Embankment or Fill

1. Place fill by benching each lift at least 2 feet into existing dam embankment or fill, or as necessary to tie new fill into existing compacted material, and in a manner that ensures continuity of compacted embankment as approved by the Engineer. If the surface of the fill or the adjacent embankment dries or cracks after exposure, or if loose material is present, bench into existing embankments sufficiently to remove loose material, rework the dry material into new moisture conditioned fill.

3.2 TEST FILL

A. Conduct a test fill before starting Dam Fill placement to establish a method specification prescribing the number of compactor passes required for compaction of Dam Fill material. The test fill will include two large-scale density tests in accordance with either ASTM D4914 or ASTM D5030 as approved to estimate achieved density, and gradation tests to confirm material complies with the specified gradation. Select density test apparatus based on a maximum particle size of 3 inches.

B. Unless otherwise approved, locate the test fill placement area outside the Dam footprint in an area acceptable to the Engineer. Construct the test fill with a total minimum working surface area of 30 feet by 75 feet not including include ramps, side slopes, and any additional area around the edges necessary to provide containment of materials for complete compaction within a flat and level working surface.

C. Independent laboratory test results, combined with visual observations, survey monitoring data collected during the test, and the large scale density test results will be used by the Engineer to evaluate whether the placement and compaction procedures will produce acceptable densities, and that compaction methods do not result in an unacceptable breakdown of the fill material.

D. Prepare a level and firm foundation subgrade for the test fill as approved by the Engineer. Construct test fills using the same placement, moisture conditioning, and compaction methods and equipment submitted and accepted by the Engineer for production work.

E. The primary purpose of the test fill is to determine the minimum number of passes required to satisfactorily consolidate the material. The test fill placement will also be used to evaluate if placement methods result in adequate distribution of particle sizes without rock nesting, and gradation compliance. Evaluate placement and compaction in accordance with the following:

1. Place a 12-inch loose lift.

2. Survey and mark a minimum of 5 locations along each side of the working surface after spreading and before compaction starts.
3. Make compactor coverages in 2-coverage increments to evaluate settlement versus roller coverages and determine the required number of coverages. Mark the control locations with paint and survey the elevation between each 2 coverages to the nearest 0.01-foot. Continue monitoring until <0.01-foot change is surveyed but make no less than 4 total coverages with settlement measurements for evaluation.
4. Enter the elevation difference between each 2 coverages on a spreadsheet and plot the average settlement vs. compactor coverages on a graph. Obtain Engineer approval before proceeding.
5. Place a second 12-inch loose lift and repeat the above steps.
6. Conduct 2 large scale density tests in locations selected by the Engineer. Test a complete sample of the excavated material for gradation (ASTM C 117 and C 136) and moisture content (ASTM D 2216).
7. Submit test fill documentation that includes the lift thickness, type of compactor, roller width, dynamic force, roller vibrations per minute and estimated travel speed; survey data, settlement vs. compactor coverages graph, field density test results, and gradation and moisture content test results.
8. The required number of coverages will be determined as the point where difference in survey settlement is <0.015 feet or otherwise accepted by the Engineer pending the compacted fill density testing.
9. Compaction procedures, including the number of compactor coverages established by the test fill and accepted by the Engineer shall be used for placement of Dam Fill material.

3.3 DAM FILL PLACEMENT AND COMPACTION

A. Dump and spread in level, continuous, approximately 12-inch thick horizontal lifts.

B. Moisture Conditioning: Add water to thoroughly wet materials during dumping and spreading of each lift unless otherwise approved by the Engineer. Add moisture by such methods as spraying the fill as it is being dumped from the truck, or other acceptable methods.

C. Compact each lift with at least 4 coverages of an approved vibratory roller unless the results of the test fill indicate additional coverages are required.

3.4 SPECIAL COMPACTION

A. Special compaction is required within 3 feet laterally of all structures, and in tight, restricted, or steep areas not accessible by larger rollers, and within 2 feet of pipes. The intent of the zones of special compaction is to prevent damage to structures or pipes from compaction equipment loads.

B. Place specially compacted fill in accordance with fill requirement except for the following:

1. Maximum particle size of 2 inches.
2. Compact in maximum 6-inch thick loose lifts.
3. Compaction equipment used in special compaction areas shall be small rollers, walk-behind sheep's-foot rollers, vibratory plates, or other small compactors appropriate for the material and as approved by the Engineer. No equipment may be used which by its weight or movement will damage, move, or tilt out of alignment any part of the pipe or structure above, adjacent, or below the ground surface.

3.5 FIELD QUALITY CONTROL

A. Give advance notice of at least 48 hours to Engineer for the following:

1. Before commencement of placement and compaction of fill.
2. Before sampling or testing fill materials.

B. The Contractor is responsible for controlling the quality of fill materials. The Contractor's independent commercial testing firm is required to take samples of materials and perform quality control observations and testing in the borrow areas, stockpile areas, and on the Dam Fill to monitor compliance.

C. All testing and sampling locations are subject to approval by the Engineer. The Engineer will select the locations of testing. When observations indicate proper moisture conditioning and compaction are not being followed, or if there is a pattern of failing tests, the Engineer reserves the right to increase the specified testing frequency. Such additional testing shall be at no cost to the Owner.

D. The final acceptance or rejection of the fill will be based on the Engineer's judgment considering test results and the general disposition of the fill.

E. The Engineer may retain its own quality assurance laboratory for material testing services. Provide equipment and labor to assist the Engineer in quality assurance testing and in obtaining soil samples. Assistance may require cutting horizontal pads or trenches with a dozer, grader or backhoe at locations selected by the Engineer for testing, observation, and sampling.

F. The Contractor is responsible for scheduling work activity in accordance with material QC testing and Engineer's review period.

G. Keep dam construction work at least 50 feet away from testing areas.

H. The testing requirements and frequency of quality control tests are shown in Table 35 73 10-2.

Table 35 73 10-2
Fill Quality Control Field and Laboratory Testing

Material	Test Type	Test Method	Testing Frequency (minimum one test per no. of cubic yards indicated)
Dam Fill	Gradation	ASTM C 117 and C 136	1,000 cy
Dam Fill	Visual	Segregation	Continuous

END OF SECTION