THORNTON JUSTICE CENTER
EXPANSIVE SOIL MITIGATION PROJECT - PHASE III

ISSUED FOR BID
JANUARY 2024

CIP 22-076

THORNTON, COLORADO

BY: _____

ENGINEER: ROBERT J. HUZJAK, P.E.
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SPECIFICATION INDEX

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 GENERAL

A. The work described in these specifications includes the following general items of work:

1. Thornton Police Department (Police) Building Upper Parking Area and Memorial Plaza

a. Demolition: Saw cutting, removal, and disposal of concrete and asphalt; removing and disposing of existing storm sewer; removing and disposing of bollards, signs, and other appurtenances designated on the plans; removing and sawing concrete masonry units (CMU) blocks, removing and disposal of retaining wall backfill; removing and salvaging of statue, granite memorial panels, and granite pavers, removing and disposal of landscaping as necessary for performance of the work.

b. Collection Trench: Excavating a groundwater collection trench along the east side of the Police building and Memorial Plaza. The trench will be up to 5 feet wide and up to 20 feet deep. A polyvinyl chloride (PVC) liner will be installed in the bottom of the trench and the trench will be backfilled using sand with an 8-inch diameter PVC collection pipe installed in the bottom of the trench. Includes excavation support for the construction of the trench, two manholes along the trench alignment, and solid PVC piping that conveys water collected in the trench to the storm sewer system.

c. Geomembrane Liner: Installing geomembrane in the upper parking area of the Police building and Memorial Plaza. Geomembrane liner includes excavating and re-grading, installing linear low density polyethylene (LLDPE) geomembrane (including attachment to existing structures), installing a geotextile cushion, backfilling, and re-paving using concrete, asphalt, or landscaping.

d. Retaining Wall: Demolition of an existing CMU retaining wall on the north side of the upper parking area and salvaging CMU facing. Replacing the wall with a mechanically stabilized CMU retaining wall founded on a reinforced concrete slab supported by drilled piers.

e. Utilities: Maintaining and protecting utilities to remain in place during construction including electrical service to in-service lights, gates, etc. during construction and installation of electrical equipment including conduits, wiring, electrical boxes, and lightpoles. Removal and installation of new fire hydrant and associated piping in Memorial Plaza.

f. Architectural Features: Installing architectural concrete, seat walls, bollards, and other architectural features within the limits of Memorial Plaza.

2. Memorial Plaza Storm Sewer

a. Installing high-density polyethylene (HDPE) storm sewer and drainage structures between Memorial Plaza and the attenuation pond across Civic Center Drive. Storm sewer replacement includes excavating, placing bedding material, backfilling above pipe, and placement of asphalt pavement and curb and gutter.

3. Temporary facilities - Constructing, maintaining, and removing temporary facilities necessary to perform construction. Temporary facilities include the following items:

   a. Site access - Design, construct, and reconfigure temporary parking and access to maintain access to the Police building and Courts building.
   b. CONTRACTOR laydown, stockpile, and storage areas - Design and construct CONTRACTOR's laydown, stockpile, and storage areas.
   c. Environmental controls - Design and construct all site grading for temporary features to prevent discharge of excavated or eroded material, and site runoff.
   d. Traffic Control - Provide traffic control when working in public streets.
   e. Temporary Building Protection - Design and construct all barricades, window covers, and other temporary facilities to protect building and occupants from construction activities.
   f. Other incidental items of work not listed above.

4. Asphalt Paving

   a. In addition to the asphalt paving performed for the Police building upper parking area, THORNTON may elect to add asphalt paving for areas not disturbed during the other Work as described above.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Measurement and payment criteria applicable to portions of the Work performed under a unit price payment method.

B. Measurement and payment criteria applicable to portions of the Work performed under a lump sum payment method.

1.2 SUBMITTALS

A. Administrative Submittals

1. Schedule of Values.
2. Monthly Payment Application.
3. Final Payment Application.

1.3 DEFINITIONS

A. Neat-Line Quantity: Quantity based on lines and dimensions shown on the Drawings.

1.4 MEASUREMENT OF QUANTITIES

A. Measurement by Volume - Measured by cubic dimension using mean length, width, and height or thickness. Unless specified otherwise, volumes shall be computed using the average-end-area method with cross sections surveyed at maximum 100-foot spacing. On curved alignments, volume computations shall utilize the length between the centroid of each area at adjacent cross sections rather than the nominal cross section spacing along the alignment.

1. Measurement for placement, installation, and backfilling of materials will be in place after Work. Measurement will be made from the limit of the neat lines shown on the Drawings or to the approved limits of excavation.

B. Measurement by Area - Measured by square dimension using mean length and width or radius.

C. Linear Measurement - Measured by linear dimension at the item centerline or mean chord, and shall be based on a horizontal projection of the actual area installed except where specified as a vertical measurement.

D. Surveys for measurement shall be in accordance with the requirements of Section 01 71 23: LAYOUT OF WORK AND QUANTITY SURVEYS.

E. Round to the nearest whole unit for pay quantities.

1.5 GENERAL PAYMENT

A. Payment under the lump sum work line item shall cover all Work not included in the unit price items of Work.

B. Separate payment will not be made for preparation of foundation or subgrade surfaces. All foundation preparation is considered incidental to other items of Work.

C. No payment will be made because of foundation or fill settlement.

D. Excavation beyond the limits shown on the Drawings shall be considered incidental to the cost of additional fill needed for backfill.

1.6 PAYMENT FOR UNIT PRICE ITEMS

A. Unit Price Work:

1. Reflect unit price quantity and price breakdown from the proposal.
2. Estimated quantities shown on the proposal are approximate and are given only for a comparison of bids. THORNTON does not either expressly or by implication warrant that the actual quantities will correspond to the estimated quantities. THORNTON reserves the right to increase or decrease the amount of work performed under unit price items, or to omit work altogether.

B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by THORNTON, multiplied by the unit price for Work that is incorporated in or made necessary by the Work.

1.7 PAYMENT FOR LUMP SUM ITEMS

A. Payment for lump sum Work shall be made in accordance with the accepted schedule of values.

B. An unbalanced or front-end loaded schedule will not be acceptable.

C. Mobilization shall be paid as outlined in Section XIV of the GENERAL CONDITIONS.

1.8 SCHEDULE OF VALUES

A. Provide breakdown of the lump sum pay item to facilitate review of progress payments.

1. List Bonds and insurance premiums, mobilization, demobilization, and contract closeout separately.
2. As a minimum, break down into the following separate pay items:

a. Collection Trench

1) Excavation
2) Temporary excavation support
3) Trench liner
4) Perforated pipe
5) Backfill

b. Mechanically Stabilized Earth Wall (MSEW) - 2

1) Demolition
2) Excavation
3) Temporary excavation support
4) Geogrid and CMU placement
5) Wall drain
6) Landscaping

c. Architectural Site Furnishings

1) Flagpoles
2) Relocation of Sherriff's Memorial Panel
3) Installation of Statue Pedestal and Structural Connection
4) Planters

d. Memorial Plaza Storm Sewer

1) Demolition and Disposal
2) Traffic Control and Staging
3) Drainage structures
4) HDPE Pipe
5) Backfill
6) Resurfacing

e. Subdrainage Pipe and Storm Sewer Repairs

1) Demolition and Disposal
2) Temporary drainage systems
3) Excavation
4) PVC pipe
5) Drainage structures
6) Backfill

f. Fire Hydrant Relocation

1) Demolition and Disposal
2) Excavation
3) Ductile Iron Pipe
4) Valve
5) Hydrant
6) Backfill

g. All Other Work not itemized separately

1) All other items

B. Submit on CONTRACTOR's standard form.

1.9 PROGRESS PAYMENTS

A. Include accepted schedule of values for each portion of Work and the unit price breakdown for Work to be paid on unit price basis, and allowances.

B. Preparation:

1. Round values to the nearest dollar.
2. List each Change Order and Written Amendment executed prior to date of payment request as separate line items.

1.10 PARTIAL PAYMENT FOR UNDELIVERED, PROJECT-SPECIFIC MANUFACTURED OR FABRICATED EQUIPMENT

A. Notwithstanding the above provisions, partial payments for undelivered (not delivered to the site or stored on the vicinity of the site) equipment or products specifically manufactured for this Project, excluding off-the-shelf or catalog items, will be made when the following conditions are met:

1. Partial payment request is supported by written acknowledgment from Suppliers that invoice requirements have been met.

2. Equipment or product is adequately insured, maintained, stored, and protected.
3. Each equipment or product item is clearly marked and segregated from other items to permit inventory and accountability.
4. Authorization has been provided for access to storage site for ENGINEER and THORNTON.
5. Equipment or product meets applicable Specifications requirements.

1.11 ADD ALTERNATIVE ITEMS

A. Add alternative items may, at THORNTON's discretion, be added to the Contract.

1.12 DEDUCT ALTERNATIVE ITEMS

A. Deduct alternative items may, at THORNTON's discretion, be deducted from the contract.

Listing of Pay Items				
Item		**Unit of Measure**	**General Description of Work Included**	**Measurement and Payment Terms**
Thornton Police Building Lower Parking Area				
1	Demolition	Lump Sum	Furnishing all equipment, materials, and labor necessary for the selective demolition and off-site disposal of existing concrete, sidewalk, curb and gutter, asphalt, and other materials to the required lines and grades. Include provisions to protect adjacent pavements (concrete or asphalt), landscape, and structures from damage. Includes storage of items to be salvaged. Includes clearing and grubbing and removal of trees and shrubs required to perform the work.	Payment for lump sum Work will be based on estimated percent complete.
2	Excavation	Cubic Yard	Furnishing all equipment, materials, and labor necessary for excavation to the required lines and grades for all areas, with the exception of excavation for and behind MSEW-2. Include off-site hauling and disposal costs at facility provided by CONTRACTOR.	Measurement will be based on the in-place volume, between the neat lines and limits of excavation shown on the Drawings or accepted by ENGINEER in the field.
3	Geomembrane	Square Yard	Subgrade preparation; furnishing, placing, and seaming and anchoring geomembrane; including pipe boots, anchor bolts, nuts, gaskets, sealant, batten bars, and quality control testing. Includes furnishing and installing geotextile cushion over apron liner. Does not include trench liner in the Collection Trench.	Measurement will be based on the area of geomembrane installed and accepted by ENGINEER.

Listing of Pay Items				
	Item	**Unit of Measure**	**General Description of Work Included**	**Measurement and Payment Terms**
4	Collection Trench	Lump Sum	Constructing a collection trench including the following: • Designing, furnishing, installing, and removing temporary excavation support system as necessary for construction of the collection trench. Include provisions for vibration monitoring. • Furnishing all equipment, materials, and labor necessary for excavation of the collection trench to the required lines and grades. Include off-site hauling and disposal costs at facility provided by CONTRACTOR. • Furnishing and installing trench liner in the bottom of the trench and geotextile cushion over the trench liner. Include anchorage to the trench walls, seaming, and subgrade preparation. • Furnishing and installing slotted and solid polyvinyl chloride (PVC) pipe in the trench bottom. Includes connections, end caps, and cleanouts. • Furnishing all labor, materials, equipment, tools, and accessories required for importing; foundation preparation; hauling, placing, spreading, and compacting coarse drain and filter sand in the collection trench.	Payment for lump sum Work will be based on estimated percent complete.
5	Drilled Piers	Lineal Foot	Furnishing all labor, equipment, and materials necessary for the installation of drilled piers to support the MSEW retaining wall. Includes drilling, disposal of spoils, cleaning the shaft, placing concrete, and reinforcement.	Measurement will be based on vertical foot of shaft constructed and accepted by the ENGINEER.
6	Retaining Wall Foundation	Lump Sum	Furnishing all labor, equipment, and materials necessary for the construction of the mat foundation supporting MSEW-2. Includes excavation, temporary shoring, subgrade preparation, formwork, mechanical couplers, and placing concrete and reinforcement.	Payment for lump sum Work will be based on estimated percent complete.

Listing of Pay Items				
	Item	**Unit of Measure**	**General Description of Work Included**	**Measurement and Payment Terms**
7	MSE Retaining Wall	Lump Sum	Furnishing all labor, equipment, and materials necessary for the installation of MSEW-2, and grading in the landscaped area north of the wall. Includes removal and salvage of existing concrete masonry units (CMU) blocks, excavation, backfill, installation of 4-inch slotted drain, 4-inch solid drain, coarse drain, and revised grading and landscaping behind the wall. Salvage existing CMU blocks that are uncracked and furnish new blocks. Furnish and install geogrid reinforcement in retaining wall backfill and install CMU blocks. Includes connection with CMU brick facing, connections with geomembrane liner and existing structures, and off-site disposal of unsuitable or left over CMU blocks.	Payment for lump sum Work will be based on estimated percent complete.
8	Structural Fill	Cubic Yard	Furnishing all labor, materials, equipment, tools, and accessories required for importing; foundation preparation; hauling, placing, spreading, and compacting structural fill for the geosynthetic liner.	Measurement will be based on the volume in-place after compaction, between the neat lines shown on the Drawings.
9	Asphalt Paving	Square Yard	Subgrade preparation, furnishing, placing, finishing, and protecting asphalt paving. Includes pavement markings, sealing joints between new asphalt and adjacent flatwork and structures. Does not include asphalt patching above the Memorial Plaza Storm Sewer in Civic Center Dr.	Measurement will be based on the surface area constructed and accepted by ENGINEER.
10	Sidewalk Concrete	Square Yard	Subgrade preparation, furnishing, placing, finishing, and protecting concrete paving. Includes all reinforcing steel, formwork, void forms, embedded items, connections, curing, and protection cutting and sealing joints between concrete, and adjacent flatwork and structures.	Measurement will be based on the surface area constructed and accepted by ENGINEER.
11	Architectural Concrete	Lump Sum	Subgrade preparation, furnishing, placing, finishing, and protecting concrete placed within Memorial Plaza. Includes all anchors, formwork, void forms, embedded items, connections, curing, and protection cutting and sealing joints. Includes concrete Types 1 through 5 as shown on the plans.	Payment for lump sum Work will be based on estimated percent complete.

Listing of Pay Items				
Item		**Unit of Measure**	**General Description of Work Included**	**Measurement and Payment Terms**
12	Flow Fill	Cubic Yard	Subgrade preparation, furnishing, placing, and protecting flow fill placed under the collection trench and the subdrainage piping downstream of the collection trench.	Measurement will be based on the volume in-place between the neat lines shown on the Drawings.
13	Curb and Gutter	Lineal Foot	Subgrade preparation, furnishing, placing, finishing, and protecting concrete curb and gutter and concrete curb. Includes reconstruction of chase drain in Upper Parking Area.	Measurement will be based on horizontal foot of curb measured at the back of curb constructed and accepted by the ENGINEER.
14	River Rock	Cubic Yard	Subgrade preparation, furnishing, placing, cleaning, and protecting all river rock. Includes weed barrier.	Measurement will be based on the surface area constructed and accepted by the ENGINEER.
15	Electrical	Lump Sum	Furnishing, installing, and operational testing of replaced electrical services impacted by the excavation in the lower parking area. Includes light pole and bollard installation.	Payment for lump sum Work will be based on estimated percent complete.
16	Signs	Lump Sum	Furnishing and installing sign posts and panels in the upper parking area and Memorial Plaza. Includes cost for all connections and foundations.	Payment for lump sum Work will be based on estimated percent complete.
17	Fence	Lump Sum	Removing and salvaging portions of existing fences and furnishing and installing salvaged and new items to re-establish fence. Includes architectural metal fence behind MSEW-2.	Payment for lump sum Work will be based on estimated percent complete.
18	Architectural Site Furnishings	Lump Sum	Furnishing all equipment, materials, and labor necessary for the installation of above grade architectural features in Memorial Plaza. Includes storage and installation of reused components, flagpoles, benches, etc.	Payment for lump sum Work will be based on estimated percent complete.

Listing of Pay Items

Item		Unit of Measure	General Description of Work Included	Measurement and Payment Terms
19	Memorial Plaza Storm Sewer	Lump Sum	Furnishing all equipment, materials, and labor necessary for removal and replacement of the existing storm sewer, including but not limited to, demolition, disposal of demolished materials, temporary drainage systems, excavation and excavation support, inlet structures, manholes, end sections, connections, fittings, backfill, placement of aggregate base course, placement of asphalt surfacing, and placement of concrete curb and gutter.	Payment for lump sum Work will be based on estimated percent complete.
20	Subdrainage Pipe and Storm Sewer Repairs	Lump Sum	Furnishing all equipment, materials, and labor necessary for placement of the subdrainage pipe and storm sewer repairs downstream of the collection trench, including but not limited to, demolition, disposal of demolished materials, temporary drainage systems, excavation and excavation support, inlet structures, manholes, connections, fittings, and backfill. Includes all solid PVC pipe downstream of the end of the collection trench and downstream of the slotted PVC pipe behind MSEW-2. Includes all stainless steel pipe for the void space drain modifications.	Payment for lump sum Work will be based on estimated percent complete.
21	Fire Hydrant Relocation	Lump Sum	Furnishing all equipment, materials, and labor necessary to remove the existing fire hydrant in Memorial Plaza and install a new fire hydrant including but not limited to demolition, disposal of demolished materials, excavation and excavation support, valves, fittings, backfill, and paving.	Payment for lump sum Work will be based on estimated percent complete.
22	All Other Items	Lump Sum	All items of Work not paid for under one of the items of Work listed above shall be included in the All Other Items line item.	Payment for lump sum Work will be based on estimated percent complete.
23	Dewatering	Lump Sum	Furnishing all equipment, materials, and labor necessary for the removal of surface water and groundwater as necessary to perform the work in the dry. Removing dewatering works when no longer needed.	Payment for lump sum Work will be based on estimated percent complete.

Listing of Pay Items				
Item		**Unit of Measure**	**General Description of Work Included**	**Measurement and Payment Terms**
24	Overexcavation	CY	Any excavation required beyond the lines and grades shown in the plans. Include off-site hauling and disposal costs at facility provided by CONTRACTOR.	Measurement will be based on the in-place volume, between the neat lines and limits of excavation shown on the Drawings or accepted by ENGINEER in the field.
25	Mobilization	Lump Sum	Mobilizing all crews, equipment, and safety measures required to begin the work.	Payment for lump sum Work will be based on the schedule provided in paragraph 1.7.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

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SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUBMITTALS

A. Administrative:

1. CONTRACTOR's water usage plan. Indicate CONTRACTOR's peak daily water demands for the Work.

1.2 THORNTON FURNISHED ITEMS

A. Construction Water

1. Water (non-potable) for construction of the Work will be furnished to CONTRACTOR by THORNTON from a local hydrant.
2. Include expected water requirements when submitting construction schedules.
3. Provide means of transporting and storing water delivered from the hydrant. Provide adequate water storage for CONTRACTOR's operations.

1.3 PROJECT MEETINGS

A. CONTRACTOR will schedule a pre-construction conference, prepare meeting agenda with participant input, preside at meetings, record key discussions to include significant proceedings and decisions, and distribute meeting notes within 5 days after meeting.

Preconstruction Conference:

1. Prior to starting Work at the site, meet with THORNTON and ENGINEER to discuss the following items:

a. Project schedule
b. Bonds and insurance
c. Project permits
d. Administrative procedures

1) Submittals
2) Progress payments
3) Changes in the Work
4) Weekly progress meetings

e. Construction sequence
f. Quality control and testing
g. Site safety
h. Site access, security, and temporary facilities
i. THORNTON authority and responsibilities
j. CONTRACTOR authority and responsibilities
k. ENGINEER authority and responsibilities
l. Resident Project Representative authority and responsibilities

2. The Preconstruction conference shall be attended by the following people:

a. THORNTON's representative (attendance mandatory).

b. CONTRACTOR's office representative (attendance mandatory).
c. CONTRACTOR's resident superintendent (attendance mandatory).
d. CONTRACTOR's safety representative (attendance mandatory).
e. ENGINEER's representative (attendance mandatory).
f. Subcontractors whom CONTRACTOR, ENGINEER, or THORNTON request to attend.
g. Others as appropriate.

B. CONTRACTOR will schedule special meetings, prepare meeting agenda with participant input, preside at meetings, record key discussions to include significant proceedings and decisions, and distribute meeting notes within 5 days after meeting.

Special Meetings:

1. Meet with THORNTON and ENGINEER when requested to discuss technical issues, construction planning, construction schedule, and contract administration. Meetings shall be scheduled at least 2 weeks before the scheduled start of the activity. At a minimum, special meetings shall be held prior to the following activities:

a. Demolition
b. Transitioning substages or stages

1) Prior to transition between Stage 1A and Stage 1B
2) Prior to transition between Stage 1B and Stage 1C
3) Prior to transition between Stage 1C and Stage 2

c. Geosynthetic installation
d. Mechanically Stabilized Earth Wall (MSEW)-2 Reconstruction
e. Placement of architectural concrete

2. Special meetings shall be attended by the following people:

a. CONTRACTOR's resident superintendent (attendance mandatory).
b. THORNTON's representative (attendance mandatory).
c. ENGINEER's representative (attendance mandatory).
d. Subcontractors whom CONTRACTOR, ENGINEER, or THORNTON request to attend.
e. Others as appropriate.

C. CONTRACTOR will schedule and conduct weekly progress meetings in accordance with the GENERAL CONDITIONS.

1.4 CONSTRUCTION SEQUENCE

A. CONTRACTOR is responsible to develop sequencing plan for approval by the ENGINEER and THORNTON. The CONTRACTOR is required to meet the following requirements:

1. For the entire construction duration, at least one of the public entrances to either the Courts Building or the Police Building must remain open and accessible. All Americans with Disabilities Act (ADA) parking spots in the parking lot adjacent to the open public entrance must be available.
2. For the entire construction duration, two lanes of traffic through Civic Center Drive should be maintained at all times with the exception of a single lane closure during the replacement of the Memorial Plaza storm sewer and the relocation of the fire hydrant in Memorial Plaza. Police access through the security gate must be maintained at all times during construction.

3. Closure of one lane of Civic Center Drive will be acceptable during construction of the Memorial Plaza Storm Sewer and the relocation of the existing fire hydrant in Memorial Plaza. If no work is being performed, two lanes must remain open. Traffic control must be provided during lane closure.
4. Water service through the existing water main along Civic Center Drive should be maintained at all times during construction except during the relocation of the existing fire hydrant in Memorial Plaza. During relocation of the fire hydrant, the gate valves on either side of the portion of the water main affected by construction should be closed to maintain service to the remaining fire hydrants on site. Each closure shall be a maximum of 48 hours and there shall be no more than 2 closures. Each closure must be approved by THORNTON.
5. Surface drainage in the Upper Parking Area must be maintained at all times during construction. Any temporary drainage structures required by the sequencing plan are the responsibility of the CONTRACTOR.
6. Before each stage has begun, the previous stage must be complete, clear of all equipment and debris, and open to THORNTON and the public for use. This does not apply to substages. Construction that has already been completed shall be protected from all subsequent construction activity.
7. During each stage, the staging area occupied by the CONTRACTOR must be enclosed with temporary construction fence on all sides. The construction fence shall be a chain link fence and screening.

B. The following outlines the Work required as part of each expected stage of construction. Stage 1 is divided into three parts. All parts of Stage 1 need to be complete and accepted for use by THORNTON prior to initiation of Stage 2.

1. Upper Parking Area - Stage 1a:

    a. Restrict parking and access.
    b. Demolition and excavation. Provide excavation support as necessary.
    c. Place drilled shafts.
    d. Place mat foundation.
    e. Install concrete masonry units (CMU) blocks, geogrid reinforcement, and drainage system.
    f. Drainage structure and pipe installations north of MSEW-2.
    g. Install collection trench.
    h. Regrade and backfill as necessary to move to the next substage.

2. Upper Parking Area - Stage 1b:

    a. Restrict parking and public access to additional work area.
    b. Demolition and excavation.
    c. Install collection trench.
    d. Remove and relocate fire hydrant.
    e. Subsurface preparation.

3. Upper Parking Area and Memorial Plaza - Stage 1c:

    a. Restrict parking and public access to additional work areas. Close Police building public entrance and provide exterior signage for pedestrian traffic detour to public entrance to Courts building. Protect existing monuments and features to remain in place.
    b. Demolition and excavation.
    c. Subgrade preparation.
    d. Geosynthetic installation.
    e. Install collection trench.

f. Drainage structures and pipe installations and connections.
g. Utility relocation.
h. Fill placement.
i. Re-paving and surface treatments.

4. Memorial Plaza - Stage 2:

a. Restrict parking and public access to work area. Close Courts building public entrance and provide exterior signage for pedestrian traffic detour to public entrance of Police building. Protect existing monuments and features to remain in place.
b. Demolition and excavation.
c. Implement traffic control and perform removal and replacement of existing storm sewer.
d. Geosynthetic installation.
e. Utility relocation.
f. Fill placement.
g. Re-paving and surface treatments.

1.5 PROJECT MILESTONES

A. Stage 1a Completion.

1. Completion 60 days after Notice to Proceed.

B. Stage 1b Completion.

1. Completion 30 days after completion of Stage 1a.

C. Stage 1c Completion.

1. Completion 75 days after completion of Stage 1b.

D. Stage 2 Completion.

1. Completion 65 days after completion of Stage 1.

E. Final Completion.

1. Final completion of all work 230 days after Notice to Proceed.

1.6 UTILITY NOTIFICATION

A. Coordinate Work with various utilities within Project limits. Notify applicable utilities prior to commencing Work, if damage occurs, or if conflicts or emergencies arise during Work. Contact the following:

1. Utility Notification Center of Colorado
2. Electricity and natural gas companies: Xcel Energy
3. Telephone Company: Qwest Communications
4. Fiber Optic: UMKR - Level 3
5. City of Thornton

1.7 REQUEST FOR INFORMATION

A. Submit questions and requests for clarifications to ENGINEER using the Request for Information (RFI) form attached at the end of this Section. RFIs shall be used for

clarification of information provided in the Specifications or shown on the Drawings, and to request substitutions for materials or methods.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

Project Name _____ RFI Number:_____

Date:_____

To: _____ From: _____

_____ _____

_____ _____

_____ _____

SUBJECT:	
SPECIFICATION SECTION:	
DRAWING NUMBER:	

QUESTION:

_____
_____
_____
_____
_____
_____
_____

WRITTEN BY: _____ DATE: _____

ATTACHMENTS: _____

RESPONSE:

_____
_____
_____
_____
_____
_____
_____

_____

WRITTEN BY: _____ DATE: _____

ATTACHMENTS: _____

CONTRACTOR ACCEPTANCE: _____

TITLE: _____ DATE: _____

SECTION 01 32 00
CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 GENERAL

1.1 DEFINITIONS

A. Critical Path Method - Critical path method (CPM) shall be interpreted to be generally as outlined in the Association of General Contractors (AGC) publication. "The Use of CPM in Construction." except that either "i-j" arrow diagrams or precedence diagramming format may be utilized.

B. Construction Schedules - Construction schedules shall include a bar chart, graphic network diagrams, and computerized construction schedule reports.

C. CPM Network - CPM network shall be in a form of a time scaled "i-j" activity-on-arrow or precedence type diagram and may be divided into a number of separate sheets with suitable match lines relating the interface points among the sheets. Individual sheets shall not exceed 22- by 34-inch.

D. Duration Estimates - The duration estimate indicated for each activity shall be computed in days and shall represent the single best estimate considering the scope of the activity work and resources planned for the activity. Except for certain non-labor activities such as curing of concrete or delivery of materials, activity duration shall not exceed 30 days nor less than one day unless otherwise accepted by THORNTON or ENGINEER.

E. Float - Unless otherwise provided herein, float as referenced in these documents is total float. Total float is a period of time measured by the number of days each non-critical path activity may be delayed before it and its succeeding activities become part of the critical path. If a non-critical path activity is delayed beyond its float period, that activity then becomes part of the critical path and controls the end date of the project.

F. Float Ownership - Neither THORNTON nor CONTRACTOR owns the float time. The project owns the float time. As such, liability for delay of the project completion date rests with the party actually causing the delay to the project completion date. For example, if Party A uses some, but not all, of the float time and Party B later uses the remainder of the float time as well as additional time beyond the float time, Party B shall be liable for the costs associated with the time that represents delay to the project's completion date. Party A would not be responsible for any costs since it did not consume all of the float time and additional float time remained; therefore, the project's completion date was unaffected.

1.2 SUBMITTALS

A. Administrative:

1. CPM Schedule.
2. Updated CPM Schedules.
3. Construction Photographs.
4. Video Recordings.

1.3 CPM SCHEDULE

A. A time-scaled network diagram of the "i-j" activity-on-arrow or precedence type. The network diagram shall describe the activities to be accomplished and their logical

relationships and show the critical path. The schedule shall include, as a minimum, the following items:

1. Obtaining permits
2. Mobilization
3. Initial site work
4. Beginning and end of access restrictions for each stage and substage
5. Police Building Upper Parking Area

    a. Demolition
    b. Excavation
    c. Mechanically Stabilized Earth Wall (MSEW)-2 Concrete Foundation
    d. Mechanically Stabilized Concrete Masonry Units (CMU) retaining wall construction
    e. Retaining wall backfill and landscaping.
    f. Polyvinyl Chloride (PVC) Storm Sewer installation and backfill
    g. Collection trench installation and backfill
    h. Geomembrane installation and backfill
    i. Concrete paving
    j. Asphalt paving

6. Memorial Plaza

    a. Demolition
    b. Excavation
    c. Collection trench installation and backfill
    d. Geomembrane installation and backfill
    e. High-Density Polyethylene (HDPE) storm sewer removal and replacement
    f. Concrete paving
    g. Architectural features

7. Utility repairs
8. Electrical work
9. Project milestones
10. Project closeout
11. Demobilization

B. The schedule shall contain sufficient detail and information to cost load the CPM schedule in accordance with the schedule of values. Each construction activity shall have been cost loaded as specified.

1.4 SCHEDULE REPORTS (FORMAT)

A. Plot or print the schedule on 22- by 34-inch paper.

B. Project Information - Each Schedule Report shall be prefaced with the following summary data:

1. Project Name
2. CONTRACTOR
3. Type of Tabulation
4. Project Duration
5. Contract Completion Date (revised to reflect time extensions)
6. The Commencement Date Stated in the Notice to Proceed
7. The Data Date and Plot Date of the Network Diagram
8. If an update, cite the new schedule completion date

1.5 PROJECT STATUS REPORTING

A. Provide monthly project status reports in the form of a written narrative report to be submitted in conjunction with the revised CPM Schedules.

B. Prepare monthly written narrative reports of the status of the project. Written status reports shall include:

1. Number of days worked, construction force, weather conditions, and list of equipment on site.
2. The status of major project components (percent complete, amount of time ahead or behind schedule).
3. The progress made on critical activities indicated on the CPM schedule.
4. The status of major material and equipment procurement.
5. Any delays encountered during the reporting period.
6. An assessment of delays encountered and impacts to the progress of the Work.
7. Changes in the Contract.
8. CONTRACTOR may include any other information pertinent to the status of the project. CONTRACTOR shall include additional status information requested by ENGINEER.

1.6 CONSTRUCTION PHOTOGRAPHS

A. Photographically document all phases of construction including preconstruction, construction progress, and post-construction.

B. ENGINEER shall have the right to select the subject matter and vantage point from which photographs are to be taken.

C. Preconstruction and post-construction:

1. Preconstruction photos shall be after the Effective Date of the Agreement but before Work begins at the site. Post-construction photos shall be at the issuance of Substantial Completion.
2. Photos for post-construction shall be taken at the same vantage points as the Preconstruction photos.

D. Construction progress photos:

1. Demonstrate progress on construction.

E. Format:

1. Digital Images

a. Submit on compact disk or flash drive
b. Date stamp on all photos

2. Label each photo with the following:

a. Project name
b. Date
c. Description of photo

1.7 VIDEO RECORDINGS

A. Video recording of the existing condition of the following:

1. Civic Center Drive
2. Parking areas
3. Access roads and gates
4. Buildings
5. Equipment (light poles, water valves, others)
6. Existing retaining walls to remain

1.8 RECORD DRAWINGS

A. Provide and maintain at the project site, one complete set of prints of the project Drawings. Keep the Drawings in good, clean, and readable condition.

B. Neatly inscribe on the project Drawings all changes in Work including relocation of lines, change in type of materials, etc. Note changes with red pencil or red ink. Note date of change. Note all data and changes on these record drawings in sufficient detail and clarity and provide information necessary for preparation of record drawings. Project Drawings shall be kept current and shall be updated weekly.

C. Review changes with THORNTON and ENGINEER at monthly pay request submittal.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUBMITTAL PROCEDURES

A. The word "submittals" shall be interpreted to include Work plans or procedures, Drawings, shop drawings, schedules, data, manuals, certifications, test reports, curves, samples, brochures, and other items furnished by CONTRACTOR for acceptance, information, or other purposes.

B. Each submittal will be returned within twenty-one (21) days following receipt of submittal, unless otherwise indicated in the Specification section. Resubmittals shall be subject to the same review time.

C. Do not perform Work related to submittals prior to obtaining the required acceptance from ENGINEER.

D. Utilize a 9-character submittal identification numbering system in the following manner:

1. The first five digits shall be the applicable Specification section number.
2. The next three digits shall be the numbers 001 to 999 to sequentially number each initial separate item or submittal under each specific section number.
3. The last character shall be a letter (A to Z) indicating the submission, or resubmission of the same Submittal, i.e., “A = 1st submission, B = 2nd submission (first resubmission), C = 3rd submission, etc. A typical submittal number would be as follows: 31 23 23 - 008 - B

E. Submittals will be reviewed no more than twice at THORNTON’s expense. Subsequent reviews will be performed by ENGINEER at CONTRACTOR’s expense. CONTRACTOR will be invoiced on a time and materials basis using the same hourly rates that are being charged to THORNTON for engineering services. Invoice amounts will be deducted from amounts due, or to become due, to CONTRACTOR. Submittals are required until accepted. Delays resulting from resubmittals will not entitle CONTRACTOR to a Contract Time extension or change in Contract Price.

F. If the items as submitted describe variations and show a departure from the Contract requirements which ENGINEER finds to be in the interest of THORNTON, and to be so minor as not to involve a change in Contract Price or Contract Time, ENGINEER may return the reviewed submittals without noting an exception.

G. Complete and submit a transmittal form with each submittal package. A copy of the form is attached at the end of this Section.

1.2 SUBMITTALS

A. Administrative:

1. Schedule of Submittal Submission: Submit 14 days after Notice to Proceed. Include the following information:

a. List of submittals (group by Specification number)
b. Estimated submission date
c. Estimated start date for corresponding items of Work

2. Schedule shall be updated on a bi-weekly basis until such time as all submittals have been approved.

1.3 SHOP DRAWINGS

A. Copies: Submit five copies or one electronic copy in .pdf format of shop drawings and product data.

B. Shop drawings are those submittals that reflect processes, layout, or method of construction. All shop drawing submittals shall contain the following information:

1. The date of submission and the dates of any previous submissions.
2. The project title and number.
3. The name of CONTRACTOR (and Subcontractor where applicable).
4. Identification of the items/submittal/product, with the Specification section number, page, and paragraph(s), and Drawing reference, if any.
5. Field dimensions, clearly identified as such.
6. Relation to adjacent or critical features of the Work or materials.
7. Design Data: show calculations, dimensions, logic, and assumptions upon which the design is based.
8. Applicable standards, such as American Society for Testing and Materials International (ASTM), American National Standards Institute (ANSI), or Federal Specification numbers.
9. Identification of deviations from Contract Documents.
10. Identification of revisions on resubmittals.
11. A blank space suitably sized for CONTRACTOR and CONTRACTOR's engineer (if necessary) stamps.

C. Prepare the submittal as follows:

1. Present in a clear and thorough manner. Include sufficient detail to show the kind, size, arrangement, and function of components or materials and compliance with the Contract Documents.
2. Include drawings that are to scale.
3. Mark pertinent products or models and show performance characteristics, capacities, dimensions, clearances, anchorages, external connections, or supports required.
4. Submit on 8-½- by 11-inch or 11- by 17-inch paper. If paper larger than 11- by 17-inch is required, use 22- by 34-inch paper.

D. Disposition: ENGINEER will review and mark up submittals and distribute marked-up copies as described below.

1. Accepted:

a. One copy to THORNTON
b. One copy to ENGINEER
c. One copy to Resident Project Representative field office
d. Remaining copies returned to CONTRACTOR
e. CONTRACTOR may begin Work described in the submittal

2. Accepted as Noted:

a. One copy to THORNTON
b. One copy to ENGINEER
c. One copy to Resident Project Representative field office.
d. Remaining copies returned to CONTRACTOR appropriately annotated.

e. CONTRACTOR may begin Work described in submittal in accordance with ENGINEER's notations, subject to CONTRACTOR's written verification and acceptance of ENGINEER's notations.

3. Not Accepted:

a. One copy retained by ENGINEER.
b. Remaining copies returned to CONTRACTOR appropriately annotated.
c. CONTRACTOR shall make corrections or develop a replacement submittal and resubmit.

4. Incomplete:

a. One copy retained by ENGINEER.
b. Remaining copies returned to CONTRACTOR appropriately annotated.
c. CONTRACTOR shall complete and resubmit or submit missing portions of the submittal.

1.4 SAMPLES

A. Unless otherwise noted, submit five samples for each required submittal.

B. Sample submittals are those submittals that reflect type or quality of product. All sample submittals shall contain the following information:

1. The date of submission and the dates of any previous submissions.
2. The project title and number.
3. The name of CONTRACTOR (and Subcontractor where applicable).
4. Identification of the items/submittal/product, with the Specification section number, page, and paragraph(s), and Drawing reference, if any.
5. Applicable standards, such as ASTM, ANSI, or Federal Specification numbers.
6. Identification of deviations from Contract Documents.
7. Identification of revisions on resubmittals.
8. Source, location, date obtained, and who obtained the sample.

C. Prepare the sample submittal as follows:

1. Present in a clear and thorough manner. Include sufficient detail to show the kind, size, arrangement, and function of components or materials, and compliance with the Contract Documents.
2. Mark pertinent products or models and show performance characteristics, capacities, dimensions, clearances, anchorages, external connections, or supports required.

D. Disposition: ENGINEER will review and mark up submittals and distribute marked-up copies as described below.

1. Accepted:

a. One copy of transmittal and one sample to THORNTON.
b. One copy of transmittal and one sample to ENGINEER.
c. One copy of transmittal and one sample to Resident Project Representative field office.
d. One copy of transmittal and one sample to CONTRACTOR.
e. CONTRACTOR may begin Work described in the submittal.

2. Accepted as Noted:

a. One copy of transmittal, with annotations, and one sample to THORNTON.
b. One copy of transmittal, with annotations, and one sample to ENGINEER.
c. One copy of transmittal, with annotations, and one sample to Resident Project Representative field office.
d. One copy of transmittal, with annotations, and one sample to CONTRACTOR.
e. CONTRACTOR may begin Work described in submittal in accordance with ENGINEER's notations, subject to CONTRACTOR's written verification and acceptance of ENGINEER's notations.

3. Not Accepted:

a. One copy of transmittal and one sample retained by ENGINEER.
b. Remaining samples returned to CONTRACTOR appropriately annotated.
c. CONTRACTOR shall make corrections or develop a replacement submittal and resubmit.

4. Incomplete:

a. One copy of transmittal, with annotations, and one sample retained by ENGINEER.
b. Remaining samples returned to CONTRACTOR appropriately annotated.
c. CONTRACTOR shall complete and resubmit or submit missing portions of the submittal.

1.5 ADMINISTRATIVE SUBMITTALS

A. Copies: Submit five copies or one electronic copy in .pdf format of administrative submittals.

B. Administrative submittals are those submittals that do not reflect quality of product or method of construction. Administrative submittals include, but are not limited to, the following items:

1. Application For Payment: In accordance with the applicable provisions of the SPECIAL CONDITONS and section 01 29 00: PAYMENT PROCEDURES. Submit two signed copies.
2. Construction Photographs: In accordance with the applicable provisions of Section 01 32 00: CONSTRUCTION PROGRESS DOCUMENTATION.
3. Video Recordings: In accordance with the applicable provisions of Section 01 32 00: CONSTRUCTION PROGRESS DOCUMENTATION.
4. Schedules: In accordance with the provisions of Section 01 32 00: CONSTRUCTION PROGRESS DOCUMENTATION.
5. Submittals Required By Law, Regulations or Governing Agencies.
6. Operation and Maintenance Manuals: In accordance with the applicable provisions of Section 01 77 00: PROJECT CLOSEOUT.
7. Record Documents: In accordance with the applicable provisions of Section 01 77 00: PROJECT CLOSEOUT.

C. All administrative submittals shall contain the following information:

1. The date of submission and the dates of any previous submissions.
2. The project title and number.
3. The name of CONTRACTOR (and Subcontractor where applicable).
4. Identification of the items/submittal/product, with the Specification section number, page, and paragraph(s), and Drawing reference, if any.
5. Identification of deviations from Contract Documents.

6. Identification of revisions on resubmittals.

D. Prepare the administrative submittal as follows:

1. Present in a clear and thorough manner. Include sufficient detail to show compliance with the Contract Documents.
2. Include drawings that are to scale.
3. Prepare schedules in accordance with the applicable requirements of Section 01 32 00: CONSTRUCTION PROGRESS DOCUMENTATION.
4. Submit on 8-1/2- by 11-inch or 11- by 17-inch paper. If paper larger than 11- by 17-inch is required, use 22- by 34-inch paper.

E. Disposition: ENGINEER will review and mark up submittals and distribute marked-up copies as described below.

1. Accepted:

a. Acceptance shall indicate that the submittal generally conforms to the requirements of the Contract Documents as to form and substance.
b. One copy to THORNTON.
c. One copy to ENGINEER.
d. One copy to Resident Project Representative field office.
e. Remaining copies returned to CONTRACTOR.
f. CONTRACTOR may begin Work described in the submittal.

2. Not Accepted:

a. One copy retained by ENGINEER.
b. Remaining copies returned to CONTRACTOR, appropriately annotated.
c. CONTRACTOR shall make corrections or develop a replacement submittal and resubmit.

1.6 QUALITY CONTROL SUBMITTALS

A. Copies: Submit five copies or one electronic copy in .pdf format of quality control submittals.

B. Quality control submittals are those submittals that present results of inspections or tests or compliance with the Specifications. All quality control submittals shall contain:

1. The date of submission and the dates of any previous submissions.
2. The project title and number.
3. The name of CONTRACTOR (and Subcontractor where applicable).
4. Identification of the items/submittal/product, with the Specification section number, page, and paragraph(s), and Drawing reference, if any.
5. Applicable standards, such as ASTM, ANSI, or Federal Specification numbers.
6. Identification of deviations from Contract Documents.
7. Identification of revisions on resubmittals.

C. Prepare the quality control submittal as follows:

1. Certificates:

a. Manufacturer’s Certificates of Compliance or Manufacturer’s Certificate of Installation: Submit in accordance with the provisions of the individual Specification section.
b. Testing Certificates: Submit in accordance with the provisions of the individual Specification section.

2. Statement of Qualifications: Evidence of qualification, certification, or registration.
3. Inspection or Test Reports: Include the following information, as a minimum:

a. Test date, testing laboratory, name of inspector.
b. Date and time of test or sample, location of test or sample, temperature at time of the test, weather conditions at the time of the test.
c. Related Specification section, type of test or inspection performed, results of test or inspection, and Specification requirement.

D. Disposition: ENGINEER will review and mark up submittals and distribute marked-up copies as described below.

1. Accepted:

a. Acceptance shall indicate that the submittal generally conforms to the requirements of the Contract Documents as to form and substance.
b. One copy to THORNTON.
c. One copy to ENGINEER.
d. One copy to Resident Project Representative field office.
e. Remaining copies returned to CONTRACTOR.
f. CONTRACTOR may begin Work described in the submittal.

2. Not Accepted:

a. One copy retained by ENGINEER.
b. Remaining copies returned to CONTRACTOR, appropriately annotated.
c. CONTRACTOR shall make corrections or develop a replacement submittal and resubmit.

1.7 RECORD DRAWINGS

A. Submit record drawings at time of final acceptance and prior to final payment.

1.8 GUARANTEES, WARRANTIES, AND CERTIFICATES

A. Submit all guarantees, warranties, and certificates prior to final payment.

1.9 TEST REPORTS

A. Refer to Section 01 45 00: QUALITY CONTROL.

1.10 DELIVERY TICKETS

A. Submit to ENGINEER one legible copy of each delivery ticket as required by the Specifications.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

Project Name:_____

TRANSMITTAL OF CONTRACTOR'S SUBMITTAL
(ATTACH TO EACH SUBMITTAL)

DATE: _____

TO: _____
_____
_____
_____
_____

SUBMITTAL NO.: _____
☐ NEW SUBMITTAL ☐ RESUBMITTAL
PREVIOUS SUBMITTAL NO.: _____
SPECIFICATION SECTION NO.: _____
(COVER ONLY ONE SECTION WITH EACH TRANSMITTAL)

FROM: _____
CONTRACTOR

_____
SCHEDULE DATE OF SUBMITTAL:

_____
_____
_____

SUBMITTAL TYPE: ☐ ADMINISTRATIVE ☐ SHOP DRAWING ☐ QUALITY CONTROL ☐ SAMPLE

THE FOLLOWING ITEMS ARE HEREBY SUBMITTED:

NUMBER OF COPIES	DESCRIPTION OF ITEM SUBMITTED (TYPE, SIZE, MODEL NUMBER, ETC.)	SPEC. PARA. NO.	DRAWING OR BROCHURE NUMBER	CONTAINS VARIATION TO CONTRACT	
				NO	YES

CONTRACTOR HEREBY CERTIFIES THAT (I) CONTRACTOR HAS COMPLIED WITH THE REQUIREMENTS OF CONTRACT DOCUMENTS IN PREPARATION, REVIEW, AND SUBMISSION OF DESIGNATED SUBMITTAL AND (II) THE SUBMITTAL IS COMPLETE AND IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND REQUIREMENTS OF LAWS AND REGULATIONS AND GOVERNING AGENCIES.

BY: _____
CONTRACTOR (AUTHORIZED SIGNATURE)

DATE RECEIVED: _____

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SECTION 01 41 26
PERMIT REQUIREMENTS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Project Permits.

1.2 SUBMITTALS

A. Shop Drawings:

1. At least 15 days prior to the start of construction, provide copies of all necessary State and local permits required to complete the Work.

1.3 PROJECT PERMITS

A. Obtain all State and local permits required for the Work. These include, but are not limited to:

1. Stormwater Discharge Associated with Construction Activity.
2. Construction Dewatering.
3. Fugitive Particle Emission Control.
4. Right-of-way use, driveway, or special use permit from State or local transportation agencies.
5. City of Thornton Traffic Control Permit
6. City of Thornton Capital Improvement Project Construction Permit
7. City of Thornton Building Permit

B. Oil and fuel storage is not permitted on site.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

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SECTION 01 42 00
REFERENCES

PART 1 GENERAL

1.1 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Without limiting the generality of other requirements of the Specifications, all Work specified herein shall meet the requirements of applicable codes and the applicable requirements of the following documents.

B. References herein to “ASTM” shall mean the American Society for Testing and Materials.

C. References herein to “ACI” shall mean the American Concrete Institute.

D. References herein to “OSHA Regulations for Construction” shall mean **Title 29, Part 1926, Construction Safety and Health Regulations for Construction**, Code of Federal Regulations (CFR), including all changes and amendments thereto.

E. References herein to “OSHA Standards” shall mean **Title 29, Part 1910, Occupational Safety and Health Standards**, Code of Federal Regulations, including all changes and amendments thereto.

F. Applied Standard Specifications: References in the Contract Documents to “Standard Specifications” or SSPWC shall mean the **Standard Specifications for Public Works Construction,** 1994 Edition.

1.2 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. All Work included in the Contract Documents, regardless if shown or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other Laws and Regulations governing the storage and conveyance of hazardous materials, including petroleum products.

1.3 ABBREVIATIONS

A. Abbreviations used throughout the Specifications and the organization or document represented are:

AA	Aluminum Association
AAMA	Architectural Aluminum Manufacturer's Association
AASHTO	American Association of State Highway Transportation Officials
ACI	American Concrete Institute
ADM	Arrow Diagramming Method
AGA	American Gas Association
AGCA	Association of General Contractors of America
AIA	American Institute of Architects
AIEE	American Institute of Electrical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ALSC	American Lumber Standards Committee
AMCA	Air Moving and Conditioning Association, Inc.
AMA	American Materials Association
ANSI	American National Standards Institute
APA	American Plywood Association (formerly DFPA)
APHA	American Public Health Association

ARI	Air-Conditioning and Refrigeration Institute
ASA	American Standards Association (now USAS)
ASHRAE	American Society of Heating, Refrigeration, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWPA	American Wood Preserver's Association
AWWA	American Water Works Association
CFR	Code of Federal Regulations
CPM	Critical Path Method
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards of U.S. Department of Standards
CSI	Construction Specifications Institute
DFPA	Douglas Fir Plywood Association (now APA)
EPA	Environmental Protection Agency
FAR	Federal Acquisition Regulations
FGMA	Flat Glass Marketing Association
FML	Factory Mutual Laboratories
FS	Federal Specifications
GRI	Geosynthetic Research Institute
HVAC	Heating, Ventilating, and Air Conditioning
IBR	Institute of Boiler and Radiator Manufacturers
MBMA	Metal Building Manufacturer's Association
MLA	Metal Lath Association
MSHA	Mine Safety and Health Administration
NAAMM	National Association of Architectural Metal Manufacturers
NBC	National Building Code
NBFU	National Bureau of Fire Underwriters
NBS	National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFPS	National Forest Products Association
NPC	National Plumbing Code
NPDES	National Pollutant Discharge Elimination System
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NWMA	National Woodwork Manufacturing Association
OSHA	Occupational Safety and Health Administration, U.S. Department of Labor
PCA	Portland Cement Association
PDM	Precedence Diagramming Method
PEI	Porcelain Enamel Institute
SBI	Steel Boiler Institute
SCPI	Structural Clay Products Institute
SDI	Steel Deck Institute
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPCC	Spill Prevention Control and Countermeasure
SPI	Steel Products Institute
SPR	Simplified Practice Recommendation
SSPC	Steel Structures Painting Council
TCA	Tile Council of America
UBC	Uniform Building Code
UL	Underwriters Laboratories

UPC	Uniform Plumbing Code
USAS	United States of America Standards (formerly ASA)
USBR	U.S. Bureau of Reclamation
USCOE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
WPCF	Water Pollution Control Federation
WWPA	Western Wood Products Association

B. Additional abbreviations, if any, will be defined as they appear in the Specifications.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

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SECTION 01 45 00
QUALITY CONTROL

PART 1 GENERAL

1.1 CONTRACTOR QUALITY CONTROL

A. CONTRACTOR's Testing Responsibilities:

1. Material property tests for all earthwork items from off-site sources. Testing requirements are listed in individual Specification sections.
2. Mix designs for concrete and asphalt.
3. Tests on items manufactured or fabricated off-site, including but not limited to, geosynthetics.
4. Field quality control tests to control CONTRACTOR fill placement operations.
5. Field quality control tests for concrete.
6. Field quality control tests for geosynthetics, including but not limited to liner seams.

B. Earthwork quality control testing schedule shall be as outlined in the individual Specification sections.

C. Provide mix designs for concrete meeting the requirements of the following section:

1. Section 03 30 50: BASIC CONCRETE MATERIALS

D. Provide mix design for asphalt meeting the requirements of the following section:

1. Section 33 12 16: ASPHALT PAVING

E. Perform all other testing and certifications as outlined in these Specifications.

1.2 ENGINEER QUALITY CONTROL

A. ENGINEER's Testing Responsibilities (ENGINEER will perform these tests on behalf of THORNTON):

1. Additional tests of earthwork materials from off-site sources to check CONTRACTOR's data, as determined appropriate by ENGINEER.
2. Tests and observe excavations and bearing surfaces for new work.
3. Field testing and visual observation of in-place earthwork materials.
4. Laboratory testing of earthwork materials.
5. Quality control observations and tests, and prepare and obtain test specimens, including cylinders, for all cast-in-place concrete materials and grout for embedded materials, during placement.

B. Unless otherwise indicated, results of all completed tests by ENGINEER will be available to CONTRACTOR at ENGINEER's site office by the end of the next working day following completion of the tests.

C. ENGINEER may perform additional field or laboratory tests on earthwork materials obtained from off-site sources; on liner seams; and on concrete aggregate gradation and quality, cement, admixtures, water and any other constituent or test as deemed necessary by ENGINEER to check CONTRACTOR's test results and verify continued compliance with Specification requirements. If additional testing by THORNTON is required, CONTRACTOR shall provide representative samples to ENGINEER from off-site

stockpiles or storage bin(s) for testing at no additional cost to THORNTON or ENGINEER. ENGINEER reserves the right to sample materials at the source of production.

D. ENGINEER will perform testing on the in-place earthwork materials, concrete, and asphalt as described in the Specification sections.

E. CONTRACTOR shall provide ENGINEER a Concrete Placement Form with the upper checkout items completed prior to every concrete placement. ENGINEER will then complete the Concrete Placement Form(s), as appropriate for each element of conventional concrete work. A blank placement form is included in this Section for CONTRACTOR's use.

F. Final acceptance of the Work will be based on a review of the quality control tests, as well as on visual observation made by ENGINEER of CONTRACTOR's work, including any work effort required to complete the project in compliance with these Contract Documents and the quality level required by ENGINEER's design.

1.3 TESTING STANDARDS

A. Earthwork quality control testing:

1. Compaction - American Society for Testing and Materials International (ASTM) D 698 or ASTM D 1557
2. Moisture Content, Oven Method - ASTM D 2216
3. Specific Gravity - ASTM D 854
4. Field Density, Sand Cone Method (plus one-point compaction and moisture content) - ASTM D 1556
5. Field Density, Drive Cylinder Method (plus one-point compaction and moisture content) - ASTM D 2937
6. Field Density and Moisture Content, Nuclear Gage Method (plus one-point compaction and moisture content) - ASTM D 6938
7. Maximum Index Density - ASTM D 4253
8. Minimum Index Density - ASTM D 4254
9. Particle Size Analysis - ASTM D 422
10. Liquid Limit, Plastic Limit, and Plasticity Index - ASTM D 4318
11. Resistance to Degradation - ASTM C 131
12. Sodium Sulfate Soundness - ASTM C 88

B. The percent compaction requirements for earthwork will be evaluated as follows: The in-place density as compacted by CONTRACTOR will be determined by the field density test using the sand-cone method or the nuclear gage method. The maximum dry density of the fill at the location of the in-place density test will be estimated using one-point compaction tests and full-curve compaction tests (family of curves) of representative fill materials. Both the one-point compaction tests and the full-curve compaction tests will be performed according to ASTM D 698 or ASTM D 1557, as appropriate. The one-point compaction data will be used in conjunction with the representative compaction curves to estimate the maximum dry density of the compacted fill at the location of the in-place density test. The percent compaction in-place will be calculated as the ratio (in percent) of the in-place dry density of the compacted fill at the location of the in-place density test to the estimated maximum dry density of the material.

C. Geosynthetic quality control testing:

1. Weld Tests - ASTM D 4437, ASTM D 5641, and ASTM D 5820, ASTM D 6214, and ASTM D 7749.
2. Material properties as described in Section 31 05 19: GEOSYNTHETICS.

D. Concrete quality control testing:

1. Sampling Fresh Concrete - ASTM C 172
2. Unit Weight - ASTM C 138
3. Air Content - ASTM C 231
4. Slump - ASTM C 143
5. Temperature - Thermometer
6. Concrete Test Cylinders - ASTM C 31
7. Capping Concrete Cylinders - ASTM C 617
8. Compressive Strength - ASTM C 39
9. Split Tensile Strength - ASTM C 496
10. Concrete Cores - ASTM C 42
11. Laboratory Qualifications - ASTM C 1077

E. Asphalt quality control testing:

1. Field Density, Nuclear Gage Method - ASTM D 2950

F. Other test requirements as described in individual Specification sections.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

CONCRETE PLACEMENT FORM

PROJECT _____

FEATURE _____

STATION _____

OFFSET _____

ELEVATION _____

CONTRACTOR _____ DATE OF PLACEMENT _____

CHECKOUT ITEM	CONTRACTOR REP	ENGINEER REP	DATE	TIME
SUB-GRADE OVER EXCAVATION COMPACTION				
BEDDING DEPTH COMP.				
FINAL CROSS SECTION				
REINFORCING STEEL				
EMBEDDED PIPING				
EMBEDDED MISC. MECHANICAL				
EMBEDDED MISC. METAL				
EMBEDDED ELECTRICAL				
DRAIN PIPING				
LINE AND GRADE				
FORMING				
BLOCKOUTS				
WATERSTOP				
PLACEMENT EQUIPMENT				
PROTECTION FOR CONCRETE				
OTHER ITEM				
FINAL CLEANUP				
OK TO PLACE CONCRETE				

ALL OF THE ABOVE MUST BE INSPECTED AND APPROVED BEFORE ORDERING CONCRETE.

TRUCK #								
START								
COMPLETE								
TRUCK #								
START								
COMPLETE								
TRUCK #								
START								
COMPLETE								

FINISHING COMPLETE TIME: _____

REMARKS _____

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 GENERAL

A. Construction facilities and temporary controls include those items necessary for performance of the Work that are not part of the permanent construction.

1.2 SUBMITTALS

A. Shop Drawings:

1. Plan for site access. The plan shall include permits and approvals for public roads.
2. Plan for on-site security.
3. Plan for staging and stockpile areas.
4. Plan for sedimentation and erosion control.
5. Plan for temporary utilities.
6. Plan for temporary construction facilities.

   a. Temporary access roads including routes, cross sections, and drainage provisions.
   b. Site Disturbance Limits; including CONTRACTOR field office layouts, parking areas, and storage yard layout.
   c. Temporary fences and barriers.

7. Staging plan to complete work and maintain the operation of the buildings. For each stage include limits of work, plan for construction access, plan for owner access to parking areas and building entrances, signage, limits of fencing, and closed building egress.

B. Administrative:

1. Copies of permits obtained by CONTRACTOR.
2. CONTRACTOR Health and Safety Plan.

1.3 DEFINITIONS

A. Low-Impact Construction work - Construction activities utilizing equipment and methods that produce noise, vibrations, and other minor disruptions that are considered tolerable for the Justice Center Project during normal business hours.

1. Examples of Low Impact Construction Work include, but are not limited to:

   a. Liner installation and seaming.
   b. Laying pipe.
   c. Hauling materials on and off-site with highway-rated dump trucks.
   d. Operation of skid-steers.
   e. Operation of rubber-tracked and rubber-tired backhoes and excavators that are equal to or smaller in weight than a CAT 420 backhoe.
   f. Operation of rubber-tired loaders that are equal to or smaller in weight than a CAT 966 loader.
   g. Fine grading of membrane subgrade and concrete subgrade.
   h. Placing, forming, and finishing concrete.

i. Operation of walk-behind vibratory plate compactors.
j. Operation of vacuum trucks.
k. Operation of remote-controlled vibratory sheepsfoot compactors equal to or smaller in weight than a WACKER RTSC2 trench compactor.

B. High-Impact Construction Work - Construction activities utilizing equipment and methods that produce noise, vibrations, and other major disruptions that are considered unacceptable for the Justice Center Project during normal business hours.

1. Examples of High Impact Construction Work include, but are not limited to:

a. Jack-hammering concrete and asphalt.
b. Saw cutting and demolition of asphalt, concrete, and brick within 35 feet of windows and doors or within 30 feet of the building.
c. Drilling and installation of trench shoring.
d. Operation of tracked excavator equipment equal to or larger in weight than a CAT 330 excavator.
e. Concrete drilling into building grade beams, including installation of batten bar anchors.
f. Compaction of pavement and fill materials with smooth drummed vibratory rollers within 50 feet of buildings.
g. Temporary disruptions in service to sanitary sewer pipes.

C. Shift - A period of construction work lasting between 8 and 12 consecutive hours not including lunch or dinner breaks.

1.4 MOBILIZATION AND PREPARATORY WORK

A. For the purposes of providing for expenses incidental to the initiation of construction, an item has been included in the proposal schedule to provide for payment for mobilization and preparatory work. The item for payment for mobilization and preparatory work is intended to compensate CONTRACTOR for operations including, but not limited to, the following items:

1. Obtaining project permits.
2. Moving equipment, supplies, and incidentals to the site.
3. Establishing field offices, buildings, and other facilities at the site.
4. Installing temporary utilities at the site.
5. Having CONTRACTOR's superintendent at the site full time.

B. All facilities, and equipment that are established at, or brought to, the work site shall be deemed to be subject to the provisions of this paragraph unless THORNTON specifically provides otherwise in writing for a particular item or items. CONTRACTOR shall be solely responsible for the adequacy, efficiency, use, protection, maintenance, repair, and preservation of all facilities and equipment. No facilities or equipment shall be dismantled or removed from the work site prior to completion of the Work under the contract without the written permission of THORNTON.

PART 2 PRODUCTS

2.1 THORNTON AND ENGINEER FIELD OFFICE

A. THORNTON will provide temporary construction office space for THORNTON and ENGINEER.

PART 3 EXECUTION

3.1 TEMPORARY UTILITIES

A. Power

1. Power will be available at the site.
2. Coordinate and pay for arranging electrical services with the local utility company. Service shall include hook-up from existing electrical service to CONTRACTOR field offices.
3. Pay monthly charges for electrical usage.

B. Water

1. Non-potable water for use in construction activities will be made available by THORNTON.
2. Provide and maintain adequate supplies of drinking water for CONTRACTOR personnel.

C. Sanitary Facilities

1. Provide and maintain suitable, weather-tight, painted, sanitary toilet facilities for all work persons during the construction period. When toilet facilities are no longer required, promptly remove from site. Disinfect and clean or treat the area as required.
2. Keep all toilet facilities clean and supplied with toilet paper at all times.

D. Lighting

1. Provide temporary lighting to meet applicable safety requirements to allow erection, application, or installation of materials, and observation and inspection of the Work.

3.2 CONSTRUCTION ACCESS ROAD

A. Construction access into the site shall be from Civic Center Drive.

B. Maintain drainage ways. Install culverts to allow water to pass without disturbing the roadway.

3.3 PROTECTION OF EXISTING ROADS

A. Obtain all permits required by THORNTON, Colorado Department of Transportation (CDOT), and Adams County during construction. Repair damage to public roads for 100 feet in each direction from the intersection with the project access road. Repairs shall be performed in accordance with the requirements of the Adams County Development Standards and Regulations.

B. Prior to using public and project access roads, perform a condition survey of these roads, including the existing culverts and head walls under these roads. The condition survey shall be performed by competent personnel that are qualified and experienced in this work. Sufficient notes, measurements, photographs, videotapes, or other documentation of the existing condition of the roads shall be performed. Survey of public roads shall extend 300 feet in each direction from the intersection with the project access road.

3.4 CONTRACTOR PARKING AREAS

A. Parking for the employees of CONTRACTOR and for THORNTON personnel will be allowed in the staging and stockpile areas.

B. Additional parking for passenger vehicles belonging to employees of CONTRACTOR will be acceptable within the northern most row of parting north of the Risk Management building. Parking in this area and other areas that are outside of the limits of the staging and stockpile areas is subject to THORNTON approval.

3.5 SITE DISTURBANCE LIMITS

A. Establish CONTRACTOR offices within site disturbance limits shown on the Drawings.

B. Stockpile equipment, supplies, imported earthfill materials, and other materials incidental to the construction within site disturbance limits shown on the Drawings or other areas approved by THORNTON.

C. Camping will not be allowed at the construction site.

3.6 STOCKPILE AREAS

A. All earthfill, and other construction materials shall be stockpiled by CONTRACTOR within site disturbance limits, or other areas approved by THORNTON.

B. Stockpiling of materials outside of the limits of site disturbance shall require the approval of THORNTON.

3.7 WEATHER PROTECTION

A. Provide protection against weather to maintain all materials, apparatus, fixtures, and work free from damage whether in shipment, in storage, or in place.

B. Do not perform wet work when temperature is below 35ºF or is forecast to be below 35ºF within the ensuing 24 hours, except when work is properly protected and sufficient heat is provided.

C. When heat is required for proper weather protection, provide temporary enclosures of work and acceptable means to provide sufficient heat to maintain a temperature of not less than 50ºF. Provide higher temperatures when required by these Specifications.

3.8 EXISTING FENCES

A. Do not remove existing fences outside work area without authorization from THORNTON. Where approved, and CONTRACTOR removes existing fences to facilitate the Work, temporary fence protection for lands adjacent to the right-of-way shall be provided at all times during the continuation of the Contract. CONTRACTOR shall rebuild fence in as good condition as found as part of the cleanup operations prior to final acceptance of the completed Work.

3.9 CONTINUATION OF SERVICE

A. Utility service shall be maintained to all areas at all times during construction of the Work, except when it is necessary to shut down a line to make a connection with a new line. A minimum of 48 hours written and verbal notice shall be given by the CONTRACTOR when it is known that service will be interrupted.

3.10 SITE SECURITY

A. Provide adequate security for protection of THORNTON's and CONTRACTOR's property, equipment, and facilities.

B. All existing and temporary gates and fences shall be secured and locked during non-working hours. Provide padlocks at all construction area gates. All gates shall be double padlocked to allow THORNTON and ENGINEER access to the site without disturbing CONTRACTOR's locks.

C. All construction areas shall be enclosed with temporary chain link fence with screening and access gates shall be locked outside of working hours.

3.11 OPERATIONS AND STORAGE AREAS

A. Do not enter on or occupy with men, tools, equipment, or material any ground outside THORNTON's property without the written consent of the owner of such ground.

B. Other contractors and employees or agents of THORNTON may for all necessary purposes enter upon the Work and premises used by CONTRACTOR. Conduct work so as not to impede unnecessarily any work being done by others on or adjacent to the site.

3.12 SAFETY

A. Safety and Health

1. CONTRACTOR shall have sole responsibility for construction site safety in accordance with the provisions of the General Conditions.
2. Maintain an accurate record of, and report to THORNTON, all cases of death, occupational diseases, or traumatic injury to employees or the public, and property damage.

3.13 CLEANUP AND DISPOSAL OF WASTE MATERIALS

A. SCOPE

1. The cleanup and disposal of waste materials and rubbish shall be in accordance with THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements, these Specifications, and applicable Laws and Regulations. Should a conflict exist in the requirements for cleanup and disposal of waste materials, the most stringent requirement shall apply.

B. CLEANUP

1. Keep work and storage areas free from accumulations of waste materials and rubbish, and before completing the Work, remove all plant and storage facilities, buildings, including concrete footings and slabs, rubbish, unused materials, concrete forms, and other materials that are not a part of the permanent Work.
2. Upon completion of the Work, and following removal of construction facilities and required cleanup, work areas shall be regraded, reclaimed, and left in a neat manner conforming to the natural appearance of the landscape.

C. DISPOSAL OF WASTE MATERIALS

1. Waste materials, including but not restricted to, waste excavated material, cleared and grubbed vegetation, refuse, garbage, sanitary wastes, chemical additives, industrial wastes, oil, and other petroleum products, shall be disposed of by CONTRACTOR by removal from the construction area. Dispose of material in an

appropriate off-site waste disposal facility. The off-site waste disposal facility shall be approved by THORNTON.

2. Burning of cleared vegetation and waste materials shall not be permitted.

3.14 WORK HOURS

A. Low impact construction work in all stages and high impact construction in stages 1a and 1b can be completed at any time during the construction duration.

B. High impact construction work in stages 1c and 2 must be completed between the hours of 6 p.m. through 7 a.m. Monday through Friday or Saturday and Sunday.

3.15 GLASS PROTECTION

A. Before work along the atrium within Memorial Plaza and any other floor level glass doors and windows, the CONTRACTOR shall install adequate window protection to protect windows along this work area.

3.16 STATUE PROTECTION

A. All statues and memorials to be removed, stored, and relocated within Memorial Plaza shall be protected by the CONTRACTOR at all times during construction.

3.17 INCIDENTAL DAMAGE

A. Any incidental damage to existing facilities not identified for demolition shall be repaired by CONTRACTOR. Repairs must be approved by THORNTON.

END OF SECTION

SECTION 01 55 26
TRAFFIC CONTROL

PART 1 GENERAL

1.1 WORK INCLUDES

A. Developing an individual Traffic Control Plan (TCP), including parking and pedestrian movement for each of the stages included in the Contract to be approved by THORNTON prior to starting construction.

B. Furnish, install, maintain, and remove all temporary traffic control signs and devices for vehicular and pedestrian traffic.

1.2 SUBMITTALS

A. Shop Drawings:

1. Traffic Control Plan: Coordinate with Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS. The TCP shall include:

a. Plan, section, and detail drawings for all temporary modifications.
b. Methods of sequencing of installation and removal of modifications.
c. Schedule of work items and related access/parking disruptions. Include duration of disruption, temporary relocation and re-routing vehicle and pedestrian traffic, temporary closure and modifications to entrances and emergency exits, and provisions to maintain handicap access.
d. Special work hours for loud and disruptive activities including jackhammering, drilling, and sewer repairs.
e. Anticipated difficulties and proposed resolutions.

1.3 SEQUENCE OF OPERATIONS

A. CONTRACTOR will not be permitted to have construction equipment, personal vehicles, or materials in the lanes open to traffic. CONTRACTOR is cautioned that all personal vehicle and construction equipment parking will be prohibited where it conflicts with safety, access, or flow of traffic at any time.

B. Traffic lanes through construction areas shall be maintained as shown on the approved traffic control plans or with a clear width of at least 11 feet per lane. When directed by THORNTON, provide and maintain an acceptable temporary asphalt surface for temporary roads or driveways.

C. During non-construction periods, all work shall be adequately protected to ensure the safety of vehicular and pedestrian traffic. Open trenches during non-construction periods are not permitted and fall protection shall be provided during non-construction periods by protective covers. CONTRACTOR must periodically check on the conditions of traffic control devices that may be utilized during the course of the Project on weekends or holidays as may be warranted to ensure that devices that are damaged or moved during non-work hours are restored.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 INSTALLATION

A. Submit a TCP showing the temporary traffic control signs, devices, and barricades. The plan shall illustrate the traffic control devices for each stage of construction.

B. Parking Control:

1. Access gates shall remain open only during periods of construction activity. Gates shall be closed during off hours.
2. Place signage at the gates to restrict public access.
3. Provide for parking in restricted area as shown on the drawings.

C. Construction Parking Control:

1. Control vehicular parking for construction personnel to preclude interference with access by emergency vehicles, or THORNTON's operations.

END OF SECTION

SECTION 01 56 00
TEMPORARY BARRICADES

PART 1 GENERAL

1.1 WORK INCLUDES

A. Barricades to protect the existing building and other facilities from construction activities.

1.2 SUBMITTALS

A. Shop Drawings:

1. Barricade Plan: Coordinate with Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS and Section 01 55 26: TRAFFIC CONTROL. The Barricade Plan shall include:

a. Plan, section, and detail drawings and technical specifications for all barricades.
b. Sequencing of installation and removal.
c. Schedule of work items and related access/parking disruptions. Include duration of disruption, temporary relocation, and handicap access and emergency egress provisions.
d. Anticipated difficulties and proposed resolutions.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 TEMPORARY BARRICADES

A. Pedestrian walkways shall be barricaded to direct access away from the construction areas. Provide directional barricades to route traffic to building entrances.

END OF SECTION

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SECTION 01 57 19
TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Abatement of Air Pollution.

B. Abatement of Noise Pollution.

C. Abatement of Water Pollution.

D. Landscape Preservation.

E. Preservation of Trees and Shrubs.

F. Preservation of Historical and Archaeological Data.

G. Protection of Endangered Species.

1.2 SUBMITTALS

A. Shop Drawings:

1. At least 5 days prior to the discharge or handling of any wastewaters, submit a detailed Water Quality Management Plan containing the following information:

   a. Copy of any approved permits.
   b. Name of the person who will be responsible for implementing and carrying out the plan.
   c. Precautions that will be taken to avoid discharge or accidental spills of oil or wastewater into river, stream, watercourse, or lake.
   d. Methods of handling and treating wastewater, including locations for evaporation or settling ponds, treatment facilities, and discharge points. Estimates of the amount of wastewater that may be handled and treated at each location.
   e. Methods for preventing or controlling runoff and erosion for all construction sites.
   f. The Water Quality Management Plan shall relate the methods and descriptions above to the conditions of required permits.

1.3 ABATEMENT OF AIR POLLUTION

A. Abatement of air pollution shall be performed in accordance with the requirements of the Air Pollution Emission Permit and applicable Laws and Regulations concerning the prevention and control of air pollution. Use such methods and devices as are reasonably available to prevent, control, and otherwise minimize atmospheric emissions or discharges of air contaminants.

B. Burning of cleared materials, combustible construction materials, and rubbish will not be allowed.

C. Apply a dust-preventive treatment or periodically water dust producing activities to prevent dust.

1.4 ABATEMENT OF NOISE POLLUTION

A. Abatement of noise pollution shall be performed in accordance with applicable Laws and Regulations regarding the prevention, control, and abatement of harmful noise levels.

1.5 ABATEMENT OF WATER POLLUTION

A. Abatement of water pollution shall be performed in accordance with the requirements of the Stormwater Discharge Permit and Section 31 25 00: EROSION AND SEDIMENTATION CONTROLS.

B. Excavated materials or other construction materials shall not be stockpiled near drainages or other watercourse perimeters where they can be washed away by storm runoff, or can in any way encroach upon the watercourse itself.

C. Include prevention measures to control silting and erosion, and to intercept and settle any runoff of sediment-laden waters. Refer to Section 31 25 00: EROSION AND SEDIMENTATION CONTROLS. Wastewater from general construction activities, such as drain water collection or other construction operations, shall not enter flowing or dry watercourses without the use of approved turbidity control methods. All such wastewaters discharged shall contain the least concentration of settleable material possible.

1.6 LANDSCAPE PRESERVATION

A. Preserve the natural landscape, and conduct operations so as to prevent unnecessary destruction, scarring, or defacing of the natural surroundings in the vicinity of the Work. Movement of crews and equipment within the rights-of-way and over routes provided for access to the Work shall be performed in a manner to prevent damage to grazing land, crops, or property.

1.7 PRESERVATION OF TREES AND SHRUBS

A. Preserve and protect existing vegetation not required or otherwise authorized to be removed. Vegetation shall be protected from damage or injury caused by CONTRACTOR construction operations, personnel, or equipment by the use of protective barriers or other methods. Removal of existing vegetation not specifically required to be removed will require prior approval by ENGINEER.

1.8 PROTECTION OF ENDANGERED SPECIES

A. There are no known endangered species at the Site.

B. Where appropriate by reason of a discovery, ENGINEER may order delays in time of performance or changes in the Work, or both. If such delays, changes, or both, are ordered, the time of performance and Contract Price will be adjusted in accordance with the applicable clauses in the Contract.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 71 23
LAYOUT OF WORK AND QUANTITY SURVEYS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Perform all layout surveys required for the control and completion of the Work, and all necessary surveys to compute quantities of work performed.

B. THORNTON has established primary control to be used by CONTRACTOR for establishing lines and grades required for the Work. Primary control consists of control points in the vicinity of the Work as described and indicated on the Drawings.

C. Preserve and maintain primary control points. Primary control points damaged or destroyed by CONTRACTOR may be reestablished by THORNTON, and the expense of reestablishment will be deducted from amounts due, or to become due, to CONTRACTOR.

1.2 SUBMITTALS

A. Administrative:

1. Survey Control Plan - a complete plan for the surveying required to lay out the Work, including methods and time tables for establishing lines and grades.
2. Surveyor Qualifications - resumes of qualifying experience for the Professional Land Surveyor who will be responsible for the supervision and direction of all of Contractor’s survey work.
3. Quantity Surveys - accompanying progress payment requests, submit a copy of applicable quantity survey notes and computations and an itemized statement for work performed or placed during the progress period measured on the basis of surveying.
4. Daily Notes - if requested by ENGINEER, submit a copy of the workday's survey notes at the conclusion of that workday.

1.3 QUALIFICATIONS

A. Provide experienced construction surveyors. Survey work shall be under the supervision and direction of a Professional Land Surveyor who is registered in the State of Colorado and has a minimum of 2 years responsible charge of construction surveys for construction similar in nature to that required by this contract. Maintain sufficient qualified personnel to perform required surveying work. All survey work performed by CONTRACTOR shall be subject to field and office review by ENGINEER

1.4 LAYOUT OF WORK

A. Use THORNTON-established primary control points to establish all lines and grades necessary to control the Work.

B. Establish, place, and replace as required, such additional monuments, control points, survey stakes, markers, and other controls as may be necessary for control, intermediate checks, and guidance of construction operations.

1.5 QUANTITY SURVEYS

A. Perform all original ground surveys as required to depict existing conditions prior to construction and to determine quantities of work for payment. Survey original ground surface to 0.5-foot contours. Perform such surveys and computations as are necessary to determine quantities of work performed or placed during each progress payment period, and perform all surveys necessary for ENGINEER to determine final quantities of work in place.

B. Notify ENGINEER at least 24 hours before performing a survey and, unless specifically waived, surveys shall be performed in the presence of an authorized representative of ENGINEER.

1.6 CONTRACTOR SURVEYS

A. Surveys required:

1. Alignment staking - Each 50 feet on tangent; each 10 feet on curves.
2. Slope staking - Each 10 feet on tangent; each 10 feet on curves; restake every 2 feet in elevation.
3. Structure - Stake out structures; checks prior to and during construction.
4. Cross section - Each 50 feet on tangent, each 10 feet on curves. Original, final, and intermediate as required, for structure sites and other locations as necessary for quantity surveys.
5. "Record" – Include all disturbed areas of the Work as required to show final topography, structures, and other features of the Work after construction.

1.7 RECORDS

A. Survey data shall be recorded in accordance with recognized professional surveying standards. Original field notes, computations, and other surveying data shall be recorded in standard survey field books. Notes or data not in accordance with standard formats will be rejected. Illegible notes or data, or erasures on any page of a field book will be considered sufficient cause for rejection of part or all of the field book. Therefore, rejection of part or all of a field book may necessitate resurveying. Corrections by ruling or lining out errors will be satisfactory.

1.8 DEGREE OF ACCURACY

A. Degree of accuracy shall be of an order high enough to satisfy tolerances specified for the Work and the following:

1. Alignment of tangents and curves shall be within 0.1 foot.
2. Structure points shall be set within 0.01 foot, horizontally and vertically, except where installation or operation considerations require tighter tolerances.
3. Cross section points shall be located within 0.1 foot, horizontally and vertically.
4. Vertical elevation for earth work shall be recorded and determined to the nearest 0.1 foot.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

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SECTION 01 74 00
CLEANING AND WASTE MANAGEMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Final Cleaning

B. Final Inspection

1.2 FINAL CLEANING

A. Requirements: CONTRACTOR is responsible for cleaning its own product and removing its own debris. Periodic cleaning will be required throughout the construction progress. At the completion of work and immediately prior to final inspection, clean the entire project as follows:

1. Thoroughly clean, sweep, wash, and polish all work and equipment provided under the Contract, including finishes. Leave the structures and site in a complete and finished condition to the satisfaction of THORNTON.
2. Direct all subcontractors to similarly perform, at the same time, an equivalent thorough cleaning of all work and equipment provided under their contracts.
3. Remove all temporary structures and all debris, including dirt, sand, gravel, rubbish and waste material.
4. Should CONTRACTOR not remove rubbish or debris or not clean the buildings and site as specified above, THORNTON reserves the right to have the cleaning done at the expense of CONTRACTOR.

B. Employ experienced workers, or professional cleaners, for final cleaning.

C. Use only cleaning materials recommended by manufacturer of surface to be cleaned.

D. In preparation for substantial completion or occupancy, conduct final inspection of sight-exposed interior and exterior surfaces, and of concealed spaces.

E. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials from sight-exposed interior and exterior finished surfaces. Polish surfaces so designated to shine finish.

F. Repair, patch, and touch up marred surfaces to specified finish, to match adjacent surfaces.

G. Remove snow and ice from access to structures during the construction progress.

H. Vacuum clean all interior spaces, including inside cabinets.

I. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw materials from heights.

J. Schedule cleaning operations so that dust and other contaminants resulting from cleaning process will not fall on wet, newly-painted surfaces.

K. Clean interior of all panel cabinets, pull boxes, and other equipment enclosures.

L. Wash and wipe clean all lighting fixtures, lamps, and other electrical equipment which may have become soiled during installation.

M. Perform touch-up painting.

N. Broom clean exterior paved surfaces; rake clean other surfaces of the grounds.

O. Remove erection plant, tools, temporary structures and other materials.

P. Remove and dispose of all water, dirt, rubbish or any other foreign substances.

1.3 FINAL INSPECTION

A. After cleaning is complete the final inspection may be scheduled. The inspection will be done with THORNTON and ENGINEER.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 01 77 00
PROJECT CLOSEOUT

PART 1 GENERAL

1.1 FINAL INSPECTION

A. Request a final inspection in writing at least ten (10) calendar days prior to the anticipated date of completion.

B. Perform final inspection with CONTRACTOR, THORNTON, and ENGINEER.

C. Work will not be considered ready for final inspection until all Work has been completed, and CONTRACTOR has certified that all items are properly operating and in compliance with all Contract terms and conditions. CONTRACTOR or his project supervisor shall be at the Site during the final inspection.

1.2 FINAL CONDITIONS SURVEY

A. Perform survey of completed construction for pavement, landscaping, and appurtenant structures. Survey to 0.5-foot contours. Plot final survey at 1 inch = 20 feet.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

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SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.1 WORK INCLUDES

A. Field verify dimensions of components to be demolished and all other site conditions that could impact demolition activities.

B. Partial demolition of the following existing site facilities:

1. Upper Parking Area and Memorial Plaza:

a. Concrete pavement
b. Asphalt paving
c. Curb and gutter
d. Bollards
e. Sign posts and panels
f. Concrete light bases
g. Metal and associated concrete foundations
h. Water main piping and appurtenances
i. Drain inlets and irrigation lines.
j. Concrete Masonry Units (CMU) Wall and Foundation
k. Landscaping
l. Architectural features

2. Memorial Plaza Storm Sewer

a. Storm sewer pipe, drain inlets, and end sections.
b. Curb and gutter
c. Asphalt paving

C. Dispose off-site of all demolished items and materials that are not designated for re-use.

1.2 SUBMITTALS

A. Shop Drawings

1. Demolition Plan:

a. Schedule of work, as part of and consistent with the progress schedule specified in Section 01 32 00: CONSTRUCTION PROGRESS DOCUMENTATION.
b. Detailed sequence of operations.
c. Methods of demolition and equipment proposed to demolish each facility, including details and methods, temporary bracing, or other elements required to support or protect features to remain.
d. Methods of protection for existing facilities to remain in place during construction and for existing facilities to be removed, stored, and reinstalled as part of the Work including but not limited to granite memorial panels, statue, building glass, building brick, structural slabs, and other building components.
e. Contingency plans addressing equipment breakdown, delays, or unplanned work stoppages.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 EXISTING UTILITIES

A. Identify and protect existing utilities in accordance with THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements.

B. Any existing irrigation piping or appurtenances that are encountered and damaged during construction and are not identified to be removed in the Drawings shall be replaced in-kind after that phase is complete.

3.2 PREPARATION

A. Cover and protect existing facilities to remain from damage due to demolition of adjacent facilities. Protection includes but is not limited to:

1. Signs and light poles to be removed, stored, and reinstalled.
2. Existing architectural panels at entrances to Police building and Courts building.
3. Granite memorial panels in Memorial Plaza.
4. Statue in Memorial Plaza.
5. Building glass and brick.

B. Any damage to structural slab, items not identified for demolition, and existing facilities outside the limits of disturbance shall be repaired in accordance with THORNTON standards and specifications. Repair plan must be accepted by THORNTON.

C. Confirm survey point locations of demolition items in field prior to demolition.

D. Evaluate the integrity of elements to be left in place, design and install all temporary bracing as may be necessary to safely perform required demolition.

E. Where noted in item specification, survey and retain record of location of existing items including fence foundations, sign posts, light poles, benches, etc. to be replaced in the same location.

3.3 CONCRETE DEMOLITION

A. Blasting is not permitted.

B. Sawcut all concrete and asphalt to be demolished.

C. Pressure wash all surfaces of demolished concrete in areas where concrete is to be placed to remove all loose and disturbed materials.

D. Portions of concrete that are above structural slabs should be removed carefully with hand equipment. Acceptable methods of removal include sawing and chipping or milling. The removal depth should be field verified using small test sections for each area.

3.4 ABANDONMENT

A. Examine existing underground facilities to be abandoned after excavation.

B. Place grouted plug consistent with Type 4 grout specified in Section 03 62 00: NON-SHRINK GROUT.

3.5 SALVAGING

A. Items identified for demolition that are replaced by similar material during construction can be salvaged if salvaged material meets the specifications required for the replaced material and is approved for reuse by the ENGINEER.

B. Granite components of Memorial Plaza including benches, granite steps, etc. shall be salvaged and provided to THORNTON for reuse. Stockpile granite materials on site and relocate material to THORNTON facility located at 88th Avenue and Colorado Boulevard. Coordinate delivery of material with THORNTON. Benches shall be maintained as one unit with all accessories and hardware. Stockpile these components at a location defined by THORNTON at the 88th Avenue facility.

C. River rock removed from landscaped median in the upper parking area shall be salvaged and provided to THORNTON for reuse. Clean river rock of deleterious material and debris and stockpile on site. Relocate material to THORNTON facility located at 88th Avenue and Colorado Boulevard. Coordinate delivery with THORNTON. Stockpile these components at a location defined by THORNTON at the 88th Avenue facility.

D. All salvaged material must be stored on-site within the limits of disturbance unless otherwise approved by THORNTON.

3.6 DISPOSAL

A. Dispose of demolished items and materials in an approved off-site facility.

B. Conform to the requirements of all applicable environmental and health regulations in handling and disposal of any identified hazardous materials.

END OF SECTION

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SECTION 03 01 30
MAINTENANCE OF CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDES

A. Repairs to defective or damaged concrete.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI)

a. 301 - Specifications for Structural Concrete

B. Definitions

1. Defective Concrete - Surface defects that include honeycomb, rock pockets, indentations greater than 3/16-inch, cracks 0.010-inch wide and larger, spalls, chips, air bubbles greater than 3/4-inch in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, and form popouts.

1.3 SUBMITTALS

A. Shop Drawings:

1. Provide plan for repair of defective or damaged concrete. Include method of repair and materials used to perform repair.

PART 2 PRODUCTS

2.1 MATERIALS

A. Non-shrink grout shall conform to the requirements of Section 03 62 00: NON-SHRINK GROUT, Type 1.

B. Epoxy grout shall conform to the requirements of Section 03 62 00: NON-SHRINK GROUT, Type 2.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to ACI 301 and these Specifications. Where these Specifications differ from ACI 301, the more stringent shall apply.

B. Grinding of concrete surfaces shall be limited in depth such that no aggregate particles are exposed more than 1/6-inch in cross-section at the finished surface. Where grinding has caused or will cause exposure of aggregate particles greater than 1/6-inch in cross-section at the finished surface, concrete shall be repaired by saw cutting, excavating and replacing the concrete. Removal shall be to the limits of the existing joint.

C. Repairs to flatwork concrete shall only be by removal and replacement.

D. Repairs to non-flatwork concrete:

1. Repairs may be made with non-shrink grout within the first 7 days after concrete placement.
2. Use epoxy grout for repairs made within 7 days from concrete placement.

3.2 PATCHING HOLES

A. Notify ENGINEER immediately upon removal of forms.

B. Holes less than 12 inches in their least dimension: Fill with non-shrink grout or epoxy grout.

C. Holes greater than 12 inches in their least dimension: Chip keyway minimum ½-inch deep into edge of opening all around. Fill hole with concrete.

D. Holes greater than 24 inches in their least dimension with no reinforcing steel extending from concrete: Grout reinforcing steel in drilled holes; reinforcing steel shall match the reinforcing in the existing concrete. Fill hole with concrete.

END OF SECTION

SECTION 03 11 00
CONCRETE FORMING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Design, fabrication, erection, and removal of formwork and accessories for cast-in-place concrete.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 301 - Specifications for Structural Concrete
b. 318/318R - Building Code Requirements for Structural Concrete and Commentary
c. 347R - Guide to Formwork for Concrete

2. U. S. Product Standard PS 1: Construction and Industrial Plywood

1.3 DEFINITIONS

A. Design Strength: As defined in Section 03 30 50: BASIC CONCRETE MATERIALS.

1.4 SUBMITTALS

A. Shop Drawings:

1. Manufacture’s product data for form ties, spreaders, inserts, other formwork accessories, and form release agent.

1.5 DESIGN REQUIREMENTS

A. Conform to the requirements of ACI 301 and the recommendations of ACI 347 to provide concrete finishes and tolerances specified in Section 03 30 00: CAST-IN-PLACE CONCRETE.

B. Design forms for full hydrostatic pressure when high range water reducer is used in concrete mix.

C. Make joints in forms watertight.

PART 2 PRODUCTS

2.1 FORM MATERIALS

A. Plywood: Douglas Fir species; solid one-side grade; sound, undamaged sheets with straight edges.

B. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to withstand the pressure resulting from placement and vibration 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 gage sheet, well matched, tight fitting, undamaged, stiffened to withstand the pressure resulting from placement and vibration of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

E. Use flexible or uniformly curved forms for curves of a radius of 100 feet or less. Do not use notched and bent forms. Use forms that maintain a uniform and smooth curve and meet the criteria in Section 03 35 00: CONCRETE FINISHING Table 1.

F. Forms for textured finish concrete: Units of face design, size, arrangement, and configuration indicated. Provide solid backing and form supports to ensure stability of textured form liners.

2.2 FORMWORK ACCESSORIES

A. Form Ties:

1. Removable metal or fixed cone type; 3/4- or 1-inch break back dimension; free of defects that will leave holes larger than 1-inch diameter in concrete surface.
2. Include a swagged or integral metal washer or a neoprene washer in the center of the tie to break surface continuity and minimize water seepage. Minimum size of washer shall be 1/16-inch-thick by 15/16-inch outside diameter.
3. Wire form ties shall not be used.

B. Form Release Agent: Colorless material that will not stain concrete, absorb moisture, or impair natural bonding or color characteristics of concrete.

C. Fillets for Chamfered Corners and All Exposed Edges: Wood strips or rigid plastic; 3/4-inch by 3/4-inch, unless otherwise shown on the Drawings.

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

PART 3 EXECUTION

3.1 INSPECTION

A. Verify lines, levels, and measurements before proceeding with formwork.

3.2 PREPARATION

A. Hand-trim sides and bottoms of earth forms; remove loose dirt prior to placing concrete.

B. Minimize form joints. Symmetrically align joints and make them watertight to prevent leakage of mortar.

C. Tape, gasket, plug, or caulk joints, gaps, and apertures in forms so joints will be watertight and resist concrete pressure without bulging.

D. Arrange and assemble formwork to permit stripping so that concrete is not damaged during form removal.

E. Arrange forms to allow stripping without removal of principal shores, where required to remain in place.

3.3 ERECTION

A. Provide bracing to ensure stability of formwork. Strengthen formwork liable to be overstressed by construction loads.

B. Provide temporary ports in formwork to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain. Close ports with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

C. Provide chamfer strips on all external corners.

D. Construct formwork to maintain tolerances in accordance with Section 03 30 00: CAST-IN-PLACE CONCRETE**.**

3.4 CLEANING

A. Thoroughly clean form surfaces to remove foreign matter as erection proceeds, and before application of form release agent.

B. Ensure that water and debris drain to exterior through cleanout ports.

C. During cold weather, remove ice and snow from forms. Do not use de-icing salts. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure. Use compressed air to remove foreign matter.

3.5 APPLICATION OF FORM RELEASE AGENT

A. Apply form release agent in accordance with manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.

B. Do not apply form release agent where concrete surfaces are scheduled to receive special finishes that may be affected by the agent.

C. Where wood forms are used and form release agent is not used, soak contact surfaces with clean water to prevent absorption of water from the concrete. Keep surfaces wet prior to placing concrete.

D. Place concrete within 14 days after form release agent is applied to form. If concrete is not placed within 14 days, remove forms and reapply form release agent.

3.6 INSERTS, EMBEDDED PARTS, AND OPENINGS

A. Provide formed openings where required for work embedded in or passing through concrete.

B. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts or embedded items.

C. Install accessories in accordance with manufacturer's instructions, level and plumb. Brace and anchor accessories so they will not move during concrete placement.

3.7 FORM REMOVAL

A. Notify ENGINEER prior to removing formwork.

B. Do not remove forms until concrete has sufficient strength to support its own weight, and construction and design loads that may be imposed upon it. As a minimum, forms shall remain in place for 36 hours after completion of respective concrete placement.

C. Load supporting forms shall remain in place until concrete has attained at least 75 percent of the specified design strength as determined by test cylinders.

D. Do not damage concrete surfaces during form removal.

E. Finish all concrete surfaces prior to applying curing compound in accordance with the requirements of Section 03 30 00: CAST-IN-PLACE CONCRETE.

END OF SECTION

SECTION 03 15 16
CONCRETE CONSTRUCTION JOINTS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Construction, expansion, and contraction joints in concrete.

B. Tooling or chamfering edges of concrete.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. City of THORNTON

a. Standards and Specifications for the Design and Construction of Public and Private Improvements.

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

a. D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types.)
b. D 1752 - Standard Specification for Preformed Sponge Rubber, Cork, and Recycled polyvinyl chloride (PVC) Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 SUBMITTALS

A. Shop Drawings:

1. Joint Filler Materials: Manufacturer's product data and installation instructions.
2. Concrete Joints:

a. Layout and location for each type of joint.

B. Samples:

1. 12-inch-long sample of joint filler material.

PART 2 PRODUCTS

2.1 JOINT FILLER MATERIAL

A. Expansion Joints in Structural Concrete: Conforming to ASTM D 1752, Sections 5.1 through 5.4, with compression requirement modified to 10 pound per square inch (psi) (7.03 gram per square millimeter (g/mm^2)) minimum and 25 psi (127.58 g/mm^2) maximum.

1. CERAMAR Flexible Foam Expansion Joint, 3/4-inch thickness. W.R. Meadows, Inc. (800) 342-5976.
2. ENGINEER accepted comparable product.

B. Expansion joints in Sidewalks and Decorative Concrete: Conforming to ASTM D 1751.

2.2 EXPANSION BOARD

A. Conforming to ASTM D1751

1. Sika Polypropylene, 1/2-inch joint thickness. Sika Corporation, 700-325-9504.
2. ENGINEER accepted comparable product.

2.3 BONDING AGENT

A. ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.4 EPOXY-BONDING ADHESIVE:

A. ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types I and II, nonload bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.5 POLYETHYLENE FILM:

A. ASTM D 4397, 1 mil (0.025 mm) thick, clear.

2.6 PLAIN DOWELS

A. Conforming to Section 03 20 00: CONCRETE REINFORCING.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to the requirements of City of THORNTON Standards and Specifications and these Specifications. Where Specifications differ, the more stringent shall apply.

3.2 CONSTRUCTION JOINT (CJ)

A. Locate construction joints at the locations shown on the Drawings and as otherwise determined by CONTRACTOR and approved by ENGINEER to facilitate construction of the Work. Relocation, addition, or elimination of any construction joint shall be subject to written approval of ENGINEER.

B. Bond is required at construction joints regardless of whether or not reinforcing steel is continuous across the joint.

C. Continue reinforcing steel across construction joints, unless otherwise shown on the Drawings.

D. Surface preparation:

1. Remove laitance and spillage from reinforcing steel and plain dowels.
2. Thoroughly clean surface to remove loose or defective concrete, coatings, sand, curing compound, and other foreign material.
3. Roughen surface to minimum of 1/4-inch amplitude:

a. Sandblast if concrete is fully cured.
b. Water blast if concrete is partially cured.

4. Do not damage waterstop or other embedded items, if present.

E. Install plain dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

3.3 CONTRACTION JOINT (CTJ)

A. Locate contraction joints at the locations shown on the Drawings or as otherwise required by ENGINEER.

B. Joints shall be formed, sawed, or tooled to a minimum depth of one-fourth (1/4) of the total thickness.

1. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

a. Tolerance: Ensure that sawed joints are within 3 inches in both directions from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

3.4 EXPANSION JOINTS (EJ)

A. Locate expansion joints at the locations shown on the Drawings or as otherwise required by ENGINEER.

1. Expansion joints are required in concrete at abutting concrete curbs, manholes, inlets, structures, or other fixed objects where indicated.
2. Locate expansion joints at intervals of 50 feet unless otherwise specified.

B. Construct so that there is no bond between abutting concrete surfaces.

C. Do not continue reinforcing steel across joint. Place plain dowels if shown on the Drawings.

D. Place concrete on one side of the joint and allow to set before abutting concrete is placed.

E. Clean abutting concrete surface of laitance, dirt, and debris.

F. Place joint filler material in accordance with manufacturer’s instructions.

1. Extend joint fillers full width and depth of joint.
2. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface.
3. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint filler sections together.

G. Place abutting concrete.

H. Seal the top expansion joints with approved caulk.

3.5 TOOLED EDGES

A. Tool or chamfer edges of concrete as shown on the Drawings or required by ENGINEER.

B. Where shown on the Drawings, outside edges of concrete shall be neatly finished with an edging tool. The radius of the tooled edges shall not be greater than 1/4 inch.

C. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 3/8-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

END OF SECTION

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Steel reinforcement, welded wire, and accessories for all concrete.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 301 - Specifications for Structural Concrete.
b. 315 - Details and Detailing of Concrete Reinforcement.
c. 318/318R - Building Code Requirements for Structural Concrete and Commentary.

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

a. A 36 - Standard Specification for Carbon Structural Steel.
b. A 82 - Standard Specification for Steel Wire, Plain, for Concrete Reinforcemen.t
c. A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
d. A 497 - Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
e. A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
f. A 706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
g. A 741 - Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcment.
h. A 767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

3. Concrete Reinforcing Steel Institute (CRSI):

a. Manual of Standard Practice.
b. Plain Reinforcing Bars.
c. 63 - Recommended Practice for Placing Reinforcing Bars.
d. 65 - Recommended Practice for Placing Bar Supports, Specifications, and Nomenclature.

4. American Welding Society (AWS):

a. D1.4 - Structural Welding Code - Reinforcing Steel.

1.3 SUBMITTALS

A. Shop Drawings:

1. Prepare in accordance with ACI 315 and CRSI Manual of Standard Practice. As a minimum, include the following:

a. Sizes, spacings, locations, and quantities of reinforcing steel and wire fabric; bending and cutting schedules; locations and dimensions of all bends, hooks, lap splices, and dowels; stirrup spacing; supporting and spacing devices.
b. Relationships to formed openings, embedded items, and equipment; relationships to adjoining concrete structures; coordination with concrete placement schedule.
c. Locations of all welded connections and mechanical couplers.

2. Product data for mechanical couplers.

B. Administrative:

1. Statement of qualifications for welder(s).

C. Quality Control:

1. Mill test certificates for reinforcing steel, indicating physical and chemical analysis, with each load of reinforcement delivered to the site.
2. Results of field testing.

1.4 QUALIFICATIONS

A. Welders: In accordance with AWS D1.4.

PART 2 PRODUCTS

2.1 STEEL REINFORCING MATERIALS

A. Reinforcing Steel: ASTM A 615, Grade 60, deformed bar, uncoated; ASTM A 706, Grade 60, deformed bar, uncoated for reinforcing steel to be welded.

B. Galvanized Reinforcing Steel: ASTM A 767, Grade 60, deformed bar.

C. Plain Dowels: ASTM A 615, Grade 60, plain bar, uncoated, cut true to length with ends square and free of burrs.

D. Plain Steel Welded Wire Reinforcement: ASTM A 1064.

2.2 ACCESSORY MATERIALS

A. Tie Wire: Minimum 16 gage, annealed type.

B. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete. Accessories fully or partially exposed after forms are removed shall be plastic, galvanized steel or plastic coated steel.

a. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength that concrete specified.
b. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 MECHANICAL COUPLERS

A. Use only where shown on the Drawings or approved by ENGINEER.

B. Couplers shall develop a tensile strength exceeding 125 percent of the yield strength of the reinforcement bars being spliced.

C. Products:

1. C2D Rebar Flange Coupler, Williams Form Engineering Co., Grand Rapids, MI.
2. Richmond DB-SAE Dowel Bar Splicer, Richmond Screw Anchor Co., Inc., Fort Worth, TX.
3. Lenton Reinforcing Steel Coupler, Erico Products, Inc., Cleveland, OH.

PART 3 EXECUTION

3.1 FABRICATION

A. Follow CRSI Manual of Standard Practice.

B. Bend bars cold.

C. Locate reinforcing splices not indicated on the Drawings at points of minimum stress.

3.2 DELIVERY, STORAGE, AND HANDLING

A. In accordance with CRSI publication “Placing Reinforcing Bars.”

3.3 REINFORCING BARS

A. Bundle or space bars, instead of field bending, where construction access through reinforcing is necessary.

B. Spacing and Positioning: Conform to ACI 318/318R.

C. Location Tolerances: Conform to CRSI 63.

D. Place, support, and secure reinforcement to prevent displacement during concrete placement.

E. Splicing:

1. Conform to requirements of ACI 318/318R.
2. Use lap splices unless otherwise shown on the Drawings or approved by ENGINEER.
3. Stagger splices in adjacent bars unless otherwise shown on Drawings.
4. Install mechanical couplers in accordance with manufacturer’s instructions. Protect as necessary to prevent concrete, cement paste, or water from entering.

F. Bend tie wires away from concrete surface to provide a minimum clearance of 1 inch from finished surface of concrete.

G. Field bending of reinforcing bars will not be allowed.

H. Do not field cut reinforcing bars unless approved by ENGINEER. Do not torch-cut reinforcing bars if field cutting is allowed.

I. Extend each end of reinforcing steel bars a minimum of one standard embedment length beyond openings in concrete.

J. Welding Reinforcement:

1. Only ASTM A 706 reinforcing bars may be welded.
2. Welding of reinforcing bars will be allowed only where shown on the Drawings or approved by ENGINEER.
3. Conform to AWS D1.4.

K. Plain Dowels:

1. Properly position and secure in place to prevent displacement during concrete placement.
2. Place so that one-half of the dowel is embedded on each side of the joint; set parallel with the finished concrete surface.
3. Grease one end of each dowel to prevent bond to the concrete.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDES

A. Cast-in-place conventional concrete required for construction of the Work.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
b. 301 - Specifications for Structural Concrete.
c. 302.1R - Guide for Concrete Floor and Slab Construction.
d. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
e. 304.2R - Placing Concrete by Pumping Methods.
f. 305R - Guide to Hot Weather Concreting.
g. 306.1 - Standard Specification for Cold Weather Concreting.
h. 309R - Guide for Consolidation of Concrete.
i. 308.1 - Standard Specification for Curing Concrete.
j. 318/318R - Building Code Requirements for Structural Concrete and Commentary.

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

a. C 31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
b. C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
c. C 143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
d. C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
e. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
f. C 1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
g. C 1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
h. E 329 - Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.
i. F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete.

B. THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements, Sections 500 and 600.

C. Where these Specifications differ from the requirements of ACI, ASTM, or THORNTON Standards and Specifications the more stringent requirements shall apply.

1.3 DEFINITIONS

A. Exposed Concrete: Concrete surfaces that can be inside or outside of structures, regardless of whether concrete is above or below water, dry at all times, or can be seen when structure is drained.

B. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 3/16 inch, cracks 0.005-inch wide and larger as well as any crack that leaks for liquid containment basins and below grade habitable spaces; cracks 0.010-inch wide and larger in non-fluid holding structures spalls, chips, air bubbles greater than 3/4 inch in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form popouts, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

C. New Concrete: Concrete less than 60-days old.

D. Design Strength: As defined in Section 03 30 50: BASIC CONCRETE MATERIALS.

E. Decorative Concrete: Concrete that includes exposed color, pattern, or texture and is generally placed within the limits of Memorial Plaza.

1.4 SUBMITTALS

A. Shop Drawings:

1. Placement drawings:

a. For all concrete.
b. Identify locations of joints; coordinate with required submittals for Section 03 15 16: CONCRETE CONSTRUCTION JOINTS.

2. Plan for cold weather concreting procedures; including procedures for transporting, placing, protecting, curing, and monitoring temperature of concrete during cold weather. Include procedures to be implemented upon abrupt changes in weather conditions or equipment failures. Include procedures for protecting the subgrade from frost, and for preventing the accumulation of ice or snow on reinforcement or forms prior to placement.
3. Plan for hot weather concreting procedures; including procedures for transporting, placing, protecting, curing, and monitoring temperature of concrete during hot weather.
4. Concrete curing methods; manufacturer’s data for curing compound.
5. Concrete repair methods and materials.

B. Administrative:

1. Manufacturer’s application instructions for curing compound.
2. Statement of Qualifications:

a. CONTRACTOR’s resident superintendent for concrete placement.

3. Pre-installation Conference minutes.

C. Quality Control:

1. Concrete batch ticket for each load of concrete delivered to the site.

1.5 QUALITY ASSURANCE

A. Pre-installation conference:

1. Meeting attendees:

   a. CONTRACTOR, including pumping, placing, finishing, and curing subcontractors. (Attendance mandatory.)
   b. ENGINEER, including field inspection personnel. (Attendance mandatory.)
   c. Concrete supplier representative. (Attendance mandatory.)
   d. Quality control testing and sampling personnel. (Attendance mandatory.)
   e. THORNTON's representative. (Attendance optional.)

2. Agenda will include, as a minimum, the following topics:

   a. Status of submittals.
   b. Mix designs; required slump and air content requirements; admixture types, dosage, performance, and re-dosing at site; concrete placement temperature requirements.
   c. Placement methods and equipment, consolidation, finishing, curing, and protection of concrete.
   d. Quality control requirements and procedures.
   e. Hot and cold weather procedures.
   f. Other specified items requiring coordination.

B. Mockups

1. Build mockups to verify selections of material to demonstrate aesthetic effects and set quality standards for materials and execution for all decorative concrete.

   a. Build mockups of full-thickness sections of decorative concrete paving to demonstrate typical joints; surface color, pattern, and texture; curing; and standard of workmanship.
   b. Build mockups of decorative concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Architect and not less than 96 inches by 96 inches.
   c. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless ENGINEER specifically approves such deviations in writing.
   d. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

PART 2 PRODUCTS

2.1 STRUCTURAL CONCRETE

A. Conform to the requirements of Section 03 30 50: BASIC CONCRETE MATERIALS.

2.2 FLATWORK CONCRETE

A. Conform to the requirements of THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements, Sections 500 and 600.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to the requirements of ACI 301, ACI 304R, THORNTON Standards and Specifications, and these Specifications. Where these Specifications differ, the more stringent shall apply.

B. Notify ENGINEER a minimum of 24 hours prior to commencement of concreting operations.

3.2 PREPARATION

A. Verify that anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, held securely, and will not cause hardship in placing concrete.

B. Remove debris and standing water from placement area. Dampen all earth and wood surfaces against which concrete will be placed. Keep surfaces moist until concrete is placed.

C. Do not place concrete until all formwork, reinforcement, and embedded items are properly placed and secured.

D. Supply concrete placement checkout cards satisfactory to ENGINEER, and a watertight container for the cards at a convenient location near each placement site. List on the checkout cards all of the various work items required prior to concrete placement. Each work item for the respective placement shall be completed and the card signed by CONTRACTOR. Each work item shall then be inspected and the card signed by ENGINEER. Concrete placement may commence when all work items have been completed, inspected, and signed by both CONTRACTOR and ENGINEER. The use of placement checkout cards may be waived by ENGINEER where their use is judged to be impracticable.

E. Have all necessary placing equipment on site prior to ordering concrete.

3.3 PLACING CONCRETE

A. For structural elements, place class of concrete indicated on the Drawings. If a concrete class is not indicated, place Class A concrete meeting the requirements of Section 03 30 50: BASIC CONCRETE MATERIALS.

B. For flatwork, place class of concrete indicated in THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements, Sections 500 and 600.

C. For decorative concrete, place Class E concrete as specified in 03 30 50.

D. Remove loose material from compacted subgrade surface immediately before placing concrete.

E. Place concrete in as nearly a continuous operation as practical.

F. Place concrete in near horizontal layers. Use spreading equipment that prevents segregation and that produces layers of widths and thickness appropriate for proper consolidation. Place each successive layer as soon as practicable after the preceding layer is completed.

G. Use delivery and placement methods that do not cause segregation. The maximum free-fall drop height allowed for concrete placement shall be 4 feet.

H. Do not disturb reinforcement, inserts, embedded items, or formed joints.

I. Do not break or interrupt successive placements such that cold joints occur.

J. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

K. Prevent debris or other objectionable material from becoming embedded in the concrete.

L. Placement Time: Place concrete within 90 minutes after water is added to cement, unless appropriate set delay admixtures are used. Use of set delay admixtures must be approved by ENGINEER.

1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 90 minutes to 75 minutes.
2. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

M. Allow a minimum of 7 days between adjacent placements at construction joints and contraction joints, unless otherwise indicated on the Drawings.

N. Inclement Weather:

1. Do not place concrete during heavy rain; defined as more than 0.3 inch per hour or 0.03 inch in 6 minutes (as defined by the Weather Bureau Glossary of Meteorology).
2. If unusual adverse weather, such as heavy rain, severe cold or heavy snow, occurs or is forecast to occur during placement, an interruption in placing operations may be approved or required by ENGINEER.
3. Fully consolidate all placed concrete materials prior to stopping work.

O. Cold Joints: Cold joints created by interruption of placement operations for any reason shall be treated as a construction joint in accordance with the requirements of Section 03 15 16: CONCRETE CONSTRUCTION JOINTS.

3.4 CONSOLIDATING CONCRETE

A. Conform to ACI 309R.

B. Use immersion-type power vibrators, suitable for the concrete mix proportions and placement conditions of the respective placement. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate to prevent dislocating reinforcement, dowels and joint devices.

C. Provide at least one standby vibrator prior to concrete placement.

3.5 COLD WEATHER PLACEMENT

A. Follow approved cold weather placement plan when the ambient air temperature is less than 40°F, or if the ambient air temperature is approaching 40°F and falling.

B. Develop cold weather placement plan in general conformance to ACI 306.1.

C. Do not place concrete against frozen earth or ice, or against forms or reinforcement with frost or ice present.

D. Maintain surface temperature of concrete above 40°F for minimum of 7 days after placement is completed.

E. Do not locally heat or dry concrete when using heating units to meet Specification requirements.

F. Do not use calcium chloride, salt, or other materials containing antifreeze agents unless otherwise specified in mix design.

3.6 HOT WEATHER PLACEMENT

A. Follow approved hot weather placement plan. Include in the plan ambient weather conditions, considering combined effects of air temperature, humidity, wind speed and solar radiation, under which hot weather placement procedures will be implemented.

B. Develop hot weather placement plan in general conformance to ACI 305R.

C. Maintain temperature of concrete at or below temperature requirements in Section 03 30 50: BASIC CONCRETE MATERIALS, until concrete is placed.

D. Provide shading, fog spraying, sprinkling, wet cover, or other means of maintaining concrete below the maximum specified temperatures.

E. For flatwork concrete and decorative concrete, cover steel reinforcement with water-soaked burlap or other means of maintaining steel below ambient air temperature immediately before embedding in concrete.

3.7 PROTECTING CONCRETE

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage.

B. Do not allow construction vehicles or equipment on concrete until it has attained its specified design strength.

3.8 QUALITY CONTROL

A. Responsibility:

1. THORNTON will perform all field quality control testing, obtain all field quality control samples, and perform all laboratory testing of field quality control samples for all cast-in-place concrete used in the Work.
2. CONTRACTOR shall provide necessary materials and adequate access to THORNTON's personnel for quality control testing.
3. THORNTON will verbally advise CONTRACTOR of results of field quality control test results upon completion of respective tests. Copies of THORNTON's field quality control test results will be provided to CONTRACTOR within 24 hours after testing.

B. General:

1. Quality control test results will be evaluated in accordance with ACI 301 and these Specifications.
2. Frequency of testing may be changed at ENGINEER's discretion.
3. Concrete samples for pumped concrete will be taken from the placement (discharge) end of the pumping line. Where sampling at the pump discharge is impractical, samples will be taken at the pump supply hopper.
4. Refer to Section 03 30 50: BASIC CONCRETE MATERIALS, for concrete quality requirements.

C. Compressive Strength:

1. Cylinder Preparation: ASTM C 31.
2. Each set shall consist of five cylinders.
3. 3 extra cylinders will be cast for each set cast during cold weather concreting operations. The extra cylinders will be field cured. Protect field curing cylinders;

place and maintain cylinders in the curing environment of the representative concrete.

4. Frequency: At least 1 set for each placement.
5. Laboratory Test Procedure: ASTM C 39.
6. For each set:

    a. 2 cylinders will be tested at 7 days.
    b. 2 cylinders will be tested at 28 days.
    c. 2 field cured cylinders will be tested at 28 days.
    d. Remaining cylinders will be retained for additional testing as needed.

D. Slump:

1. Test Procedure: ASTM C 143.
2. Frequency: 1 test for each truckload or batch.

E. Air Content:

1. Test Procedure: ASTM C 231.
2. Frequency: 1 test for each truckload or batch.

F. Temperature:

1. Frequency: 1 test for each truckload or batch.
2. Measure temperature immediately prior to placement.

END OF SECTION

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SECTION 03 30 50
BASIC CONCRETE MATERIALS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Material and mix requirements for conventional concrete.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
b. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
c. 301 - Specifications for Structural Concrete.
d. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete
e. 304.2R - Placing Concrete by Pumping Methods.
f. 311.5R - Batch Plant Inspection and Field Testing of Ready-Mixed Concrete.
g. 318/318R - Building Code Requirements for Structural Concrete and Commentary.

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

a. C 33 - Standard Specifications for Concrete Aggregates.
b. C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
c. C 88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
d. C 94 - Standard Specifications for Ready-Mixed Concrete.
e. C 143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
f. C 150 - Standard Specifications for Portland Cement.
g. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
h. C 192 - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
i. C 231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
j. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
k. C 311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete.
l. C 452 - Standard Test Method for Potential Expansion of Portland-Cement Mortars Exposed to Sulfate.
m. C 494 - Standard Specification for Chemical Admixtures for Concrete.
n. C 595 - Standard Specification for Blended Hydraulic Cements.
o. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
p. C 979 - Standard Specification for Pigments for Integrally Colored Concrete.

q. C 1012 - Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
r. C 1018 - Standard Test Method for Flexural Toughness and First-Crack Strength of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading).
s. C 1116 -Standard Specification for Fiber-Reinforced Concrete.
t. C 1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
u. C 1240 - Standard Specification for Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
v. D 4791 - Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

B. THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements, Sections 500 and 600.

C. Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction.

D. Where these Specifications differ from the requirements of ACI, ASTM, THORNTON, or CDOT, the more stringent requirements shall apply.

1.3 DEFINITIONS

A. Design Strength: Required minimum compressive strength of concrete at respective age, as specified in this Section.

B. Cementitious Materials: Portland cement and fly ash.

1.4 SUBMITTALS

A. Shop Drawings:

1. Product Data: Cement, fly ash, aggregate, admixtures, and water.

a. Cement and fly ash (if used), indicate sources of materials; include certification(s) of compliance with specified requirements.
b. Coarse and fine aggregates; include sources of materials and test data demonstrating compliance with specified gradation and quality requirements.
c. Admixtures include manufacturers and certification(s) of compliance with specified requirements.
d. Indicate source(s) and chemical test results of water source(s) for use in all concreting operations.

2. Mix Design Data: Include mix proportions and complete test results demonstrating compliance with specified requirements. Include mix design provisions for pumping concrete if applicable to proposed means and methods for construction.

B. Samples:

1. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color, pattern, or texture selection, provide a minimum sample consisting of product data only.
2. Samples for Verification: For each type of exposed color, pattern, or texture indicated, provide a minimum sample consisting of 12 inch by 12 inch concrete sample.

3. Design Mixture: For each decorative concrete paving mixture, include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Administrative:

1. Statement of Qualifications:

a. Mix designer.
b. Batch plant.

D. Quality Control:

1. Manufacturers' Certificates of Compliance:

a. Portland Cement.
b. Fly Ash.
c. Coarse Aggregate.
d. Fine Aggregate.
e. Admixtures.

1.5 QUALIFICATIONS

A. Mix designer shall be a licensed professional engineer registered in the State of Colorado or a Colorado Department of Transportation approved concrete mix designer, with a minimum of 5 years of experience in the design of concrete mixes.

B. Batch plant shall be currently certified by the National Ready Mixed Concrete Association.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

A. Cement:

1. ASTM C 150, Portland Type II, Type I/II, or approved equivalent.
2. Gray color.
3. Meet the optional chemical requirements for low-alkali cement specified in Table 2 of ASTM C 150.
4. Meet the optional physical requirements for false-set limitation specified in Table 4 of ASTM C 150.
5. Meet the optional physical requirements for heat of hydration specified in Table 4 of ASTM C 150.
6. Furnish from one source.

B. Fly Ash:

1. Class F, meeting applicable requirements of ASTM C 618.
2. Loss on ignition: Maximum 3 percent.

C. Slag Cement:

1. ASTM C989/C989M, Grade 100 or 120

D. Blended Hydraulic Cement:

1. ASTM C 595.

E. Aggregates:

1. Fine and coarse aggregates shall conform to applicable requirements of ASTM C 33 as modified by these Specifications.
2. Fine and coarse aggregates shall not be potentially reactive as determined in accordance with the provisions of ASTM C 33 Appendix X1.
3. Fine and coarse aggregates shall not be of a carbonate-based rock, unless its suitability and durability is proven by tests and approved by ENGINEER.
4. Fine aggregate shall be composed of natural sands.
5. Coarse aggregates shall be composed of natural gravel, crushed gravel, crushed stone, or combinations thereof.
6. Coarse aggregates shall contain no more than 15 percent flat or elongated particles, with maximum-to-minimum dimensions of 5 to 1.
7. Limit deleterious substances in coarse aggregate in accordance with the requirements for Class Designation 3S in Table 3 of ASTM C 33 for Concrete Classes A, B, C, and F. Limit deleterious substances in coarse aggregate in accordance with the requirements for Class Designation 4S in Table 3 of ASTM C 33 for all types of Decorative Concrete (Class E).
8. Coarse aggregate gradations shall conform to the requirements in Table 1.

Table 1

Concrete Class	ASTM C 33 Size No.	Nominal Maximum Aggregate Size (inches)
A	57	1-1/2
B	67	3/4
C	56	1
E	67	3/4
F	8	3/8

F. Admixtures:

1. Furnish each admixture from a single manufacturer.
2. Air-Entraining Admixture:

   a. ASTM C 260.

3. Water-Reducing Admixture:

   a. ASTM C 494, Type A or Type D.
   b. Products:

      1) Pozzolith or Polyheed, Master Builders, Inc., Cleveland, OH.
      2) WRDA or HYCOL, W.R. Grace & Co., Cambridge, MA.
      3) Eucon WR-91, Euclid Chemical Co., Cleveland, OH.

4. High Range Water Reducing Admixture (Superplasticizer):

   a. ASTM C 494, Type F or Type G.
   b. Products:

      1) Rheobuild or Polyheed, Master Builders, Inc., Cleveland, OH.
      2) Daracem, W.R. Grace & Co., Cambridge, MA.
      3) Eucon 537, Euclid Chemical Co., Cleveland, OH.

5. Color Additive:

a. ASTM C 979: Synthetic mineral-oxide pigmenets or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
b. Color: As listed on the Drawings for the Type of concrete specified and as approved by THORNTON.
c. Products:

1) Davis Colors.
2) L.M. Scofield Company, Douglasville, Georgia.

G. Fiber Reinforcing

1. ASTM C 1116 – Standard Specifications for Fiber-Reinforced Concrete.

a. Synthetic fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C 116, Type III, 1/2 to 1-1/2 inches long.

2. Products: Buckeye Ultra Fiber 500, Fibermesh Company or approved equal.

H. Water:

1. Conforming to applicable provisions of ASTM C 94.

2.2 CONCRETE MIX PROPORTIONS

A. Provide the following classes of structural concrete for use in the Work:

1. Class A: General use in structural reinforced concrete elements.
2. Class B: Use in drilled shafts and other structural reinforced concrete elements where placements and consolidation are facilitated by smaller aggregate size.
3. Class C: Use for backfill concrete.
4. Class D: Use for flatwork and sidewalk. Mix shall meet the requirements in THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements. Pre-approved CDOT Class D concrete mix designs will be acceptable. Include fiber reinforcing.
5. Class E: Use for decorative concrete generally placed within the limits of Memorial Plaza and Civic Center Dr median.
6. Class F: Use for masonry walls and bond beams.

B. Conform to the requirements of Table 2.

Table 2

Concrete Class	Minimum Compressive Strength (psi)	Slump Range at Placement Site (inches)	Maximum Water-Cementitious Ratio	Minimum Cementitious Content (lbs per cubic yard)	Air Content (%)
A	5000 @ 28 days	3 - 5	0.40	600	4.0 - 7.0
B	5000 @ 28 days	4 - 6	0.40	640	4.5 - 7.5
C	2500 @ 28 days	2 - 4	0.65	400	4.5 - 7.5
E	4500 @ 28days	3 - 5	0.50		4.5 - 7.5
F	4000 @ 28days	8 - 10	0.45	520	6.0 - 9.0

C. All concrete shall be air-entrained. Air content at the point of placement shall conform to the requirements of ACI 301. Unless otherwise approved by ENGINEER, all exposures shall be considered “Severe.”

D. For Class A, Class B, Class C, and Class F concrete, fly ash may constitute up to 15 percent by weight of the total cementitious content. For Class E, fly ash make constitute up to 25 percent by weight.

E. Use set-retarding and water-reducing admixtures during hot weather only when approved by ENGINEER.

F. Limit water-soluable, chloride-ion content in hardened concrete to 0.15 to 0.30 percent by weight of cement.

G. For Class D and Class E concrete, uniformly disperse synthetic fiber in concrete mixture at manufacturer’s recommended rate, but not less than 1.0 lb/cu. yd.

H. For Class E concrete, add color pigment to concrete mixture according to manufacturer’s written instructions and to result in hardened concrete color consistent with approved mockup.

2.3 CONCRETE TEMPERATURE

A. Batch concrete as necessary to achieve the following placement temperatures:

1. Class A, Class B, Class C, Class E, and Class F concrete between 50^{o}F and 90^{o}F.
2. Class D concrete as specified in THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements.

B. Use materials and/or procedures necessary to achieve required placement temperatures; including, but not limited to, the following:

1. Replace all or a part of the mixing water with chilled water.
2. Replace all or a part of the mixing water with ice.
3. Introduce liquid nitrogen into the concrete as it is batched.

2.4 BATCHING, MIXING, AND TRANSPORTING

A. Batch, mix and deliver to placement site in accordance with ASTM C 94.

1. For concrete batches of 1 cubic yard (CY), (0.76 cubic meter (m^3)) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 CY (0.76 m^3), increase mixing time by 15 seconds for each additional 1 CY. (0.76 m^3).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 EXECUTION

3.1 MIX DESIGN

A. Develop mix design for each class of conventional concrete required for the Work, including CDOT Class D concrete that is required for flatwork and is referenced in THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements.

B. Conform to ACI 211.1 and ACI 301.

C. Supporting test data and documentation must represent the actual mix proportions proposed, including all admixtures.

END OF SECTION

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SECTION 03 35 00
CONCRETE FINISHING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Finishing concrete.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
b. 301 - Specifications for Structural Concrete.

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

a. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

3. THORNTON

a. Specifications for Design and Construction of Public and Private Improvements.

B. Where these Specifications differ from the requirements of ACI or ASTM, the more stringent requirements shall apply.

1.3 DEFINITIONS

A. Exposed Concrete: Concrete surfaces that can be inside or outside of structures, regardless of whether concrete is above or below water, dry at all times, or can be seen when structure is drained.

B. Defective Areas: Surface defects that include honeycomb, rock pockets, indentations greater than 3/16 inch, cracks 0.005-inch wide and larger as well as any crack that leaks for liquid containment basins and below grade habitable spaces; cracks 0.010-inch wide and larger in non-fluid holding structures spalls, chips, air bubbles greater than 3/4 inch in diameter, pinholes, bug holes, embedded debris, lift lines, sand lines, bleed lines, leakage from form joints, fins and other projections, form popouts, texture irregularities, and stains and other color variations that cannot be removed by cleaning.

C. New Concrete: Concrete less than 60-days old.

D. Design Strength: As defined in Section 03 30 50: BASIC CONCRETE MATERIALS.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Conform to ACI 301, except as modified by these Specifications.

3.2 FINISHING

A. Finish flatwork concrete (including but not limited to, sidewalk, curb and gutter, cross pans, handicap ramps, and general exterior flatwork such as plazas and aprons) in accordance with SPECIAL CONDITIONS.

B. Chamfer or round off all exposed edges as shown on the Drawings. Round off all exposed edges where edge treatment is not otherwise indicated. Round off with steel edging tool with a 1/4-inch radius.

C. Classes of finish for formed concrete surfaces are designated as **F1**, **F2**, or **F4**.

1. **F1**: Applies to formed surfaces upon or against which fill material or concrete will be placed.

   a. Protect form tie rod ends from moisture on surfaces that will be in contact with fill material if they are below the maximum water table elevation. Protection shall consist of recessing the tie rod ends and filling the recesses with dry pack or other approved material or by an alternative system approved by ENGINEER.
   b. Cut off form tie rod ends flush with formed surfaces that will be in contact with concrete above the maximum water table elevation, or recess form tie rod ends without filling.

2. **F2**: Applies to all formed surfaces not permanently concealed by fill material or concrete, or not required to receive finish **F4**.

   a. Recessed form tie rods to allow removal with a minimum of 1-inch recess to the tie rod ends. Dry pack finish recess to match adjacent concrete surface texture and color.

3. **F4**: Applies to formed surfaces for which accurate alignment and evenness of surface are of paramount importance from the standpoint of reducing destructive effects of high-velocity water flow. All formed surfaces requiring finish **F4** are shown on the Drawings.

D. Classes of finish for unformed concrete surfaces are designated as **U1**, **U2**, or **U3**.

1. **U1** (screed finish): Applies to unformed surfaces that will be covered by fill material or by concrete. Finish **U1** is also the first stage of finishes **U2** and **U3**. Finishing operations shall consist of sufficient leveling and screeding to produce even, uniform surfaces.
2. **U2** (float finish): Applies to unformed surfaces not permanently concealed by fill material or concrete (**U2B** requires brooming after floating). Finish **U2** is also the second stage of finish **U3**.

   a. Floating may be performed with hand- or power-driven equipment except for concrete to receive finish **U3**. Floating operations for concrete receiving finish **U3** should be performed using bull floats or darbies.

b. Begin floating as soon as the screeded surface has stiffened sufficiently. Float only as necessary to produce a surface that is free from screed marks and uniform in texture before excess moisture or bleedwater appears on the surface.

c. If finish **U3** is to be applied, begin second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

3. **U3** (integrally colored concrete finish): Applies generally to decorative concrete surfaces within Memorial Plaza.

a. Integrally Colored Concrete Broom Finish: After final floating, apply the following finish:

1) Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

b. Integrally Colored Concrete Sandscape Finish: After final floating, apply the following finish:

1) Areas noted for sandscape finish shall receive a light retarder surface application to expose the sand in the concrete.

c. Integrally Colored Concrete Exposed Aggregate Finish: After final floating, apply the following finish:

1) Areas noted for exposed aggregate finish shall receive a heavy retarder surface application to expose the aggregate in the concrete.

4. Slope interior surfaces for drainage where shown on the Drawings or required by ENGINEER. Surfaces that will be exposed to the weather and that would normally be level shall be sloped for drainage. Narrow surfaces, such as tops of walls and curbs, shall be sloped approximately 3/8-inch per foot of width; and broader surfaces, such as walks, roadways, platforms, and decks, shall be sloped approximately 1/4-inch per foot; unless the use of other slopes or level surfaces is indicated on the Drawings or required by ENGINEER.

E. Do not add extra water to the surface of the concrete to aid in finishing.

F. Broom finish: Fine or medium-course broom for walking surfaces. Finish in direction perpendicular to normal walking direction or as directed by the ENGINEER.

3.3 PROTECTING CONCRETE

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage.

B. Do not allow construction vehicles or equipment on concrete until it has attained its specified design strength.

3.4 TOLERANCES

A. Flatwork concrete tolerances in accordance with SPECIAL CONDITIONS.

B. Tolerances are defined as allowable variation from specified lines, grades, and dimensions, and as allowable magnitude of surface irregularities.

C. Allowable Variation From Specified Lines, Grades, and Dimensions:

1. Conform to ACI 117.
2. Variation is defined as the distance between the actual position of the structure or any element of the structure and the specified position of the respective structure or element.

D. Allowable Magnitude of Surface Irregularities:

1. As specified in Table 1.
2. Concrete surface irregularities are defined as bulges, depressions, and offsets in hardened concrete surfaces.
3. Concrete surface irregularities are classified as "abrupt" or "gradual" and are measured relative to the actual concrete surface.
4. Abrupt Surface Irregularities:

a. Defined as: offsets of the finished surface of formed surfaces, such as those caused by misaligned or loose forms, loose knots in form lumber, or other similar forming faults; and offsets of the finished surface of unformed surfaces, such as those caused by differential movement at joints.
b. Measured using a 6-inch-long straight edge, held firmly against the concrete surface at the offset.
c. The magnitude is the greatest distance from the concrete surface to the edge of the straight edge nearest the concrete.

5. Gradual Surface Irregularities:

a. Defined as bulges and depressions resulting in gradual changes on the concrete surface.
b. Measured using a template conforming to the design profile of the concrete surface being examined, held firmly against the concrete surface. Provide necessary templates, with a minimum length of 10 feet.
c. The magnitude is the greatest distance from the concrete surface to the nearest edge of the template.

TABLE 1
TOLERANCES FOR CONCRETE SURFACE IRREGULARITIES

A. Offsets (abrupt irregularities): 1. F4 Surfaces: 0.125 inch 2. U3 Surfaces: 0.125 inch
C. Gradual Changes (gradual irregularities): 1. F4 Surfaces: 0.125 inch per 10 feet, 0.5 in max deviation 2. U3 Surfaces: 0.125 inch per 10 feet, 0.5 inch max deviation

3.5 QUALITY CONTROL

A. Tolerances:

1. Variation of all hardened concrete structures or elements of structures will be measured as necessary to verify compliance with Specification requirements.
2. CONTRACTOR shall provide appropriate templates for THORNTON's use in measuring variation measurements.

END OF SECTION

SECTION 03 37 16
PUMPED CONCRETE

PART 1 GENERAL

1.1 WORK INCLUDES

A. Pumped concrete required for construction of the Work.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 301 - Specifications for Structural Concrete.
b. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
c. 305R - Guide to Hot Weather Concreting.
d. 306.1 - Standard Specification for Cold Weather Concreting.

B. Where these Specifications differ from the requirements of ACI or American Society for Testing and Materials International (ASTM), the more stringent requirements shall apply.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Conform to ACI 304, except as modified by these Specifications.

3.2 PUMPED CONCRETE

A. Pumping Concrete:

1. Conform to ACI 304.2R.
2. Maintain standby pumping equipment on site, such that any interruption in placement operations due to equipment failure will not result in the formation of a cold joint.
3. Pipelines shall be steep pipe or flexible hose. Do not use aluminum pipe.
4. Inside diameter of pipeline shall be minimum three times the maximum aggregate size of the concrete mix.
5. Water introduced at any point in the pump shall be ejected outside the concrete placed for the Work. Concrete in the pump that exceeds 90 minutes for the point water was added to the cement shall be wasted.

B. Placement Time: Place concrete within 90 minutes after water is added to cement, unless appropriate set delay admixtures are used.

END OF SECTION

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SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Curing concrete surfaces.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 301 - Specifications for Structural Concrete.
b. 308.1 - Standard Specification for Curing Concrete.

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

a. C 171 - Standard Specification for Sheet Materials for Curing Concrete.
b. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
c. C 1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

3. American Association of State Highway and Transportation Officials (AASHTO):

a. M 182 - Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

B. Where these Specifications differ from the requirements of ACI or ASTM, the more stringent requirements shall apply.

1.3 DEFINITIONS

A. Exposed Concrete: Concrete surfaces that can be inside or outside of structures, regardless of whether concrete is above or below water, dry at all times, or can be seen when structure is drained.

1.4 SUBMITTALS

A. Shop Drawings:

1. Concrete curing methods; manufacturer’s data for curing compound.
2. Plan for cold weather concrete curing procedures.
3. Plan for hot weather concrete curing procedures.

B. Administrative:

1. Manufacturer’s application instructions for curing compound.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store in a suitable location and protect from weather, corrosion, vandalism, or other damage. Do not store directly on ground surface.

PART 2 PRODUCTS

2.1 CURING COMPOUND

A. Traditional Concrete: Water-based, high solids content non-yellowing curing compound meeting the requirements of ASTM C 309 and ASTM C 1315.

B. Decorative Concrete:

1. Waterborne, meeting the requirements of ASTM C 309, Type I, Class B, manufactured for colored concrete.

   a. For integrally colored concrete, curing compound shall be pigmented type approved by coloring admixture manufacturer.
   b. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

2. Clear, Waterborne, Membrane-Forming Curing, and Sealing Compound: ASTM C 1315, Type I, Class A, manufactured for use with colored concrete.
3. Slip-Resistance-Enhancing Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer to enhance slip resistance of sealed paving surface.

2.2 EVAPORATION RETARDER

A. Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

2.3 IMPERVIOUS SHEET MATERIALS

A. Conform to the requirements of ASTM C 171, except that polyethylene sheet shall not be used.

2.4 BURLAP AND COTTON MAT

A. Conform to the requirements of AASHTO M 182.

2.5 WATER

A. Provide water that is clean and free from injurious amounts of fuel, oil, salt, etc.

PART 3 EXECUTION

3.1 GENERAL

A. Conform to the requirements of ACI 301, ACI 308.1, and these Specifications. Where these Specifications differ from ACI 301, or ACI 308.1, the more stringent shall apply.

B. Maintain surface temperature of concrete above 40°F and below 90ºF for minimum of 7 days after placement is completed. Provide a high/low thermometer at the concrete surface to record temperature for the duration of the curing period.

C. Protect the concrete from rapid temperature changes for the curing period. Rapid temperature changes are more than 5ºF in one hour.

D. Do not locally heat or dry concrete when using heating units to meet Specification requirements.

E. Provide shading, fog spraying, sprinkling, wet cover, or other means of maintaining concrete below the maximum specified temperatures.

3.2 CURING CONCRETE

A. Follow approved curing procedures.

B. Develop curing procedures in general conformance to ACI 308.1.

C. Cure concrete in walls using one of the following methods:

1. Option 1 - Leave form work in place and keep forms and exposed concrete surfaces wet constantly for 7 days.
2. Option 2 - Remove forms and apply curing compound. Do not apply curing compound to surfaces of construction joints.
3. Option 3 - Remove forms and keep concrete surfaces wet constantly for 7 days.

D. Cure concrete in slabs using one of the following methods:

1. Option 1 - Maintain ponded water on exposed surface for 7 days.
2. Option 2 - Cover exposed surface with wet burlap. Keep burlap wet constantly for 7 days. Remove and dispose of burlap after curing is completed.
3. Option 3 - Apply curing compound to exposed surface. Do not apply curing compound to surfaces of construction joints.

E. Apply curing compound in accordance with manufacturer’s instructions.

1. Cure integrally colored concrete with a clear curing compound.

3.3 PROTECTING CONCRETE

A. Protect concrete from premature drying, excessively hot or cold temperatures, rain, and mechanical damage.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot (psf) by height before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

3.4 SEALER APPLICATION

A. Clear Acrylic Sealer: Apply to all decorative concrete and all concrete flatwork.

1. Apply uniformly in two coats in continuous operations according to manufacturer's written instructions. Allow first coat to dry before applying second coat, at 90 degrees to the direction of the first coat, using same application methods and rates.

a. Begin sealing dry surface no sooner than 14 days after concrete placement.
b. Allow stained concrete surfaces to dry before applying sealer.
c. Thoroughly mix slip-resistance-enhancing additive into sealer before applying sealer according to manufacturer's written instructions. Stir sealer occasionally during application to maintain even distribution of additive.

END OF SECTION

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SECTION 03 62 00
NON-SHRINK GROUT

PART 1 GENERAL

1.1 WORK INCLUDES

A. The following grout types:

1. Cement based non-shrink grout (Type 1).
2. Non-shrink epoxy grout (Type 2).
3. Epoxy anchor grout (Type 3).
4. Cement-bentonite non-shrink grout (Type 4).
5. Cement-bentonite non-shrink grout (Type 5).

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

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

a. C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch or 50 millimeters Cube Specimens).
b. C 531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
c. C 579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
d. C 827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
e. C 881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
f. C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
g. C 939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
h. C 1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non shrink).
i. C 1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
j. D 1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
k. D 1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 SUBMITTALS

A. Shop Drawings:

1. Product data of all grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing grout.
3. Forming method for fluid grout placements.
4. Curing method for all grouts.

B. Administrative:

1. Manufacturer’s instructions.
2. Statement of Qualifications for grout manufacturer.

C. Quality Control:

1. Manufacturer's Written Instructions:

a. Cement-water ratio of grout topping.
b. Mixing of grout.

2. Manufacturer's Certificate of Compliance:

a. Grout free from chlorides and other corrosion-causing chemicals.
b. Non-shrink grout properties of Type 2 and 3, verifying expansion at 3 or 14 days will not exceed the 28-day expansion and non-shrink properties are not based on gas or gypsum expansion.
c. Statements of Qualification: Non-shrink grout manufacturer's representative.

1.4 QUALIFICATIONS

A. Non-shrink grout manufacturer shall have a minimum of 1 year experience in installation of similar grouting or grout placement.

PART 2 PRODUCTS

2.1 CEMENT

A. Cement for grout shall conform to the requirements of Section 03 30 50: BASIC CONCRETE MATERIALS.

2.2 CEMENT BASED NON-SHRINK GROUT (TYPE 1)

A. Type 1 non-shrink grout shall have a minimum 28-day compressive strength of 7,000 pound per square inch (psi) when mixed at a fluid consistency.

B. Type 1 non-shrink grout shall meet the requirements of ASTM C 1107, Grade C when tested using the amount of water needed to achieve the following properties:

1. Fluid consistency (20 to 30 seconds) per ASTM C 939.
2. At temperatures of 45, 70, and 90ºF.
3. The grout when tested shall not bleed or segregate at maximum allowed water.

C. Provide certification that the expansion at 3 or 14 days does not exceed the 28-day expansion and that its non-shrink property is not based on gas production or gypsum expansion.

D. Fluid grout shall pass through the flow cone, with a continuous flow, 1 hour after mixing.

E. Grout shall be pre-tested per the specified grout test requirements.

F. Type 1 non-shrink grout shall be Masterflow 938 by Master Builders, or equal.

2.3 NON-SHRINK EPOXY GROUT (TYPE 2)

A. Type 2 grout shall be a flowable, non-shrink, 100 percent solids system. Type 2 grout shall have three components: resin, hardener, and specially blended aggregate, all pre-

measured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the Manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

B. Provide certification that the vertical volume change at all times before hardening shall be between 0.0 percent shrinkage and 4.0 percent expansion when measured according to ASTM C 827 (modified for epoxy grouts by using an indicator ball with a specific gravity between 0.9 and 1.1).

C. Provide certification that the length change after hardening shall be negligible (less than 0.0006 in/in) and the coefficient of thermal expansion shall be less than 0.00003 in/in ºF when tested according to ASTM C 531.

D. The compressive creep at one year shall be negligible (less than .001 in/in) when tested under a 400 psi constant load at 140ºF according to ASTM C 1181.

E. The 7-day compressive strength shall be minimum 15,000 psi when tested according to ASTM C 579, modified to 1-1/2-inch square cubes.

F. The grout shall be capable of maintaining a flowable consistency for a minimum of 30 minutes at 70ºF.

G. The shear bond strength to Portland cement concrete shall be greater than the shear strength of the concrete when tested according to ASTM C 882.

H. Do not reduce aggregate loading or add solvents to increase flowability.

I. Type 2 grout shall be Five Star Epoxy Grout by Five Star Products, Inc.; Ceilcote 648 CP Plus by Master Builders; or equal.

2.4 EPOXY ANCHOR GROUT (TYPE 3)

A. Type 3 grout shall conform to ASTM C 881, Type IV, Class B and C, Grade 3.

B. Manufacturer shall certify that the epoxy grout will maintain 90 percent of the required strength up to a temperature of 140ºF.

C. Type 3 grout shall come in two-chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.

D. Type 3 grout shall be capable of being used in submersed applications.

E. If average working temperature will be over 100ºF, use cement based non-shrink grout.

2.5 CEMENT-BENTONITE NON-SHRINK GROUT (TYPE 4)

A. Type 4 grout shall be a mixture of cement, pulverized bentonite, and water. The cement-bentonite mixture shall contain 10 gallons of water and between 4 to 6 pounds of bentonite for each 94-pound sack of cement. The cement and water shall be mixed first. Then:

1. For Type 4 grout that is to be pumped into a borehole, add bentonite to the cement-water mixture to form a smooth, consistent slurry that is as thick as possible while still being pumpable.
2. For Type 4 grout that will be placed as backfill, add bentonite to the cement-water mixture to form a smooth, consistent slurry that is as thick as possible while still being placeable.

3. The amount of bentonite added will vary depending on the application and desired mixture consistency.

2.6 CEMENT-BENTONITE NON-SHRINK GROUT (TYPE 5)

A. Type 5 grout shall be a mixture of cement, pulverized bentonite, and water. The cement-bentonite mixture shall contain 45 gallons of water and between 30 to 40 pounds of bentonite for each 94-pound sack of cement. The cement and water shall be mixed first. Then add bentonite to the cement-water mixture to form a smooth, consistent slurry that is as thick as possible while still being pumpable. The amount of bentonite added will vary depending on the application and desired mixture consistency.

2.7 BENTONITE

A. Bentonite products shall be as manufactured by American Colloid Co., Arlington Heights, IL. Bentonite shall have the following characteristics:

1. Minimum purity of 90 percent montmorillonite clay.
2. Moisture content no more than 10 percent as packaged.
3. Ground to pass a No. 200 sieve.
4. Meet criteria defined by the American Petroleum Institute (API) Specification 13.

PART 3 EXECUTION

3.1 GENERAL

A. Grout shall not be placed until base concrete or masonry has attained its design strength unless authorized by ENGINEER.

B. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of saturation period excess water shall be removed. Concrete substrate shall not be wet prior to placement of grouts.

C. Except for cement-bentonite grout all surfaces that will be in contact with grout shall be free of grease, oil, dirt, loose rust, curing compounds, laitance, loose concrete, and other deleterious materials.

3.2 GROUTING PROCEDURES

A. General:

1. All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Base Plate Grouting:

1. Provide a 1-inch-thickness of grout, 1/2-inch plus tolerance.
2. After the base plate has been set in position, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink grout. The mixture shall be of a trowelable consistency and tamped or rodded into the space between the plate and the base concrete.

C. Epoxy Anchor Grout:

1. Grout shall be proportioned and mixed with automatic equipment.
2. Unless otherwise indicated by the manufacturer, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar, but shall not

be less than 8 diameters for threaded rods, or 12 diameters for reinforcing or smooth bars.

D. Topping Grout and Concrete Fill:

1. All mechanical, electrical, and finish work shall be completed prior to placement of topping or concrete fill. To ensure bonding to the base slab, the base slab shall be given an exposed finish.
2. The minimum thickness of grout topping and concrete fill shall be 1 inch. Where the finished surface of concrete fill is to form an intersecting angle of less than 45 degrees with the concrete surface, it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3-1/2 inches wide by 1-1/2 inches deep.
3. The base slab shall be thoroughly cleaned and wetted to saturated surface dry, prior to placing topping and fill.
4. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.
5. The surface shall be tested with a straight edge to detect high and low spots, which shall be immediately eliminated. When the topping and fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand troweling. During finishing, no water, dry cement, or a mixture of dry cement and sand shall be applied to the surface.

E. Cement Based Non-Shrink Grout used for anchor bolts:

1. When the bolt diameter is 1 inch or less, the hole diameter should be a minimum of 2 inches. When the bolt's diameter is greater than 1 inch, the hole diameter should be at least twice the bolt diameter.
2. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

3.3 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, so as to assure that the space to be grouted is completely filled.

3.4 CURING

A. Grout should be cured according to the manufacturer's recommendations.

B. Temperature of the foundation plate, supporting concrete foundation, and the grout should be maintained between 40ºF and 90ºF during grouting, and for a minimum of 24 hours afterward. Machinery and baseplates will cool at low temperatures or heat up at hot temperatures or in the sun more rapidly than the grout and should be avoided during the curing period.

C. Cement based grout should be protected from extreme drying conditions by covering all exposed grout surfaces with continually wetted burlap for a minimum of 3 days. Immediately after the moist curing period, two coats of a curing compound shall be applied.

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SECTION 05 12 00
STRUCTURAL STEEL AND MISCELLANEOUS METALWORK

PART 1 GENERAL

1.1 WORK INCLUDES

A. Structural steel and miscellaneous metalwork including, but not limited to, the following items:

1. Structural steel.
2. Structural fasteners.
3. Anchor bolts and epoxy anchors.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

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

a. A 36/A 36M - Specification for Carbon Structural Steel.
b. A 53/A 53M - Specification for Pipe, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
c. A 143 - Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedures for Detecting Embrittlement.
d. A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
e. A 325 - Specification for High-Strength Bolts for Structural Steel Joints.
f. A 384 - Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
g. A 385 - Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
h. A 500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
i. A 563 - Specification for Carbon and Alloy Steel Nuts.
j. A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
k. F 436 - Specification for Hardened Steel Washers.
l. F 593 - Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
m. F 594 - Specification for Stainless Steel Nuts.
n. F 1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-psi Yield Strength.

2. American Institute of Steel Construction (AISC):

a. *Specification for Structural Steel Buildings* - Allowable Stress Design and Plastic Design, June 1, 1989 Fourth Impression, September 2002.
b. *Code of Standard Practice for Steel Buildings and Bridges*, March 7, 2002.
c. *Specification for Structural Joints Using ASTM A 325 or A 490 Bolts*, June 23, 2000.

3. American Welding Society (AWS):

a. D1.1 - Structural Welding Code, Steel.

4. Occupational Safety and Health Administration (OSHA) and local safety and building codes, together with applicable federal and local laws.

B. Where these Specifications differ from the requirements of AISC, AWS, or ASTM, the more stringent requirements shall apply.

C. The latest approved edition of these standards shall be used, unless specified otherwise by the ENGINEER.

1.3 SUBMITTALS

A. Shop Drawings:

1. For Fabricated Items: Complete drawings showing details of fabrication and assembly, and demonstrating compliance with Specification requirements. Include all dimensions, tolerances, sizes, finishes, fasteners, welds, and materials of construction. Identify all field connections.
2. For Standard Manufactured Items: Manufacturer's catalog work sheets showing illustrated cuts of items to be furnished and demonstrating compliance with Specification requirements. Include scale details, dimensions, fasteners, finishes, and materials of construction.
3. Placement or erection drawings for all fabricated items, structural steel and embedded steel showing assembly details and relationships to adjoining work. Reproduction of Contract Documents will not be accepted for this purpose. Verify all dimensions to ensure proper fit of all items.
4. Reference all construction materials by ASTM designations and grades.

B. Administrative:

1. Statement of Qualifications:

a. Welders and welding operators.

C. Quality Control:

1. Manufacturers' Certificates of Compliance for specified products.

PART 2 PRODUCTS

2.1 STRUCTURAL STEEL

A. Rolled Shapes: ASTM A 992.

B. Plates and Angles: ASTM A 36.

C. Hollow structural sections (HSS): ASTM A 500, Grade B.

D. Steel pipe: ASTM A 53, Type E or S, Grade B.

E. Finishes:

1. Galvanized unless specified otherwise.
2. Conform to requirements in Section 09 90 00: PAINTING AND COATING.

2.2 THREADED FASTENERS AND ANCHORS

A. Anchor Bolts:

1. Carbon Steel: ASTM F 1554, Grade 36.

a. Anchor bolts, washers, and nuts shall be purchased from the same supplier and shipped preassembled.

B. Structural Bolts:

1. Carbon Steel: ASTM A 325N, Type 1.

C. Nuts:

1. Carbon Steel: ASTM A 563, Grade A.

D. Washers:

1. Carbon Steel: ASTM F 844.

E. Epoxy anchors:

1. Stainless Steel Threaded Rod: AISI Type 316.

F. Expansion Anchors:

1. Stainless Steel: A151 Type 304.

G. Shear Stud:

1. Carbon Steel: ASTM F 1554, Grade 36.

2.3 MESH

A. Stainless steel: AISI Type 316.

2.4 FABRICATION

A. General:

1. Conform to AISC *Specification for Structural Steel Buildings* and these Specifications.
2. Mark and match mark materials for field assembly.

B. Connections:

1. Shop Connections: Welded or bolted, as shown.
2. Field Connections: Bolted, unless otherwise approved by ENGINEER.
3. Conform to AISC *Specification for Structural Steel Buildings* for bolted double-angle shear connections, unless indicated otherwise.
4. Provide bolt length and thread length appropriate for the connection type shown, with hardened washers as required.
5. Steel Deck: Fabricate steel deck accessories from the same gauge and material as adjacent steel deck.

C. Welded Construction:

1. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.
2. Steel Deck: Metal decking is to be attached to the structural frame in conformance with AWS D1.1 “Structural Welding Code – Steel” and D1.3 “Structural Welding Code – Sheet Steel.”

D. Interface with Other Work:

1. Holes:

a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
b. No flame-cut holes will be permitted without approval of ENGINEER.

2. Weld threaded nuts to framing, and other specialty items as shown to receive other Work.

E. Galvanizing:

1. Anchor rods, washers, nuts, and base-plate shall be galvanized by the same process.
2. Fabricate steel to be galvanized in accordance with ASTM A 153. Avoid fabrication techniques that could cause distortion or embrittlement of steel.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to galvanizing.
4. Remove, by blast cleaning or other methods, surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Conform to requirements of Section 09 90 00: PAINTING AND COATING.
6. Galvanize components of bolted assemblies separately before assembly.

PART 3 EXECUTION

3.1 ERECTION

A. Conform to AISC Specification for Structural Steel Buildings, AISC Code of Standard Practice, and these Specifications.

B. High Strength Bolted Connections:

1. Conform to AISC Specification for Structural Joints.
2. Hardened Washers:

a. Provide at locations required by Washer Requirements section of AISC Specification for Structural Joints, to include slip critical connections using slotted or oversized holes.
b. Use beveled style and extra thickness where required by AISC Specification for Structural Steel Buildings.
c. Use square or rectangular beveled washers at inner flange surfaces of American Standard beams and channels.
d. Do not substitute Direct Tension Indicator (DTI) for hardened flat washers required at slotted and oversize holes.

3. For bearing-type connections not fully tensioned (N,X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.

C. Fully Tensioned Bolted Connections:

1. Use DTIs for TC bolts at slip critical (SC) and fully tensioned (FT) bearing-type connections.
2. DTIs

    a. Position within bolted assembly in accordance with ASTM F 959.
    b. Install bolts, with DTIs plus hardened washers as required, in all holes of an assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.

3. Final tighten bolts, beginning at most rigid part of bolted connection and progressing toward free edges, until final twist-off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in Table 2, ASTM F 959.

3.2 ANCHOR BOLTS

A. Coordinate installation of anchor bolts and other connectors required for securing structural steel to in-place work.

B. Provide templates and other devices for presetting bolts and other anchors to accurate locations.

C. Coordinate with Section 03 30 00: CAST-IN-PLACE CONCRETE.

3.3 EXPANSION ANCHORS

A. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10 percent of specified torque. 100 percent of the specified torque is not achieved within the reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the ENGINEER.

3.4 SETTING BASES AND BEARING PLATES

A. Remove bond-reducing substances from bearing surfaces and roughen to improve bond.

B. Clean bottom surface of base and bearing plates.

C. Set loose and attached baseplates and bearing plates for structural members on wedges, shims, leveling nuts, or other adjustable devices.

D. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to placing grout.

E. Grout Under Baseplates: Type 2, as specified in Section 03 62 00: NON-SHRINK GROUT, prior to placing loads on structure.

3.5 SHEAR STUDS

A. Install in accordance with Section A4.3 AISC/SDI C-2017 Standard.

3.6 FIELD ASSEMBLY

A. Set structural frames accurately to lines and elevations shown.

B. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.

C. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.

D. Level and plumb individual members of structure within tolerances shown in AISC *Code of Standard Practice*.

E. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.

F. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.

G. Provide additional field connection material as required by AISC *Code of Standard Practice.*

H. Splice members only where indicated and accepted on shop drawings.

3.7 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in erection bolting are encountered, immediately notify ENGINEER for approval of one of the following methods of correction:

1. Ream holes that must be enlarged to admit bolts and use oversized bolts.
2. Plug weld misaligned holes and re-drill holes to admit standard size bolts.
3. Drill additional holes in connection, conforming with AISC Standards for bolt spacing and end and edge distances, and add additional bolts.
4. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.

B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

3.8 MISFITS AT ANCHOR BOLTS

A. Resolve misalignments between anchor bolts and bolt holes in steel members in accordance with approved submittal.

B. Do not flame cut to enlarge holes.

3.9 GAS CUTTING

A. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.

B. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by ENGINEER.

C. Finish flame-cut sections equivalent to sheared and punched appearance.

3.10 REPAIR AND CLEANING

A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.

B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.

C. Remove weld back-up bars and grind smooth where indicated on Drawings.

D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application and as specified in Section 09 90 00: PAINTING AND COATING.

3.11 REPAIR OF DAMAGED HOT-DIP GALVANIZED COATING

A. Conform to requirements of Section 09 90 00: PAINTING AND COATING.

3.12 FIELD QUALITY CONTROL

A. High-Strength Bolted Connections:

1. OWNER may perform the following inspection and testing in accordance with the AISC *Specification for Structural Joints*:

a. Marking identification and conformance to ASTM standards.
b. Alignment of bolt holes.
c. Placement, type, and thickness of hardened washers.
d. Tightening of bolts.

2. Bearing-Type Connections Not Fully Tensioned (N, X): Snug tight condition with plies of joint in firm contact.
3. Nondestructive Testing (NDT) Report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections necessary to meet code acceptance criteria.
4. Defective Connections: Correct and re-inspect defective and improperly tightened high-strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance with Specification requirements.

B. Welded Connections:

1. Visually inspect field welds in accordance with AWS D1.1, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. OWNER may perform the following inspection and testing of field welds:

a. Groove welds:

1) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.
2) Use RT only for butt joint groove welds.

b. Fillet welds larger than 5/16-inch: Liquid penetrant (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.
c. All Welds: Visually inspected (VT).

3. Repair and retest defective welds.

END OF SECTION

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SECTION 07 10 00
DAMPPROOFING AND WATERPROOFING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Dampproofing and waterproofing for the retaining wall foundation, manholes, and inlets.

1.2 SUBMITTALS

A. Shop Drawings: Copies of manufacturer's literature for products proposed.

B. Samples: Cured membrane applied to 12-inch-square by 1/4-inch-thick plywood or similar rigid base.

C. Quality Control:

1. Certification of compliance with product requirements specified.
2. Copy of guarantee to be provided. Upon completion and acceptance of the Work required by this Section, submit an executed copy of the guarantee.
3. Applicator approval letter from membrane manufacturer.

1.3 QUALITY ASSURANCE

A. Applicator: Approved and licensed by fluid applied waterproofing manufacturer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in sealed, undamaged containers. Identify each container with material name, date of manufacture, and lot number.

B. Store material in dry area out of direct sunlight. Storage area temperature shall not exceed 90ºF.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Perform work only when existing and forecasted weather conditions are within limits established by manufacturer of materials and products used.

B. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive waterproofing.

PART 2 PRODUCTS

2.1 MEMBRANE

A. Polyurethane elastomer-based fluid applied waterproofing membrane.

B. Manufacturers and Product:

1. 3M Co., St. Paul, MN; Scotch-Clad Brand Deck Coating.
2. The Neogard Corp., Dallas, TX; Perma-Gard III.
3. Gaco Western, Seattle, WA; LM-60.
4. Carlisle Coatings and Waterproofing, Sapulpa, OK; CCW-525.
5. Sonneborn, Shakopee, MN; HLM 5000.
6. W.R. Grace & Co., Cambridge, MA; Procor 20.

7. Pecora Corp., Harleyville, PA; Duramem V500.

2.2 RELATED MATERIALS

A. Compatible with components produced by membrane manufacturer:

1. Primers: As recommended by membrane manufacturer for type of substrate involved.
2. Sealants: Low modulus, unmodified polyurethane or as recommended by membrane manufacturer.
3. Backer Rod: Expanded polyethylene rod as manufactured by Dow Chemical, Ethafoam.
4. Flashing Reinforcement: Woven, uncoated fiberglass mesh on 0.050-inch-thick procured neoprene.
5. Protection Board: Approved by membrane manufacturer.

PART 3 EXECUTION

3.1 CONDITIONS OF SURFACES

A. Verify curing methods used for concrete are compatible with membrane system.

3.2 PREPARATION

A. Cleaning:

1. Thoroughly clean surfaces to receive membrane following membrane manufacturer's recommendations.
2. Treat as necessary to remove laitance, loose material on surface, grease, oil, and other contaminants that will affect bond of the membrane.
3. Vacuum clean or clear water wash surfaces and allow to dry completely.

B. Fill voids and control joints with sealant and overcoat with nonflow membrane material. Fill or coat visible shrinkage cracks to minimum 2 inches either side of crack.

3.3 FLASHINGS-FLUID APPLIED

A. Unless Drawings establish more restrictive requirements, the following minimum requirements apply:

1. Fill construction joint voids with backer rod and sealant in accordance with requirements of membrane manufacturer.
2. Nonreinforced Flashing:

a. Install nonreinforced flashing at construction joints not subject to movement, at all intersecting surfaces that are structurally and rigidly connected, and at all piping or other penetrations through membraned surfaces that do not require reinforced flashing.
b. Apply 50-mil minimum dry film thickness of membrane for 4 inches minimum onto adjacent surfaces.
c. At projections through a vertical membrane, extend flashing coat 4 inches minimum onto penetrating element.

3. Reinforced Flashing:

a. Apply flashing reinforcement over cracks, expansion and control joints, and at changes of plane where adjacent surfaces are not structurally and rigidly connected and also at penetrations through a membrane surface.

b. Apply 50-mil dry film thickness embedment coat of membrane to surfaces to be flashed.
c. Embed reinforcement in wet coating. Embedment coating should extend 2 inches beyond reinforcement.

3.4 MEMBRANE

A. Install following safety and weather conditions required by manufacturer or as modified by applicable rules and regulations of federal, state, and local authorities having jurisdiction.

B. Following manufacturer's instructions, apply membrane material with a calibrated notched squeegee, trowel, or approved spray equipment to produce a 50-mil minimum dry thickness.

C. Extend membrane over previously flashed areas.

D. Use nonflow membrane material for vertical surfaces.

E. Allow membrane to cure overnight. At temperatures less than 75ºF and relative humidity less than 50 percent, extend curing time.

3.5 PROTECTION

A. Protect cured vertical membranes exposed to backfilling operations with protection board.

B. Butt all boards; do not overlap.

C. Adhere or bond protection boards to membrane as recommended by membrane manufacturer.

3.6 CLEANING

A. Clean stains from adjacent surfaces with toluene, 1-1-1, trichloroethane, xylene, commercial tar remover, or as recommended by the membrane manufacturer.

B. Remove foreign matter from finished membrane surface.

3.7 APPLICATION SCHEDULE

A. Membrane:

1. Apply waterproofing membrane and protection board to exterior surfaces of all below grade walls. Apply membrane from top of footings to 6 inches below finished grade.

END OF SECTION

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SECTION 07 92 00
SEALANTS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Caulking and sealant work required to seal interior and exterior moving and non-moving joints to prevent penetration of light, air, and moisture.

B. Work to be caulked includes:

1. Exterior:

a. Perimeters of exterior openings where door frames or louvers meet adjacent building materials. (1B)
b. Perimeters of exterior openings where aluminum skylight frames or materials meet adjacent building materials. (1E)
c. Expansion joint between concrete slab-on-grade and building walls or other elements. (1A)
d. Joints between dissimilar materials. (1C)
e. Masonry control and expansion joints. (1F)
f. Vertical control and expansion joints. (1D)
g. Horizontal slab saw cut joints. (1G)
h. Concrete joints for aprons, sidewalk, curb and gutter, etc. (1J)

1.2 SUBMITTALS

A. Shop Drawings: Schedule indicating specific locations on project requiring sealants, with indication of sealant system to be used, for review. Include space for selection of color by ENGINEER.

B. Samples: Caulking and sealing compound and all available colors: sealant color selections shall not be limited to “standard” colors. The color selection for sealants will not be limited to one color for each sealant; ENGINEER reserves the prerogative to select different colors for the same sealant condition at interior and exterior conditions. The color of sealants at hollow metal doors and frames, and pre-finished louvers will not be limited to standard colors; ENGINEER will select up to two custom colors if required to match exterior materials.

1. ENGINEER will make an initial selection from color brochures/all available colors.
2. Submit actual material samples of sealant colors designated in initial selection for final review and selection by ENGINEER. ENGINEER may request up to three different wet samples for a final color selection.

C. Administrative:

1. Product Data: Information regarding: performance, use, service temperature range, Shore A hardness, tensile strength at break, tensile elongation, 100 percent modulus, tear strength, and adhesion in peel.
2. Warranty.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver caulking and sealing compounds to the job in unbroken, sealed containers bearing the manufacturer's name, labels, product identification, batch numbers, and mixing

directions. Store materials in sealed containers in a dry protected area above the ground or floor.

B. Protect caulking materials before, during, and after installation. Protect the installed work of other trades during installation.

C. Do not use caulking materials that have been stored for a period of time exceeding the maximum recommended shelf life of the materials.

1.4 WARRANTY

A. 5-year warranty agreeing to repair or replace joint sealers that fail to perform:

1. As air-tight and water-tight joints.
2. Fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability.
3. Appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated.

1.5 JOB CONDITIONS

A. Temperature Conditions: Do not proceed with the installation of sealants under adverse weather conditions when joint to be sealed is damp, wet, or frozen, or when ambient and substrate temperatures are below or above the manufacturer's recommended limitations for installation or below 40ºF (4.4ºC). Consult the manufacturer for specific instructions before proceeding.

B. Environmental Conditions: Do not apply material if it is raining or snowing, or if they appear to be imminent.

PART 2 **PRODUCTS**

2.1 MATERIALS

A. Sealants:

1. POLYURETHANE BASE (Elastomeric), self-leveling; 2 component, chemical cure, conforming to Fed. Spec. # TT-S-00227E, Type I, Class A. Use for joint types: (1A), (4A), (1C), (1G)

   a. Sikaflex - 2C-SL.
   b. Sonneborn - Sonolastic SL 2.

2. POLYURETHANE BASE (Elastomeric), non-sag, 2 component chemical cure, conforming to Fed. Spec. # TT-S-00227E, Type II, Class A. Use for joint types: (1B), (1D), (1F), (2A), (2B), (2D)

   a. Sikaflex - 2C-NS.
   b. Sonneborn - Sonolastic NP 2.
   c. Pecora Dynatrol II.

3. SILICONE (Elastomeric), non-sag, for weatherproofing applications, one-part, natural cure, conforming to Fed. Spec. # TT-S-001543A and TT-S-00230C and ASTM C 920, Type-S, Grade NS, Class 25. Use for joint types: (1E).

   a. GE SCS2000 SilPruf.
   b. Dow Corning 795 or 790.

4. ACRYLIC LATEX (Elastomeric), non-sag, one-part, acrylic latex caulk for use below latex paints; conforming to ASTM C 834. Use for joint types: (2E).

    a. Sonneborn Sonolac.
    b. Pecora AC-20 + Silicone.

5. POLYURETHANE BASE (Elastomeric), self-leveling, one component, conforming to Fed. Spec. #TT-S-00230C, Type I, Class A. Use for joint types: (2C), (1H).

    a. Sikaflex - 1C SL.
    b. Sonneborn Sonolasatic SL 1.

6. SILICONE (Elastomeric), non-sag, one component, conforming to Fed. Spec. #TT-S-001543A Class A. Use for joint type (1J).

    a. Dow Corning 888.

B. Sealant Cord: Provide soft, conformable sealant cord made of 100 percent expanded PTFE, temperature range -450ºF to 600ºF, ASTM F 36 compressibility 55 to 80 percent, and ASTM F 38 creep relaxation 38 to 40 percent.

1. GORE Joint Sealant.
2. INERTEX UHF Joint Sealant.
3. Readi-Seal Expanded PTFE joint Sealant.

C. Joint Backing (Backer Rod):

1. General: Provide sealant backings of material and type which are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
2. Plastic Foam Joint Fillers: Provide preformed compressible, resilient, non-waxing, non-extruding, non-staining strips of flexible, nongassing plastic foam. Provide material nonabsorbent to water and gas; and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

    a. Either open-cell polyurethane foam or closed-cell polyethylene foam, unless otherwise indicated and subject to approval of sealant manufacturer for intended sealant to be used.

D. Sealant Primer: Primer shall be suitable for substrate surfaces as recommended by the sealant/primer manufacturer. Determination if the primer is staining or non-staining must be made prior to application.

E. Bond Breaker: Where joint space does not provide space for foam joint fillers, provide polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure.

F. Semi-Mastic Dampproofing:

1. Sonneborn - Hydrocide 700B.
2. W.R. Meadows - Sealmastic Type 2.
3. Or accepted equal.

G. Cleaning Agent: As recommended by sealant manufacturer.

H. Mechanical Membrane Connections: Provide sealant that conforms to 31 05 19: GEOSYNTHETICS.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect the joint configuration, the joint surface, and backing forming the sealant rabbet (where applicable). Report, in writing, any and all detrimental conditions which may affect the performance of the product.

B. Do not proceed with the installation of sealant if the joint width is less than indicated on the Drawings or less than allowed by the joint sealer manufacturer for the application intended.

C. Surface Condition: Joint surfaces to receive a sealant shall be sound, smooth, clean, dry, and free of all visible contaminants. Review with installer of substrate regarding application of non-visible coatings.

D. Dampproofing

1. Verify that surfaces are solid, free of frozen matter, loose particles, cracks, pits, rough projections, or foreign matter detrimental to adhesion of dampproofing. Follow product manufacturer's requirements for substrate conditions.
2. Do not apply dampproofing to damp, frozen, dirty, dusty, or deck surfaces.
3. Report any condition that may potentially affect proper application. Commencement of work indicates acceptance of surface receiving dampproofing.

E. Acceptance: Beginning of Work means acceptance of existing conditions by installer.

3.2 PREPARATION OF SURFACES

A. Where an irregular surface or sensitive joint border exists apply masking tape at the edge of the joint to insure joint neatness and protection. Remove tape after sealant is applied.

B. Primer: Thoroughly clean joints and apply primer, if recommended by sealant manufacturer, to dry surfaces. Apply primer prior to application of joint backing, bond breaker, or sealants. Protect adjacent surfaces from staining or discoloration.

C. Joint Backing: Install joint fillers to support sealants during applications and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths which allow optimum sealant movement capability.

1. Install joint backing with approximately 30 percent compression.
2. Do not stretch, twist, puncture, or tear joint backing.
3. Butt joint backing at intersections.
4. Remove open-cell joint fillers which have become wet prior to sealant application and replace with dry material.

D. Bond Breaker Tape: Install bond breaker tape smoothly at back of joint where joint backing is not required or cannot be installed. (Sealant shall adhere only to the sides and not to the back of the joint so as to eliminate three-sided adhesion).

E. Dampproofing:

1. Apply dampproofing to clean, dry surfaces.

a. Remove dirt, dust, sand, grit, mud, oil, grease, and other foreign matter.
b. Protect surfaces not to be coated from contamination, discoloration, or other damage with drop cloths or other suitable methods.

2. Prepare substrates receiving dampproofing per product manufacturer's recommendations.
3. Do not add any adulterants or unauthorized thinners. Thinning is only permitted with written approval of ENGINEER.

3.3 INSTALLATION

A. Sealant Application:

1. Apply sealant in accordance with manufacturer's application manual and instructions. Comply with recommendations of Elastomeric Sealant Installation Standard ASTM C 962 and Latex Sealant Installation Standard ASTM C 790.
2. Use hand guns or pressure equipment, with proper nozzle size, on clean, dry, properly prepared substrates. Force sealant into joint and against sides of joint to make uniform. Avoid pulling of the sealant from the sides. Fill sealant space completely with sealant.

B. Joints:

1. Install sealants to depths as recommended by the sealant manufacturer, but within the following general limitations, measured at the center (thin) section of the bead:

   a. For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but neither more than 0.625 inch deep nor less than 0.375 inch deep.
   b. For normal moving joints sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but neither more than 0.5 inch deep nor less than 0.25 inch deep.
   c. For joints sealed with non-elastomeric sealants and caulking compounds, fill joints to a depth in the range of 75 percent to 125 percent of joint width.

2. Install sealant into the prepared joints when the joints are at the midpoint of their designed expansion and contraction cycle.

C. Tooling:

1. Tooling is required to ensure firm full contact with the interfaces of the joint. Tool joints to form smooth, uniform beads with slightly concave surfaces. Finished joints shall be straight, uniform, smooth, and neatly finished. Remove any excess sealant from adjacent surfaces of joint, leaving the work in a neat, clean condition. Tooling agents should only be used if recommended by the sealant manufacturer.
2. Except as otherwise indicated, fill sealant recess to slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that the joint will not trap moisture and dirt.

D. Set all thresholds in full bed of polyurethane based sealant.

E. Dampproofing Applications - General:

1. Extent of application: Apply dampproofing to all building walls below grade where an occupiable space occurs on the opposite side of the wall.
2. Apply Work in accordance with manufacturer's instructions.
3. Do not apply initial coating until moisture content of surface is within moisture limitations of coating manufacturer.
4. Apply products with suitable brushes, rollers, or spraying equipment.

a. Apply at rate as recommended by product manufacturer for the surface involved.
b. Keep brushes, rollers, and spraying equipment clean, dry, free from contaminants, and suitable for the finish required.

5. Apply from 2 inches below finish grade elevation to top of footings, bottom of lower level slab or as shown on the Drawings. Do not permit coating to be applied to top of concrete walls or above specified limits.
6. Comply with recommendation of product manufacturer for drying time between succeeding coats.
7. Make edges of coating adjoining other materials or colors clean and sharp with no overlapping.
8. Seal protrusions through dampproofing. Seal watertight.
9. Inspection:

a. Do not apply additional coats until completed coat has been inspected by ENGINEER.
b. Only inspected coats of paint will be considered in determining number of coats applied.

F. Application - Dampproofing:

1. Provide primer if required by product manufacturer.
2. Apply in two coats with high pile rollers, brush, or air spray equipment recommended by the manufacturer.
3. Application Rate: 30 to 35 square feet per gallon per coat (provide 1/8-inch total thickness).

a. Application rate may vary with manufacturer.

3.4 PROTECTION

A. Complete backfill operations as required by product manufacturer. Place backfill in a manner that will not rupture or damage the film or displace the coating or membrane. Allow for proper cure time. Do not exceed maximum allowed time for dampproofing to be exposed prior to backfilling.

B. Protect finished dampproofing from damage until completion of backfilling.

3.5 CLEANING

A. Clean off excess compound or smears with cleaning material recommended by the manufacturer of the compound.

END OF SECTION

SECTION 10 14 26
SIGN POSTS AND PANELS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Furnishing and installing all sign posts and panels as shown on the plans.

B. Storing and re-installing all sign panels as shown on the plans.

1.2 REFERENCES

A. Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD):

1. Chapter 2B – Regulatory Signs, Barricades, and Gates.

B. THORNTON Standard Specifications:

1. Section 704 Traffic Signing Standards.

1.3 SUBMITTALS

A. Shop Drawings:

1. Sign Layout diagram.
2. Manufacturer's Product Information (Cut Sheets):

a. Sign face material.
b. Pedestal pole and base.
c. Mounting hardware.

PART 2 PRODUCT

2.1 GENERAL

A. All equipment shall meet the requirements of the MUTCD (2009) and THORNTON Standards and Specifications.

B. Signs:

1. Sizes and colors shall be in accordance with MUTCD and THORNTON Standard Specification Section 704.

PART 3 EXECUTION

3.1 GENERAL

A. Coordinate selection of signs with THORNTON.

B. All installations shall be in accordance with MUTCD and THORNTON Standard Specifications Section 704.

C. Replace damaged or defective signs.

END OF SECTION

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SECTION 21 11 00
FACILITY FIRE-SUPPRESSION WATER-SERVICE PIPING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Removal of existing fire hydrant, valve, and associated piping.

B. Installation of fire hydrant, valves, and associated service piping and valves at Memorial Plaza.

1.2 SUBMITTALS

A. Shop Drawings:

1. Dimensional drawings including piping and valve arrangements.
2. Fabricator names and locations for all fire hydrant and valve components. Include factory data sheets.
3. Painting schedule
4. All hydraulic performance information including manufacturers certified statement that the inspection and specified tests in the THORNTON Standards and Specifications have been made the results comply the requirement of applicable standards.

B. Administrative:

1. Work Plan: The plan shall include the following information:

a. Installation procedures for the fire hydrant, service piping, valves, and other materials necessary for installation.
b. Duration of the removal work and duration of the installation work.
c. Plan for isolation of the affected portion of the water line including date/times to be approved by THORNTON.
d. Traffic control required for the Work.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handling

1. According to manufacturer’s recommendations.
2. Handle to prevent damage to the fire hydrant components by impact, bending, compression, or abrasion.

B. Storage

1. Fire hydrant shall be stored in accordance with the manufacturer’s specifications.

1.4 MANUFACTURER

A. Approved manufacturers listed in the THORNTON Standards and Specifications.

B. Other Manufacturers as approved in writing by ENGINEER and approved by THORNTON.

PART 2 PRODUCTS

2.1 FIRE HYDRANT

A. Hydrants shall meet requirements of THORNTON Standards and Specifications, Fire Hydrant Assembly Detail.

2.2 SERVICE PIPING:

A. Ductile iron pipe meeting requirements of THORNTON Standards and Specifications.

B. Polyvinyl chloride (PVC) Pressure Pipe meeting the requirements of THORNTON Standards and Specifications.

2.3 GATE VALVE

A. Gate valve shall meet the requirements of THORNTON Standards and Specifications.

2.4 WARRANTY

A. Warranty:

1. The manufacturer warrants that the water hydrant and other components will be free of defects in workmanship for one year from date of authorized acceptance.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:

1. Provide all materials, equipment, and labor necessary to install all items associated with the fire hydrant, valves, and service piping.
2. Install in accordance with manufacturers recommendation and THORNTON Standards and Specifications.

B. Isolation

1. Coordinate with THORNTON to close gate valves required to isolate the water main prior to construction.

C. Hydrostatic Testing:

1. Hydrostatic static shall be performed in accordance the THORNTON Standards and Specifications

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 PROJECT SCOPE

A. Requirements for the electrical features being furnished and installed under these Specifications shall be in accordance with the requirements of this Section.

B. These Specifications, including the Drawings, outline the general requirements for the electrical design and are based on proposed equipment ratings, locations, and conditions to provide for estimated equipment loads and proposed power and lighting circuit ratings.

C. The CONTRACTOR shall coordinate all electrical installations and designs and shall place the electrical equipment accurately in position; level and plumb, connect, and adjust the electrical equipment; and make the electrical installations ready for service.

D. After the CONTRACTOR has selected the equipment and completed the equipment location, outline and layout drawings, the electrical equipment ratings and power circuits shall be checked, coordinated, and revised as needed.

E. The CONTRACTOR shall furnish and install all materials and equipment and provide all labor required and necessary to complete the work shown on drawings and/or listed below and all other work and miscellaneous items, not specifically mentioned, but inferred for a complete installation, including all accessories and appurtenances required for testing the system. It is the intent of drawings and Specifications that all systems be complete and ready for operation.

F. The CONTRACTOR shall perform electrical systems demolition, cutting and patching for electrical construction, and provide touchup painting.

G. The CONTRACTOR shall contact UNCC 1-800-922-1987 two full working days prior to any digging to request utility system locates. Any system, wire, cable, or piping damaged during the construction process shall be repaired or replaced to the Owner's satisfaction without additional cost to the Owner.

H. The CONTRACTOR shall notify the ENGINEER a minimum of 48 hours prior to any inspection as well as prior to covering up any work.

1.2 RELATED SECTIONS

A. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. The District Guideline "Technical Details Volume I and II" shall also apply to this section.

1.3 REFERENCES

A. The latest edition of the following standards and codes, standard publications of professional organizations, and the State of Colorado are the minimum requirements for this work.

1. American National Standards Institute (ANSI)
2. American Society for Testing and Materials (ASTM)
3. Association of Edison Illuminating Companies (AEIC)

4. Code of Federal Regulations (CFR)
5. Insulated Cable Engineer's Association (ICEA)
6. Institute of Electrical and Electronic Engineers (IEEE)
7. National Electrical Manufacturer's Association (NEMA)
8. National Fire Protection Association (NFPA)
9. NFPA 70, The National Electrical Code (NEC-latest edition)
10. International Energy Conservation Code (IECC)
11. Underwriters' Laboratories, Inc. (UL)
12. State, City, and Local Authorities

1.4 CONTRACTOR SUBMITTALS

A. General

1. All drawings and technical data are required to be furnished by the CONTRACTOR shall be written in English, and all units of measurements shall be in the English system. All drawings shall be made expressly for this Contract. Typical drawings are not acceptable. The drawings and data shall be complete and accurate in their content. Originals and all copies shall be legible. Drawings shall be prepared using AutoCAD format and shall be drawn to scale and shall have neat lettering. Freehand sketches will not be accepted.
2. Shop Drawings shall include bills of material, front views, assembly drawings, mounting details, schematic diagrams, elementary diagrams, block diagrams, and wiring diagrams. Shop Drawings shall show overall dimensions and minimum clearances for all electrical equipment. Full-size drawings shall be submitted.
3. The drawings shall be prepared using graphical symbols and device function numbers conforming to the latest applicable standards of ANSI.

B. Approval Shop Drawings and Data

1. The CONTRACTOR shall furnish Shop Drawings, data, and instructions for the equipment for approval by the ENGINEER.
2. Approval drawings shall show:

a. Equipment locations, outlines, and layouts: Approval drawings and information shall show equipment locations with respect to the structure, enclosure construction, conduit entries where applicable, grounding plan showing ground rod locations, dimensions, arrangement of components within the enclosures, and section arrangement.
b. Bills of material: Bills of material shall give information of each piece of equipment including type, style, manufacturer, and other pertinent information such as scales, trip ratings, settings, and other information, as applicable.
c. Nameplates: Nameplate lists shall provide information on material, sizes, and engraved lettering.
d. Schematic Diagrams: Schematic diagram drawings shall show complete functional operation of the equipment including equipment devices and components that are identifiable by reference to the bill of material item.
e. Wiring diagram: Wiring diagram drawings shall show complete wiring of the equipment devices and components including terminal block numbers and wire (conductor) designations.
f. Manufacturer's data: Manufacturer's data, such as catalog cut sheets, shall be clearly marked to indicate the item being provided. The data shall provide sufficient comprehensive product information to fully demonstrate that the product meets the requirements of these specifications.

C. Final Drawings

D. The CONTRACTOR shall furnish final drawings for all electrical systems. All final drawings shall show all changes and revision dates made up to the time the drawings are furnished. The drawings shall show "as-built" equipment and installations. All drawings furnished shall apply specifically to the equipment actually furnished. No equipment shall be shipped until the drawings have been updated to show the equipment at the time of shipment. The final drawings shall include the requirements of 01 33 00 – Submittals. The following final drawings shall be furnished.

1. Outlines and location of equipment relative to the structure.
2. Grounding plan and location of ground rods and grounding connections.
3. Nameplate lists.
4. Panel Directories.
5. Location of conduit hubs, knockouts, openings, and pull boxes.
6. Schematic diagrams.
7. Wiring diagrams.

E. Test Reports

1. The CONTRACTOR shall submit to the ENGINEER certified copies of test reports as required in Section 26 08 00: TESTING FOR ELECTRICAL SYSTEMS or as required by specific sections of Division 26. Ground resistance or equipment that does not successfully pass the testing requirements, will be rejected. Equipment tests are defined within Section 26 08 00: TESTING FOR ELECTRICAL SYSTEMS and the specific equipment requirement Sections elsewhere in these Specifications.

F. Operation and Maintenance Instructions, Descriptive Data, and Bills of Material

1. Each set of material shall be assembled into one binder with a cover and front index sheet.
2. The operation and maintenance instructions shall be descriptive data that apply specifically to the equipment furnished and shall include the features pertaining to operation, maintenance, control, relaying, instrumentation, programming, and other features.
3. Descriptive data and bills of material shall describe the components furnished. These data shall be such that the components can be identified as to manufacturer, type, rating, characteristics, and other identification so that a component to be replaced could be ordered from the description furnished.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to State of Colorado, and marked for intended use.

B. Comply with NFPA 70, the National Electrical Code (latest edition).

C. All equipment and materials will be new and unused and shall conform with the current applicable industry standards. All equipment and materials shall be installed in compliance with manufacturer’s recommendations and requirements. Workmanship and neat appearance shall be as important as electrical and mechanical operation. Defective or damaged materials shall be replaced or repaired prior to final acceptance in a manner meeting approval of Architect and/or ENGINEER and at no additional cost to Owner.

D. The State of Colorado Department of Regulatory Agencies (Electrical Board) is the Authority Having Jurisdiction for this project.

1.6 DEFINITIONS

A. Instructions such as "Provide" shall mean the same as though the words "This Contractor shall" preceded each such instruction. "Provide" shall mean "Furnish and Install." Where the words "Accepted" or "Acceptable" are used, such "Accepted" or "Acceptable" action by the ENGINEER and/or Architect denotes that the work or equipment item is in conformance with the design concept of the project and, in general, complies with pertinent information given in the Contract Documents.

1.7 SEQUENCING AND COORDINATION

A. The electrical system construction sequence shall follow the general project sequence.

B. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installation.

C. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

D. Coordinate electrical service components (primary feeder(s), utility company transformer, secondary service entrance feeder, main disconnection means and sequence, metering equipment, grounding, etc.) as well as access and connections to utility company equipment furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

E. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, CONTRACTOR shall be responsible for all work required to expose and restore the concealed work in addition to all required modifications.

F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

G. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Electrical equipment and materials shall be as specified on the drawings and in accordance with standards referenced in Article 1.03.

B. All equipment nameplates shall be in English. All signs and symbols shall be in compliance with Section 26 05 53: IDENTIFICATION FOR ELECTRICAL.

C. Mounting bolts, nuts, and washers for items of electrical equipment shall be ASTM A276Type 316 stainless steel. Cadmium-plated mounting hardware will not be permitted.

D. In addition to the electrical materials specified herein, the CONTRACTOR shall furnish and install shims, grout, expansion anchors, wood blocking, anchor bolts, screws, nuts, washers, and all other hardware and incidentals required to complete the electrical installation.

2.2 TOUCHUP PAINT

A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.

B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

2.3 TOOLS

A. The CONTRACTOR shall furnish all special tools and appliances as required for maintenance and adjustment of electrical equipment. The CONTRACTOR shall furnish all additional tools and equipment as necessary to properly install, adjust, and check the operation of the electrical equipment.

PART 3 EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

A. General

1. Installation of electrical equipment shall be in accordance with the manufacturer's installation instructions. Nuts and bolts used in electrical equipment assembly and installation shall be tightened by the use of torque wrenches to torque values recommended by the equipment manufacturer.
2. The CONTRACTOR shall make all electrical wire, cable, conduit, and grounding connections and furnish all miscellaneous materials that are required for making these connections to the equipment.
3. The CONTRACTOR shall drill all holes and provide all fastenings required for mounting or installing electrical equipment and materials.
4. Any electrical equipment installed on concrete foundations shall be given full and even bearing by being grouted in place. Grouting shall be in accordance with Section 03 30 00: CONCRETE.
5. Repair of damage to painted and/or galvanized surfaces shall be made in accordance with manufacturer’s recommendations.
6. Repair or replacement of damaged parts shall be in accordance with Article 1.05.

B. Equipment Identification

1. The completed electrical installation shall be provided with adequate identification of circuits and equipment to assist personnel during maintenance.
2. Nameplates shall be provided for all panelboards, panels, starters, switches, and push button stations. In addition to the nameplates shown, control devices shall be equipped with standard collar type legend plates, as required.
3. Control devices within enclosures shall be identified with nameplates.
4. Terminal strips shall be identified by imprinted marker strips.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Adhere to clearances required by the NEC-latest edition, NFPA 70. Connect for ease of disconnecting, with minimum interference with other installations.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

B. Coordinate the repair and refinish of disturbed finish materials and other surfaces with the appropriate trade to have areas restored to match adjacent undisturbed surfaces. This CONTRACTOR is responsible for all costs of repairs required by work performed by this CONTRACTOR. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.3 FIELD TESTING AND STARTUP

A. After the electrical installations have been completed, the CONTRACTOR shall operationally test the electrical equipment and circuits installed under these specifications, unless specifically indicated otherwise herein, to demonstrate that the requirements of these specifications have been fulfilled.

B. The CONTRACTOR shall have available, at the construction site, drawings that show the electrical installation at the time of the examination, instruction books, equipment tests reports, coordination curves, and data.

C. Immediately prior to the acceptance tests, the CONTRACTOR shall service all electrical equipment in accordance with manufacturer's instructions.

D. While performing the functions of testing and checkout, the CONTRACTOR shall retain full responsibility for the removal and replacement of any wiring connections. The CONTRACTOR shall make wiring changes, setting adjustments, equipment replacements, or other revisions, which are necessary for the proper and adequate functioning of the installation. The CONTRACTOR shall be responsible for and shall replace at the CONTRACTOR’s own expense any wiring, instruments, or equipment which may be damaged in the checkout process.

1. All switches shall be tested for correct operation.
2. All instrumentation systems shall be calibrated and tested for proper operation.
3. The grounding system shall be tested for proper resistance.

3.4 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways
2. Conductors and Cables
3. Supporting Devices for Electrical Components
4. Electrical Identification
5. Cutting and Patching for Electrical Construction
6. Touchup Painting

3.5 CLEANING AND PROTECTION

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Final Acceptance.

3.6 WARRANTY

A. The CONTRACTOR shall warranty all electrical workmanship and materials for a minimum of one year or for the warranty period specified in individual sections, whichever is greater. The warranty period shall extend from the date of Final Acceptance.

END OF SECTION

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SECTION 26 05 19
LOW-VOLTAGE POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SCOPE

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600V and less.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. The latest edition of the following standards and codes are the minimum requirements for this work.

1. Insulated Cable Engineer's Association (ICEA)
2. InterNational Electrical Testing Association (NETA ATS)
3. National Electrical Contractors Association (NECA)
4. National Electrical Manufacturer's Association (NEMA)
5. National Fire Protection Association (NFPA)
6. NFPA 70, The National Electrical Code (NEC-latest edition)
7. Underwriters' Laboratories, Inc. (UL)

1.3 SUBMITTALS

A. The CONTRACTOR shall submit manufacturers' catalog data for the wire and cables in accordance with the requirements of this Section, and Section 26 05 00: COMMON WORK RESULTS FOR ELECTRICAL.

1.4 QUALITY ASSURANCE

A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in Occupational Safety and Health Administration (OSHA) Regulation 1910.7.

B. Comply with NFPA 70.

PART 2 PRODUCTS

2.1 MATERIALS

A. The insulated conductors furnished shall be of the proper voltage rating, type, and size for the application, and shall have been manufactured within twenty four (24) months prior to receipt of the notice to proceed under this contract. All conductors shall be stranded copper unless specifically stated otherwise. All conductors shall be suitable for installation in a vertical position. All conductors shall have an AWG or kcmil designation.

B. 600-Volt, Single Conductor for General Use Other Than Direct Burial: The insulated conductors shall conform to the requirements of NEC-latest edition, shall bear the UL label, shall be suitable for general use other than direct burial, and shall be NEC-latest edition type THW, THWN/THHN or XHHW.

C. Polyethylene warning tape: Polyethylene warning tape for installation above buried power feeders shall be 6 inches wide, yellow in color, with CAUTION printed continuously the full length of the tape.

D. Multiconductor Power and Control Cable: Multiconductor cables shall be provided as noted on the Drawings. The multiconductor cables shall be as follows:

1. 600 volts insulated.
2. Multiconductor type suitable for installation in trays and conduits.
3. Individual conductors shall be insulated with NEC-latest edition type THHN insulation and color-coded.
4. Polyester tape, or equivalent, over the conductor group.
5. Shielded with 100 percent aluminum foil taper and with minimum No. 18 AWG tinned and copper drain wire.
6. An overall covering (jacket) of thermoplastic or neoprene.

    a. Cable with No. 14 AWG individual conductors:

        1) 3/C and smaller - 45 mils thick.
        2) 4/C to 12/C - 60 mils thick.
        3) Over 12/C - 80 mils thick.

E. Instrumentation Cable: The instrumentation cable shall be suitable for all uses and shall be as follows:

1. Twisted pair, individually shielded, having varying lengths of lay to minimize crosstalk.
2. UL listed and labeled, Type TC.
3. Voltage: 300V.
4. Conductors tinned copper, stranded, and No. 18 AWG minimum.
5. Pair Shield: Aluminum coated Mylar with tinned copper drain wire, No. 18 AWG minimum.
6. Jacket: Plenum Rated.
7. Conductor Identification: ICEA S-61-402, black and white in pairs. White conductor printed numerically for group identification.

F. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wires and Cables:

    a. Southwire Company.
    b. The Okonite Company
    c. USA Wire & Cable, Inc.

2. Connectors for Wires and Cables:

    a. AMP Incorporated.
    b. General Signal; O-Z/Gedney Unit.
    c. 3M Company; Electrical Products Division.

2.2 WIRES AND CABLES 600-VOLT NOMINAL OR LESS

A. UL-listed building wires and cables with appropriate ratings for installed application.

B. Rubber Insulation Material: Comply with NEMA WC 3.

C. Thermoplastic Insulation Material: Comply with NEMA WC 5.

D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.

E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.

F. Factory applied color coded insulation the entire length of conductors for all wire.

G. Conductor Material: Copper.

H. Stranding: Solid conductor for No. 10 AWG and smaller (except for Engine/Generator Control Wiring); stranded conductor for larger than No. 10 AWG.

I. Insulation Color: All insulated conductors (service entrance, feeder, and branch circuit) shall have full colored insulation, colors as specified in Section 26 05 53: IDENTIFICATION FOR ELECTRICAL SYSTEMS, for the entire length of the conductor. Neutral conductors installed, in compliance with the NEC-latest edition for each single pole breaker, shall have a tracer stripe to match the phase conductor color. (Contact Omnicable.com / 303-574-9444 or equivalent for striped conductors).

J. Use of AC, MC, NM, ENT, or other manufactured pre-wired systems cable is prohibited.

2.3 CONNECTORS AND SPLICES 600-VOLT NOMINAL OR LESS

A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 “Wire and Insulation Applications" Article.

B. Electrical Tape:

1. Plastic tape, 8.5 mils maximum thickness, 1,000,000 megohms minimum insulation resistance, oil-resistant vinyl backing, oil-resistant acrylic adhesive, incapable of supporting combustion per ASTM D-568 Test Method B.
2. 3M +33 Type.

C. Cable Lubricants:

1. Wire pulling lubricants shall be specifically recommended by the cable manufacturer for assisting in pulling jacketed cables. Cable lubricants shall be soapstone, graphite, or talc for rubber or plastic-insulated cables. Lubricants shall be rated for use in low temperatures (-20º F). Lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.
2. Ideal Yellow #77, Aqua Blue, Poly Water, Dyna Blue or equivalent.

2.4 MISCELLANEOUS WIRING MATERIAL

A. Miscellaneous Connecting and Splicing Devices: Miscellaneous products, such as heat shrink tubing, electrical insulation, plug caps, splices and kits, tapes, terminal blocks, and terminations, shall be approved for the specific application.

B. Joint compounds shall be approved for the specific type metal joint to be prepared.

C. Cable ties, clamps, and identification shall be nylon, self-locking.

D. Fire-seal fittings, certified by UL, for installation where sleeves penetrate fire-rated walls, floors, etc., as required by NEC-latest edition Article 300-21. Size fire seals for the application.

PART 3 EXECUTION

3.1 GENERAL

A. All wiring shall be in compliance with the NEC-latest edition: All single phase branch circuits originating at single pole or multi-pole breakers (120V single phase circuits, or 277V single phase circuits) shall be installed with a dedicated neutral conductor for each phase conductor. The neutral conductor shall have a tracer stripe (the stripe color shall match the color of the phase conductor).

B. All wiring shall be routed through an UL-listed raceway regardless of voltage application, unless specified otherwise on the drawings or under other sections of these Specifications.

C. Derate conductor ampacities based on the NEC-latest edition when more than three current carrying conductors are installed in one raceway.

D. No conductors or cable shall be pulled into any portion of conduit system until all construction work, which might damage the wire, has been completed and raceways have been swabbed. In no case shall wire be left exposed where students and staff may have access.

E. Lubricate cables to facilitate pulling. Lubrication material shall be inert to cable and raceways and rated for -20°F for pulling #4AWG and larger wires.

F. Install compression connectors with hydraulic die, embossing die code into connector. Connect to bus with Belleville type washers for positive pressure over complete contact area. Insulate with heat shrink tubing.

G. Sizes of conduits, unless specifically shown otherwise, shall be determined from Chapter 9 of the latest National Electrical Code based on THW wire in electric metallic tubing.

3.2 INSTALLATION 600 VOLTS, NOMINAL OR LESS GENERAL

A. Unless otherwise indicated, all wiring for branch circuits shall be #12 AWG protected by 20- ampere circuit breakers. Wire size shall be increased to account for voltage drop for all 120-volt circuits over 75 feet, and all 277-volt circuits over 150 feet to the first outlet. Wire size shall be uniform for the entire length of the circuit unless noted otherwise. Homeruns which indicate upgrading circuit conductors for voltage drop, e.g., #10AWG wire on 20-ampere circuit, shall have the conductor size indicated carried throughout the circuit to the last device or fixture.

B. Do not splice feeders or dedicated branch circuits unless otherwise indicated. Install all wire continuous from outlet to outlet or terminal to terminal. Splices in cables when required shall be made in handholes, pull boxes or junction boxes and shall be in strict accordance with cable manufacturer's recommendations utilizing solderless connectors UL approved for the use (splices for pole mounted luminaires shall be made in the curved carlon box installed in the pole base unless the pole base is flush with grade in which case splices shall be made in the pole handhole). Make up splices in outlet boxes with 8 inches of correctly color-coded tails left in box. Splices in wires size #10AWG and smaller shall be made with insulated spring type wire connectors, "Scotchlok." Use UL listed compression

connectors (Ilsco Clear Tap or Burndy Hi Press), for wire splices and taps, #8AWG and larger. All insulating tape used on circuits of 600 volts and less shall be 3-M +33. Tape or heat shrink uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of the conductor. Terminate spare conductors with electrical tape.

C. Make connections, splices, taps and joints with solderless devices, mechanically and electrically secure.

D. Provide a separate neutral for dimmer branch circuits, ground fault interrupter branch circuits, lighting branch circuits serving electronic ballasts.

E. All phase, neutral, and ground conductors shall be tagged with corresponding circuit numbers at panelboard as well as at all junction and outlet boxes.

F. Make all ground, neutral, and line connections to receptacle and wiring device terminals by means of the side terminal screw connections. Branch conductors shall not be connected to the device with backside “push-in” connectors. Provide ground jumper from outlet box to ground terminal of receptacle.

3.3 STORAGE AND HANDLING

A. Store wiring materials in a protected environment not subject to physical damage or the effects of sunlight or inclement weather.

3.4 FIELD QUALITY CONTROL

A. Wire and Cable Tests (600 Volts): Measure the insulating resistance of service entrance conductors, feeder circuit conductors, and service ground. Measurements shall be taken between conductors and between conductors and ground. Resistance shall be 1,000,000 ohms or more when tested at 500 volts by megger without branch circuit loads. Tests and procedures shall meet the approval of the ENGINEER and shall be in accordance with the applicable ICEA standards for the wires and cables to be installed. Furnish all instruments, equipment, and personnel required for testing, and conduct tests in the presence of the ENGINEER. Submit written reports of the tests and results to the ENGINEER.

B. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL

PART 1 GENERAL

1.1 SCOPE

A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)
ANSI/ASTM B3 Soft or Annealed Copper Wire
ANSI/ASTM B8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ANSI/UL 467 Grounding and Bonding Equipment

B. NFPA70 - NATIONAL ELECTRICAL CODE (NEC-latest edition)

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the State of Colorado, and marked for intended use.

1. Comply with UL 467.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Grounding Conductors, Cables, Connectors, and Rods:

a. ILSCO.
b. Kearney/Cooper Power Systems.
c. Lyncole XIT Grounding.
d. O-Z/Gedney Co.; a business of the EGS Electrical Group.
e. Raco, Inc.; Division of Hubbell.
f. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Low-Voltage Power Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.

H. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type. Burndy Hi-Press series lugs, ILSCO Clear Taps may be used for wire sizes #8 through 500kcmil.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Sectional type; copper-clad steel.

1. Size: 3/4 in diameter by 120 inches.

PART 3 EXECUTION

3.1 APPLICATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. In raceways, use insulated equipment grounding conductors.

C. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.

D. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and branch circuits. This grounding conductor shall be in addition to the ground path provided by the continuously grounded metallic raceway system that encloses the phase and neutral conductors. Where there are parallel feeders installed in more than one raceway, each raceway shall have a green insulated equipment ground conductor. Provide ground bushings bonded to grounding conductor at both ends of all feeder conduits.

C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

3.3 INSTALLATION

A. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
2. Interconnect ground rods with grounding electrode conductors. Use exothermic weld connections without exposing steel or damaging copper coating.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

B. All connections to ground buses shall be by mechanical means.

C. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors. Use Burndy QGFL 34 B1 type connectors for attachment to building steel.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate both ends of conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

G. Compression-Type Connections (#8 and Larger): Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

H. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate the entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

A. Tests: Perform the following field quality-control testing:

1. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.
2. Test completed grounding system at each service disconnect enclosure grounding terminal, the maximum ground-resistance shall not exceed 5 ohms. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.
3. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify ENGINEER promptly and include recommendations to reduce ground resistance.

B. Final testing and reporting shall be performed by the independent testing firm.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SCOPE

A. The CONTRACTOR shall furnish and install supports, fasteners, and anchors for all electrical conduits; boxes, switchboards, panelboards, transformers, and accessories required for a complete and secure electrical system. The term "conduit" shall be considered synonymous with the term "raceway" as defined in Article 100 of the National Electric Code (NEC)-latest edition.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. The latest edition of the following standards and codes, are the minimum requirements for this work.

NFPA No. 70 National Electrical Code (NEC-latest edition)

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. For structures assigned to Seismic Design Category B, C, D, E or F, where the requirements of Section 13.2.1 of American Society of Civil Engineers (ASCE) 7 for nonstructural components, supports or attachments are met by seismic qualification as specified in Item 2 therein, components shall meet the seismic qualification by analysis, testing or experience data. Certificates of compliance for the seismic qualification shall be submitted to the Building Official/Authority Having Jurisdiction.

2.2 SUPPORTING DEVICES FOR ELECTRICAL COMPONENTS

A. Provide hangers and supports to support raceways, fixtures, cabinets, boxes, etc. as manufactured by B-Line, Unistrut, Binkley or Kindorf.

B. Material: Cold-formed steel, with corrosion-resistant coating.

C. Metal Items for Use Outdoors or in Damp Locations: Steel, hot-dip galvanized after fabrication.

D. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch (14-millimeters (mm)) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.

1. Channel Thickness: Selected to suit structural loading.
2. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

F. Pipe Sleeves: American Society for Testing and Materials International (ASTM) A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

G. Fabricated supports, use structural steel or steel channel, rigidly welded or bolted to present a neat appearance.

H. Expansion Anchors: Carbon-steel wedge or sleeve type. Anchors shall be removable type.

I. Toggle Bolts: All-steel springhead type.

J. Mounting bolts, nuts, and washers for items of electrical equipment shall be ASTM A276Type 316 stainless steel. Cadmium-plated mounting hardware will not be permitted.

K. Perforated pipe strap and wire supports are prohibited.

L. Powder-actuated anchors are prohibited without specific written permission.

M. Concrete housekeeping pads for transformers and free standing floor mounted switchgear enclosures and cabinets shall be in compliance with Division 3 Concrete. Housekeeping pads shall be a minimum of four inches high and extend 3 inches beyond the footprint of the supported equipment.

PART 3 EXECUTION

3.1 GENERAL

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC-latest edition requirements.

1. Fasten supports directly to structure. Do not fasten supports to piping, ductwork, mechanical equipment, conduit, or ceiling system suspension wires or wire of any type.
2. Drilling or other modification of structural steel members is prohibited without specific written permission from the structural ENGINEER.

B. Coordinate with the building structural system and with other electrical installation.

C. Electrical system layouts indicated on drawings are generally diagrammatic, but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

D. Consult all other drawings. Verify all scales and report any dimensional discrepancies or other conflicts to Architect before submitting bid.

E. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect, and conform to all structural requirements when cutting or boring structure is necessary and permitted.

F. Raceway Supports: Comply with the NEC-latest edition and the following requirements:

1. 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. Provide a minimum of 20 percent space available for future raceways for all multiple raceway supports.
2. Support parallel runs of horizontal raceways together on trapeze-type hangers.

3. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
4. Space supports for raceways in accordance with NEC-latest edition, but in no case shall support spacing exceed 8-feet between supports or 2-feet from any box or conduit body.
5. Support raceway within 1 foot of box and access fittings.
6. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway connections.
7. Wire will not be allowed for conduit support.

G. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors or preset inserts.

H. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls.

I. Use expansion anchors or preset inserts in solid masonry walls

J. Use self-drilling anchors or expansion anchor on concrete surfaces

K. Use sheet metal screws in sheet metal studs.

L. Use hexagon head bolts with spring lock washers under all nuts.

M. Sleeves: Install in concrete slabs and walls for raceways and cable installations. All penetrations through walls and floors shall be sealed. For non-rated walls and floors apply additional materials used in penetrated wall construction (grout, gyp-board, and tape, etc.) or non-rated gap sealant.

END OF SECTION

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SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL GENERAL

PART 1 GENERAL

1.1 SCOPE

A. The CONTRACTOR shall furnish and install all electrical conduits; boxes, and accessories required for the installation of conductors for the power, control, and instrumentation services. The term "conduit" shall be considered synonymous with the term "raceway" as defined in Article 100 of the National Electric Code (NEC)-latest edition.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. The latest edition of the following standards and codes are the minimum requirements for this Work.

American National Standards Institute (ANSI) C80.1 Rigid Steel Conduit, Zinc-coated
ANSI C80.6 Intermediate Metal Conduit, Zinc-coated ANSI C80.3 Electrical Metallic Tubing, Zinc-coated
National Electrical Manufacturers' Association (NEMA) FB 1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies
NEMA RN 1 Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
NEMA TC2 Rigid Nonmetallic Conduit (Schedule 40 and Schedule 80) NEMA TC 3PVC Fittings for Use with Rigid PVC Conduit and Tubing
National Fire Protection Association (NFPA) No. 70 National Electrical Code (NEC-latest edition)
Underwriters Laboratories Inc. (UL)-651 Standard for Safety Schedule 40 and 80 PVC Conduit

B. Sizes of conduits, unless specifically shown otherwise, shall be determined from Tables in Chapter 9 of latest NEC-latest edition).

PART 2 PRODUCTS

2.1 RACEWAYS AND FITTINGS

A. Metallic Conduit Systems:

1. Electrical Metallic Conduit (EMT). EMT shall be zinc-coated steel, galvanized on the outside, and coated on the inside with a hard smooth lacquer finish. EMT fittings shall be steel set-screw type with insulated throats.
2. Flexible Metal Conduit (FMC): FMC shall be single strip, continuous, flexible interlocked double-wrapped steel, zinc-coated inside and out forming smooth internal wiring channel with steel compression fittings.
3. Intermediate Metal Conduit (IMC): IMC shall be hot-dipped galvanized with a zinc-coating. Fittings shall be steel threaded type.
4. Liquid tight Flexible Steel Conduit (LFSC): FLSC shall be zinc-coated steel the same as FMC except with sunlight-resistant and mineral-oil-resistant plastic jacket. Fittings shall be cast malleable iron or steel body and gland nut, cadmium-plated with one-piece brass grounding bushings threaded to interior of conduit. Provide

spiral molded vinyl sealing ring between gland nut and bushing and nylon insulated throat.

5. Rigid Steel Conduit (RSC): RSC shall be heavy wall, hot dipped galvanized steel inside and out with threaded ends. RSC fittings shall be steel, threaded type. Plastic-coated Rigid Steel Conduit shall be rigid galvanized steel conduit having a 0.030 inch (.762 millimeter (mm)) minimum thick factory-bonded PVC jacket, using pre-jacketed couplings as manufactured by Pittsburgh Robroy, Plastic Applicator, Occidental or approved equal.

B. Nonmetallic Conduit Systems:

1. Rigid Nonmetallic Conduit (RNC): RNC shall be PVC Schedule 40 or 80 suitable for 90°C. Provide solvent cemented type fittings matched to conduit type and material.
2. Liquidtight Flexible Nonmetallic Conduit (LFNC): LFNC shall comply with UL3.

C. Metal Wireways: Wireways shall be hinged cover or screw cover complete with all necessary manufactured fittings which shall be of one manufacturer. Wireways shall be G.E. Type HS or ITE KEL Duct or acceptable equal.

1. Material: Sheet metal sized and shaped as indicated.
2. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system. Provide wire retainers at not greater than 12 inches (300 mm) on center.
3. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
4. Wireway Covers: Hinged type.
5. Exterior, wet, or damp locations shall be NEMA 250 Type 3R.
6. Finish: Manufacturer's standard enamel finish.

D. Bushings: For steel conduit larger than 1/2-inch size, provide insulated type bushings, designed to prevent abrasion of wires without impairing the continuity of the conduit grounding system. Grounding bushings shall be locking type and shall be provided with a feed-through compression lug for securing the ground cables. Unions shall be electro-galvanized ferrous alloy type Appleton UNF or UNY, Crouse-Hinds UNF or UNY, or equal.

Grounding bushings shall be steel type and installed at both ends of the conduit on all feeders, as well as all transformer, motor, motor controller, kitchen, and TVSS equipment branch circuits.

E. Sealing Fittings: Provide threaded, zinc or cadmium coated, cast or malleable iron type for steel conduits. Fittings used to prevent passage of water vapor shall be of the continuous drain type.

F. Provide minimum 3/4-inch conduit for all circuit homeruns from the source panel to the first device.

G. Use of MC cable is prohibited except for luminaire connection whips.

H. Use of AC, NM, ENT, or other manufactured pre-wired systems cable is prohibited.

2.2 OUTLET, JUNCTION AND PULL BOXES

A. Acceptable Manufacturers:

1. Boxes and Cabinets; Bell, Bowers, Raco, Steel City, Appleton, Carlton, Lew Electric, National Electric Products, or equivalent.
2. Floor boxes; Walker, Hubbell, Raceway Components Inc., Bowers, Rotco Inc., Steel City, Appleton, Lew Electric, or equivalent.

B. Outlet, Junction and Pull Boxes:

1. Cast Type Boxes: Cast type boxes shall be ferrous alloy and have gasketed cast covers and inside threaded hubs with adapters as necessary. Cast-metal boxes shall comply with NEMA 3R. Covers shall be cast metal weatherproof while in-use type.
2. Galvanized Pressed Steel Type Boxes: Boxes shall be pressed steel, galvanized or cadmium-plated (4-inch by 2 1/8 inch deep minimum square for all wall locations, 4 11/16-inch by 2 1/8 inch deep minimum square for all above ceiling locations), with galvanized cover or extension ring as required (extension rings are not allowed on new construction, one extension ring is allowed on existing recessed boxes where conductor length will still comply with the latest NEC requirements). Knockout type shall be used with knockouts removed only where necessary to accommodate the conduit entering. Boxes shall comply with NEMA OS 1. Provide a grounding terminal in each box containing a green equipment ground conductor, or serving motors, lighting fixtures, or receptacles. Grounding terminal shall be green-colored washer-in-head machine screw or grounding bushing.
3. Field gang type boxes are prohibited in all applications and extension boxes are prohibited on new construction.
4. Floor Boxes and Fittings:

    a. General: Provide surface floor boxes and fittings of the types, ratings, and configurations as shown on the Drawings.

5. Cover and Device Plates: Provide device plates for each switch, receptacle, signal and telephone outlet, and special purpose outlet. Do not use sectional gang plates. Provide multi-gang outlet plates for multi-gang boxes. Provide high impact thermoplastic or nylon for devices in finished areas, and galvanized steel on surface-mounted devices in unfinished areas, unless otherwise selected by Architect. Surface outlet coverplates shall have beveled edges. Color of thermoplastic device plates shall be the same as the device or as selected by Architect.
6. Cut-in/after-set boxes are not allowed.

C. Metal Pull Boxes: Pull boxes shall be screw cover complete with all necessary manufactured fittings which shall be of one manufacturer.

1. Material: Sheet metal sized and shaped as indicated.
2. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
3. Exterior, wet, or damp locations shall be NEMA 250 Type 3R.
4. Finish Manufacturer's standard enamel finish.

D. Flush with grade enclosures and pull boxes shall be QUAZITE® as manufactured by Strongwell or approved equal. The pull/splice box shall be constructed of polymer concrete consisting of sand and aggregate bound together with a polymer resin. Internal reinforcement may be provided by means of steel, fiberglass, or a combination of the two. Boxes and covers shall be concrete gray, and sustain a minimum vertical test load of 22,568# over a 10 inch square. Boxes shall be stackable for extra depth.

PART 3 EXECUTION

3.1 GENERAL

A. Electrical system layouts indicated on drawings are generally diagrammatic but shall be followed as closely as actual construction and work of other trades will permit. Govern exact routing of raceways and locations of outlets by structure and equipment served. Take all dimensions from architectural drawings.

B. Consult all other drawings. Verify all scales and report any dimensional discrepancies or other conflicts to Architect before submitting bid.

C. All home runs to panelboards are intended to be started from outlet nearest panel and continuing in general direction of that panel. Continue such circuits to panel as though routes were completely indicated. Terminate homeruns of signal, alarm, and communications systems in a similar manner.

D. Avoid cutting and boring holes through structure or structural members wherever possible. Obtain prior approval of Architect and conform to all structural requirements when cutting or boring structure is necessary and permitted.

E. Furnish and install all necessary hardware, hangers, blocking, brackets, bracing, runners, etc. required for equipment specified under this section.

F. Raceways shall be installed and complete prior to pulling any wire into raceway.

3.2 RACEWAYS - GENERAL

A. Protect all non-PVC coated metallic raceway in earth or fill from corrosion with two coats of corrosion resistant paint or tape wrap.

B. Elbows for conduit installed below grade or floor slabs and vertical conduit risers to above grade or floor slabs shall be rigid steel conduit with factory PVC coating or two coats of corrosion resistant paint or tape wrap.

C. Tie embedded raceways securely in place prior to concrete placement. Raceways installed below floor slabs shall extend a minimum of 4 inches (100 mm) above the finished slab or housekeeping pad to the first connector. Install capped bushings on conduit stub ups.

D. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb. (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire. Tag both ends noting destination.

E. Use temporary raceway caps to prevent foreign matter from entering conduits.

F. Make all bends using an approved bending tool. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated. Cut all conduits square and ream all cuts to remove burrs. Exercise all necessary precautions during the construction period to prevent entry or accumulation of moisture, dust, concrete, and all foreign matter into the raceway system. The contractor shall pull a mandrel through each raceway to ensure the raceway interior is clean and dry prior to pulling conductors or cable.

G. Make bends in exposed parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for exposed parallel raceways.

H. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72 inch (183 cm) liquid tight flexible conduit. Install separate ground conductor across flexible connections.

I. Above grade - defined as areas above finished grade for a building exterior and above top surface of any slabs (or other concrete work on grade) for a building interior. Installation of and materials for above-grade raceways shall conform with the following:

1. Install conduit concealed within finished walls, ceilings, and floors except at surface cabinets, for motor and equipment connections, and in building service equipment rooms unless otherwise indicated. Surface metal raceways shall be used where raceways are specified or allowed to be installed exposed in finished areas.
2. Route all conduit/raceways, exposed and concealed, parallel or perpendicular to building lines with right angle turns and symmetrical bends.
3. Paint all surface conduit, installed in finished areas, to match the adjacent surfaces on which it is mounted.
4. Install raceways a minimum of 6 inches (150 mm) away from parallel runs of flues and steam pipes or other heated lines. Locate horizontal raceway runs above water and steam piping.
5. Install raceways a minimum of 6 inches below the roof deck.
6. Provide for waterproofing of all raceways, outlets, fittings, etc. which penetrate exterior walls or the roof to preserve the weatherproof integrity of the building. Provide pockets for waterflashing and counterflashing or pitch pockets for waterproofing of all raceways, outlets, fittings, etc. which penetrate roof. Wherever conduits penetrate concrete walls to outdoors, the CONTRACTOR shall provide a watertight seal as manufactured by O.Z. Gedney Company, Type CSMC; Thunderline Corporation, Link Seal, or equal.
7. Raceways between cabinets, fittings or boxes shall not exceed 200 feet (60 m) for straight runs or 100 feet (30 m) for runs with the maximum number of bends.
8. Provide one empty 3/4-inch (20 mm) conduit for each set of three spare circuit breakers or spaces in flush-mounted panelboards into the overhead accessible ceiling space.
9. Raceways Above Suspended Ceilings:

    a. Raceways shall not be supported from ceiling support wires. Provide independent support of raceways.
    b. Install conduit 1 foot (300 mm) minimum above top of ceiling.

10. Rigid metallic steel conduit shall be installed in the following above-grade areas:

    a. Where exposed/surface mounted, exterior locations, and where subject to damage. Rigid steel conduit shall extend to a minimum of 8 feet above finished floor/grade.
    b. Where specifically required by the National Electrical Code - 2008.

11. Electrical Metallic Tubing (EMT): May be installed in:

    a. Concealed locations in furred or masonry walls or ceilings.
    b. Embedded in poured insulating fills.
    c. Exposed areas at least 4 feet (2.5 m) above floor.

12. Liquid tight flexible metal conduit shall be provided in sufficient lengths for makeup of motors, transformers, or equipment, and/or raceway connections where isolation of sound and vibration transmission is required. Liquid-tight flexible metal conduit shall contain a separate equipment grounding conductor, sized per NEC-latest edition requirements.

13. Flexible metallic 3/8-inch (10 mm) fixture whip connections to recessed lighting fixtures shall not exceed 6 feet (1.8 m) in length.
14. Surface raceways, where indicated on drawings, shall be metal and of a size approved for number and size of wires to be installed and shall be installed in a neat, workmanlike manner, with runs parallel or perpendicular to walls and partitions. Raceways, elbows, fittings, outlets and devices shall be of same manufacturer, and designed for use together.
15. Conduit Supports and Fasteners:

    a. Supports: Provide supports for horizontal steel conduits and EMT not more 2 feet from boxes and conduit bodies, and not more than 8 feet (2.5 m) apart with one support near each elbow or bend, including runs above suspended ceilings.
    b. Individual: Install spring steel fasteners with hanger rods on conduits 1-1/2 inch (40 mm) or smaller. Install individual pipe hangers for conduits larger than 1-1/2 inch (40 mm).
    c. Trapezes: Install multiple (trapeze) pipe hangers where two or more horizontal conduits run parallel and at the same elevation. Secure each conduit to the horizontal hanger member by a U-bolt, one-hole strap or other specially designed and approved fastener. Install 3/16-inch (5 mm) diameter or larger steel rods for trapezes, spring steel fasteners, clips and clamps. Wire or perforated strapping shall not be used for the support of any conduit.
    d. Roof Top Conduit Support: Fasten pipe to stands specifically manufactured for support of pipes installed on roofs. Stands shall support pipe a minimum of 6 inches above the roof and be resistant to damage from environmental conditions and other causes such as birds. Stands shall be Caddy Pyramid 50 series or equivalent. Support stands requiring fastening through the roof membrane are prohibited.
    e. Fastening: Fasten pipe straps and hanger rods to concrete by means of inserts or expansion bolts, to brickwork by means of expansion bolts, and to hollow masonry by means of toggle bolts. Wooden plugs and shields shall not be used. Power-driven fasteners may be used to attach pipe straps and hanger rods to concrete where approved by Architect. Install raceway on steel construction with approved clamps which do not depend on friction or set-screw pressure alone.

16. Fittings: Use approved type couplings and connectors in all conduit runs, and make all joints tight. Provide insulated bushings or rain-tight connections with insulated throats for all terminations in pipe sizes 1-1/4" (32 mm) and larger. Provide waterproof fittings for all runs in wet locations, such as exposed to weather, buried in slabs, etc. Provide raceway expansion joints, in compliance with NEC-latest edition and approved by the State, with necessary bonding conductor at building expansion joints, between structures and where required to compensate for raceway or building thermal expansion and contraction.
17. Firestops and seals shall be provided for penetrations through fire-rated walls and floors. Firestops and seals shall be 3M's fire barrier sealant CP 25WB and/or composite sheets #CS195, or equal, and shall be applied in accordance with manufacturer's recommendations. Products which are affected by water are not acceptable.

J. Below Grade: Defined as area below finished grade for a building exterior and below bottom floor slab for a building interior. Installation of and materials for below-grade raceways shall conform with the following:

1. Elbows for conduit installed below grade or floor slabs and vertical conduit risers to above grade or floor slabs shall be rigid steel conduit with factory PVC coating or two coats of corrosion resistant paint or tape wrap.
2. Below-grade raceways shall turn up and extend 48 inches minimum above floor or equipment foundation.
3. Install conduits below slab-on-grade concrete 12 inch minimum below bottom of concrete slab unless shown otherwise on the drawings.
4. Install exterior underground conduits 30 inch minimum below finished grade unless shown otherwise on the Drawings.
5. Non-encased Raceways: Unless specifically noted on Drawings for concrete encasement, provide either of the following raceway systems for installation below slabs on grade or in earth or gravel.

    a. Rigid, heavy-wall, Schedule 40 or 80, polyvinyl chloride PVC plastic conduit, suitable for direct burial. All offsets and 90-degree ells shall be rigid plastic-coated conduit. Provide continuous ground wire for all non-metallic conduits.
    b. Rigid steel conduit that is not completely encased in concrete but is in contact with ground or on a vapor barrier shall be wrapped with Scotchrap 51 half-lapped, or shall have an additional outside factory coating of polyvinyl chloride with a minimum coat thickness of 30 mils (0.762 mm). Other PVC or Phenolic-resin-epoxy coating material, which is equally flexible and chemically resistant, may be used providing approval by the ENGINEER is obtained prior to installation. Provide pre-jacketed couplings to provide a substantially watertight jacketing system.
    c. All underground conduits and ducts 2 inches (50 mm) and larger shall be proven clear by pulling through a ball mandrel (diameter approximately 85% of conduit inside diameter) followed by close fitting wire brush and wad of felt or similar material. Clear raceway of all obstructions and dirt prior to pulling in wires or cables. Clean empty raceways similarly. Clear or replace any raceway which rejects ball mandrel.
    d. Provide seal-off fittings where conduits enter or leave hazardous wiring area or areas of widely different temperature and/or humidity.

6. Non-Metallic Raceway Installations:

    a. Joints shall be made using the material recommended by the raceway manufacturer. Components shall be cleaned prior to assembly.
    b. Raceway cutoffs shall be square and shall not deform conduit. Ream rough surfaces.
    c. Provide male box adapters to terminate raceways.
    d. Where separable terminations are required, provide PVC threaded adapters with locknuts or bushings. Provide "O" rings for watertight installations.
    e. Bends shall be made by methods that do not deform or damage the conduit.
    f. Provide expansion fittings where required in compliance with NEC-latest edition and approved by the State.
    g. Raceway supports shall be installed to allow the non-metallic conduit to slide through the supports.
    h. Non-metallic raceway is not permitted within the building.

3.3 OUTLET, JUNCTION AND PULL BOXES

A. Provide galvanized or zinc-coated, pressed steel outlet boxes for all locations except where otherwise indicated or where cast metal boxes are required by the NEC-latest edition.

Provide plaster or tile rings for all flush outlets installed where wood, drywall, tile, plaster, etc. types of finishes are applied. All outlets for exterior application shall be cast, weatherproof type, with gasket and cast coverplate. Tile boxes of extra depth may be used for interior, dry applications where masonry block or brick walls constitute the finished wall surface. In any event, provide outlet boxes of proper type and design for the particular fixture or device to be installed. Structural conditions and obstructions or other equipment items shall govern exact location of outlets and equipment.

B. Junction and Pull Boxes: Use outlet boxes as junction boxes wherever possible. Larger junction and pull boxes over 12 inches (300 mm) in any dimension shall be fabricated from sheet steel, sized according to NEC-latest edition, and have screw-on covers. All junction boxes shall be accessible.

C. Surface-mounted device boxes mounted below 8 feet shall be Surface Metal Raceway boxes or (Bell) cast-type boxes with threaded knock-outs (with knock-outs only as required by conduit entering/leaving).

D. Flush with Grade Pull Boxes: Provide junction/pull boxes wherever underground conduit runs exceed 500 feet or where required to comply with the maximum number/radius of bends per the NEC. Junction/Pull boxes shall be sized according to NEC-latest edition and have lockable screw-on covers. All junction boxes shall be accessible.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL

PART 1 GENERAL

1.1 SCOPE

A. This Section includes electrical identification materials and devices required to comply with American National Standards Institute (ANSI) C2, National Fire Protection Association (NFPA) 70, Occupational Safety and Health Administration (OSHA) standards, and the State of Colorado.

B. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 REFERENCES

A. NFPA 70 National Electrical Code (NEC)(-latest edition)

B. NESC National Electrical Safety Code

1.3 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

C. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4- millimeters (mm)) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

D. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

E. Tape Labels: Embossed adhesive tape, with 3/16 inch white characters.

F. "Kroy" Labels: Kroy tape with 3/8 inch minimum characters.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with 29 Code of Federal Regulations (CFR), Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum 1/16-inch (1.6 mm) thick for signs up to 20 square inches (129 square cm) and 1/8-inch (3.2 mm) thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.

C. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

C. Polyethylene warning tape: Polyethylene warning tape for installation above buried power feeders shall be 6 inches wide, yellow in color, with CAUTION printed continuously the full length of the tape.

PART 3 EXECUTION

3.1 INSTALLATION

A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

C. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations. Use consistent designations throughout Project.

1. White characters on black background for "Normal",
2. White characters on red background for "Emergency" and fire alarm devices
3. White characters on green background for "Ground".

D. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime surfaces using type of primer specified for surface.
3. Apply one intermediate and one finish coat of enamel.

E. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:

1. Apply the following colors to the systems listed below:

a. Fire Alarm System: Red
b. Emergency Power System: Red

F. Device Coverplates: Use preprinted label for identification of circuits at all individual wall switches and receptacles, control device stations. Locate label on the front side of the coverplate as well as identify circuits with permanent ink on the backside of the coverplate.

G. Wire Identification: Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number as indicated on equipment manufacturer's shop drawings for control wiring.

H. Junction Box and Pull Box Identification: Use an indelible black marker to inscribe circuit or bus, switch numbers, and source panel on the outside of each junction and pullbox cover.

I. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

J. Secondary Service, Feeder, and Branch-Circuit Conductors: Factory Color-coded insulation throughout the entire length of the conductor

1. Color-code 208/120-volt system as follows:

a. Phase A: Black
b. Phase B: Red
c. Phase C: Blue
d. Neutral: White with a phase colored stripe
e. Ground: Green

2. Color-code 480/277-volt system as follows:

a. Phase A: Brown
b. Phase B: Orange
c. Phase C: Yellow
d. Neutral: Gray with a phase colored stripe
e. Ground: Green

3. Lighting Controls:

a. Yellow

4. Factory applied colored insulation the entire length of all conductors.

K. Equipment Identification Labels: Engraved plastic laminate. Install on ceiling grid or access door below each electrical device or electrical unit of equipment installed above the ceiling. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

L. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

1. Distribution and control equipment

a. Identify equipment as well as loads served.
b. 1/4-inch lettering for equipment designation.

c. 1/8-inch lettering to identify voltage rating, fault current rating, and source.
d. 1/8-inch lettering for individual switches identifying loads served.

2. Panelboards, Switchboards, electrical cabinets, and enclosures:

a. 1/4-inch lettering for equipment designation
b. 1/8-inch lettering to identify voltage rating, fault current rating, and source.

3. Individual Control Equipment (timeclocks, lighting control relay cabinets, and contactors) Circuit Breakers and Switches in Panelboards and Switchboards:

a. 1/8-inch lettering to identify circuit and load served, including location.
b. 1/8-inch lettering to identify voltage rating, fault current rating, and source.

4. Individual Circuit Breakers, Enclosed Disconnect Switches, and Motor Starters:

a. 1/8-inch lettering to identify load served.
b. 1/8-inch lettering to identify voltage rating, fault current rating, and source.

END OF SECTION

SECTION 26 08 00
TESTING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 PROVISIONS

A. The drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.2 TEST REPORT SUBMITTALS

A. Provide a single submittal with examples of test reports for each system to be tested to the OWNER/ARCHITECT/ENGINEER prior to testing in accordance with Division 1.

B. Submit results of testing (1 hard copy and 1 electronic (PDF) copy) for each system to the OWNER/ARCHITECT/ENGINEER when complete in accordance with Division 1.

1.3 SCOPE

A. The CONTRACTOR shall perform routine insulation resistance, continuity, and rotation tests for all distribution and utilization equipment prior to any acceptance testing.

B. The CONTRACTOR shall perform visual and mechanical inspections, verifying that the equipment nameplate information meets the intent of the drawings and specifications.

C. It is the purpose of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications and manufacturer's requirements.

D. The tests and inspections shall determine suitability for energization. Equipment shall not be energized until accepted by the testing firm.

E. The CONTRACTOR shall supply a suitable and stable source of power to each test site.

F. The CONTRACTOR shall maintain a written record of all tests, and upon completion of the project shall assemble and certify a final test report to ARCHITECT/ENGINEER/OWNER.

1.4 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act
2. Accident Prevention Manual for Industrial Operations, National Safety Council
3. Applicable state and local safety operating procedures
4. Owner's safety practices
5. National Fire Protection Association (NFPA) - NFPA 70E
6. American National Standards for Personnel Protection

1.5 QUALIFICATIONS OF TESTING PERSONNEL

A. The testing personnel shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

B. The lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing or equal.

C. The terms used herewithin, such as test agency, test contractor, testing laboratory, or contractor test company, shall be construed to mean the testing personnel.

D. Test Equipment Suitability: Comply with NETA ATS, Section 5.2.

E. Test Equipment Calibration: Comply with NETA ATS, Section 5.3.

1.6 APPLICABLE CODES, STANDARDS, AND REFERENCES

A. All inspections and tests shall be in accordance with the following codes and standards except as provided otherwise herein:

1. National Electrical Manufacturer's Association - NEMA
2. American Society for Testing and Materials - ASTM
3. Institute of Electrical and Electronic Engineers - IEEE
4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1999
5. American National Standards Institute - ANSI C2: National Electrical Safety Code
6. Codes and ordinances of the State, County, and City
7. Insulated Cable Engineers Association - ICEA
8. Association of Edison Illuminating Companies - AEIC
9. Occupational Safety and Health Administration - OSHA
10. National Fire Protection Association - NFPA

a. ANSI/NFPA 70: National Electrical Code
b. ANSI/NFPA 70B: Electrical Equipment Maintenance
c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces
d. ANSI/NFPA 780: Lightning Protection Code
e. ANSI/NFPA 101: Life Safety Code

B. All inspections and tests shall utilize the following references:

1. Project design specifications
2. Project design drawings
3. Manufacturer's instruction manuals applicable to each particular apparatus

PART 2 PRODUCTS

2.1 NOT USED

PART 3 EXECUTION

3.1 SWITCHGEAR, SWITCHBOARDS, AND PANELBOARDS

A. Visual and Mechanical Inspection:

1. Inspect for physical damage.
2. Verify proper installation. This includes alignment, anchorage, clearances, grounding, bending radius of cables, wiring aesthetics, etc.
3. Inspect for proper identification, nameplate ratings, sizes of protective devices, switches, and busses, and adherence to one-line diagrams.
4. Check tightness of accessible bolted bus joints, cable connections, and anchor bolts.

5. Physically test all electrical or mechanical interlocks to assure proper function.
6. Inspect for proper operation of space heaters and thermostat settings (if applicable)
7. Clean interior and insulator surfaces.
8. Exercise all active components and verify proper barrier and shutter installation and operation.
9. Verify proper neutral and ground connections.
10. Implement settings of overcurrent protective devices per the coordination study.

3.2 CABLES - LOW-VOLTAGE - 600V MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect cables for physical damage and proper connection in accordance with single-line diagram.
2. Test cable mechanical connections to manufacturer's recommended values using a calibrated torque wrench.
3. Check cable color coding with applicable Engineer's specifications and National Electrical Code standards.

B. Electrical Tests:

1. Perform continuity test to insure proper cable connection.
2. Perform phase rotation tests. Color code conductors.

C. Test Values:

1. Bolt torque values should be in accordance with NETA Table 10.12 of ATS 1999 unless otherwise specified by the manufacturer.
2. Evaluate insulation-resistance results by comparison with cables of same length and type. Investigate any values less than 100 megohms.

3.3 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Inspect ground system for compliance with codes, drawings, and specifications.

B. Electrical Tests:

1. Perform fall-of-potential test or alternative in accordance with IEEE 81 on the main grounding electrode and the perimeter ground.
2. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.
3. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

C. Test Values:

1. The maximum ground-resistance shall not exceed 5 ohms. If resistance to ground exceeds specified values, notify OWNER/ARCHITECT/ENGINEER promptly and include recommendations to reduce ground resistance.

3.4 LOW VOLTAGE CIRCUIT BREAKERS

A. Visual and Mechanical Inspection:

1. Inspect for physical damage.
2. Mechanical operational test will be made in accordance with manufacturer's instructions.
3. Check tightness of all hardware connections.
4. Check cell fit and element alignment (if applicable).

3.5 WIRING DEVICES

A. Visual and Mechanical Inspection:

1. Inspect relays for physical damage, presence of foreign material, moisture, and corrosion.
2. Clean cover glass and relay components as required.
3. Check for freedom of movement, proper travel and alignment and tightness of mounting hardware and tap screws.

3.6 SYSTEM FUNCTION TESTS

A. General: Perform system function tests upon completion of equipment component tests as defined in this specification. It is the purpose of system function tests to prove the proper interaction of all sensing, processing, and action devices.

END OF SECTION

SECTION 31 05 19
GEOSYNTHETICS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Apron Liner (Geomembrane).

B. Trench Liner.

C. Geotextile cushion.

D. Separation geotextile.

E. Geogrid reinforcement for the Concrete Masonry Units (CMU) retaining wall.

F. Expanded polystyrene foam blocks

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

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

a. A 36 - Standard Specification for Carbon Structural Steel.
b. C 881 - Standard Specification for Epoxy – Resin-Base Bonding Systems for Concrete.
c. D 413 - Standard Test Methods for Rubber Property Adhesion to Flexible Substrate.
d. D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
e. D 751 - Standard Test Methods for Coated Fabrics.
f. D 792 - Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
g. D 822 - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
h. D 882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
i. D 1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
j. D 1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-μm) Sieve.
k. D 1203 - Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods.
l. D 1204 - Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature.
m. D 1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
n. D 1505 - Standard Test Method for the Density of Plastics by the Density-Gradient Technique.
o. D 1603 - Test Method for Carbon Black Content in Olefin Plastics.
p. D 1777 - Standard Test Method for Thickness of Textile Materials.
q. D 1790 - Standard Test Method for Brittleness Temperature of Plastic Sheeting by Impact.

r. D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
s. 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.
t. D 3895 - Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.
u. D 4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
v. D 4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
w. D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
x. D 4354 - Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (NECP) for Testing.
y. D 4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
z. D 4437 - Standard Practice for Non-Destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
aa. D 4439 - Standard Terminology for Geosynthetics.
bb. D 4491 - Standard Test Method for Water Permeability of Geotextiles by Permittivity.
cc. D 4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
dd. D 4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ee. D 4716 - Test Method for Determining the (in-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
ff. D 4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
gg. D 4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembrane, and Related Products.
hh. D 4873 - Guide for Identification, Storage, Handling of Geosynthetic Rolls and Samples.
ii. D 5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
jj. D 5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.
kk. D 5262 - Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.
ll. D 5321 - Standard Test Method of Determining the Shear Strength of Soil Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear.
mm. D 5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
nn. D 5641 - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
oo. D 5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.
pp. D 5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
qq. D 5884 - Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes.
rr. D 5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

ss. D 5887 - Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
tt. D 6214 - Determining the Integrity of Field Seams Used in Joining Geomembranes by Chemical Fusion Methods.
uu. D 6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile – Related Products using a 50mm Probe.
vv. D 6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
ww. D 6497 - Standard Guide for Mechanical Attachment of Geomembrane to Penetrations or Structures.
xx. D 6636 - Standard Test Method or Determination of Ply Adhesion Strength of Reinforced Geomembranes.
yy. D 6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
zz. D 7003 - Standard Test Method for Strip Tensile Properties of Reinforced Geomembranes.
aaa. D 7004 - Standard Test Method for Grab Tensile Properties of Reinforced Geomembranes.
bbb. D 7238 - Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Florescent UV Condensation Apparatus.
ccc. D 7749 - Standard Test Method for Determining the Integrity of Seams Produced using Thermo-fusion Methods for Reinforced Geomembranes by the Grab Method.
ddd. F 593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
eee. F 594 - Standard Specification for Stainless Steel Nuts.

2. Geosynthetic Research Institute (GRI):

a. GRI Test Method GM9 - Cold Weather Seaming of Geomembranes.
b. GRI Test Method GT 12(a) - Test Methods and Properties for Nonwoven Geotextiles used as Protection (or Cushioning) Materials.
c. GRI Test Method GM 19 - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.
d. GRI Test Method GM 25 - Test Methods, Test Properties, and Testing Frequency for Reinforced Linear Low-Density Polyethylene (LLDPE-R) Geomembranes.
e. GRI Test Method GM 29 - Field Integrity Evaluation of Geomembrane Seams (and Sheet) Using Destructive and/or Nondestructive Testing.
f. GRI Test Method GG4(a) - Determination of the Long-Term Design Strength of Stiff Geogrids.

1.3 DEFINITIONS

A. Coupon - A portion of material or laboratory sample from which multiple specimens can be taken for testing.

B. Seam - The connection of two or more pieces of material by mechanical or fusion methods that provides the integrity of a single piece of material.

C. Extrusion Fillet Seaming - This seaming technique involves extruding molten resin at the edge of an overlapped geomembrane on another to form a continuous bond.

D. Hot Wedge Seaming - A thermal technique which melts the two opposing geomembrane surfaces to be seamed by running a hot metal wedge or knife between them. Pressure is applied to the top or bottom geomembrane, or both, to form a continuous bond.

E. Installer - The party responsible for field handling, transporting, storing, deploying, seaming, and seam testing the geosynthetic.

F. Free-fall - Unacceptable installation technique where liner materials are allowed to travel down slopes in an unrestrained or uncontrolled manner.

G. Geosynthetic - Range of materials including geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites.

H. Geosynthetic Manufacturer(s) - The parties responsible for manufacturing geosynthetic products.

I. Geosynthetic Quality Assurance Laboratory (Testing Laboratory) - THORNTON will retain testing laboratory to perform quality control field and laboratory testing. The testing laboratory shall have completed at least two projects with a similar scope and materials.

J. Geotextile - A permeable, woven or non-woven fabric comprised solely of synthetic fibers.

K. Liner - Generic term used to describe geosynthetic materials used to form an essentially impermeable geomembrane.

L. Geomembrane Liner - Scrim Reinforced Polyethylene (geomembrane) membrane used to line the perimeter of the Courts Building.

M. Linear Low Density Polyethylene (LLDPE) - The type of polyethylene used in geomembrane. A ethylene/α-olefin copolymer having a linear molecular structure. LLDPE resins have a natural density in the range of 0.915 to 0.926 g/ml.

N. Lot - A unit of production, or a group of other units or packages, taken for sampling or statistical examination, having one or more common properties and being readily separable from other similar units. Finished roll will be identified by a roll number traceable to the resin lot used.

O. Minimum Average Roll Value (MARV) - The mean minus two standard deviations of a particular physical property of a material; provides 97.7 percent confidence that the property in question will meet the published value.

P. Overlap - The width of geosynthetic in contact with the adjacent geosynthetic panel. The distance is measured perpendicular from overlying edge of one geosynthetic panel to the underlying edge of the adjacent panel.

Q. Panel - The unit area of geosynthetic that will be seamed in the field. A panel is identified as a roll or portion of a roll that is equal to or larger than 100 square feet.

R. Patch - Unit area of a geosynthetic that will be seamed in the field that is less than 100 square feet.

S. Prepared Surface - The soil or bedrock layer surface that immediately underlies a geosynthetic material.

T. EPS Foam - Expanded polystyrene foam blocks.

1.4 SUBMITTALS

A. Shop Drawings

1. Geomembrane and Trench Liner Installation Plan is to include:

    a. Proposed panel layout with seam locations identified.
    b. Order of installing panels.
    c. Anchorage and ballasting methods during installation.
    d. Procedures and equipment that will be used to place, install, and seam liners.
    e. Procedures that will be used to protect the liners.
    f. Procedures to install liner around penetrations through the liner.
    g. Procedures and manufacturer guidelines for installing mechanical connections to concrete.
    h. Procedures to place geotextile cushion over the liners.
    i. Hot weather installation procedures when the ambient air temperature exceeds 100°F.

2. Record drawings of the liner showing all seams, panels, and repairs.

B. Samples

1. One square yard of each proposed geosynthetic material.
2. Batch and roll number of materials installed.

C. Administrative

1. Manufacturer Qualifications.
2. Installer Qualifications.
3. Material Warranty.

    a. Material shall be warranted against manufacturer's defects for a period of 20 years from the date of installation.

4. Liner Installation Warranty.

    a. Installation shall be warranted against defects in workmanship for a period of 1 year from the date of substantial completion.

5. Manufacturer's literature including recommendations for storage and installation.

D. Quality Control:

1. Manufacturer's certified test reports and certificates of compliance demonstrating that both the raw materials used in the manufacture of the geosynthetic materials and the final products conform to the requirements specified.
2. Certifications from each geosynthetic manufacturer that furnished products have specified property values. Certified property values shall be MARV values.
3. Installer's daily log.
4. Signed certificate verifying installer's visual inspection and approval of prepared surface beneath geosynthetic.
5. Results of CONTRACTOR Laboratory Testing Program, if performed.

1.5 QUALIFICATIONS

A. Liner Manufacturer:

1. The manufacturer shall have at least 5 years experience with manufacturing of geosynthetics.
2. Experience shall include successful fabrication of at least 10,000,000 square feet of the specified materials within the past 5 years.

B. Liner Installer:

1. Have experience in construction of liners using the specified products.
2. Have installed liners using specified products on at least five projects and have installed a minimum of 5,000,000 square feet of geomembrane.
3. The installation shall be performed under the direction of a field installation supervisor who shall be responsible throughout the installation, including, but not limited to, geosynthetic panel layout, seaming, patching, testing, repairs and all other activities of the installer. The field installation supervisor shall have installed or supervised the installation of a minimum of 5 projects involving at least 3,000,000 square feet of the specified products.
4. Seaming shall be performed under the direction of Master Seamer(s) who have seamed a minimum of 3,000,000 square feet of each installed product.
5. Have installed a minimum of 2,000 feet of batten bars to reinforced concrete.

1.6 QUALITY CONTROL

A. Installer:

1. Inspect prepared surface prior to geosynthetic installation and verify that prepared surface complies with these specifications, manufacturer's recommendations, and that it is adequate for geosynthetic installation, including exposed grade beams.
2. Provide signed certificate verifying visual inspection and approval of prepared surface beneath each geosynthetic installed.
3. Perform field testing of field seams in accordance with these specifications.
4. Keep an installer's daily log to record:

a. Sketches of actual locations (with dimensions) of field seams.
b. Installation notes.
c. Actual quantities of material installed and seamed.
d. Weather conditions.
e. Field problems and corrective actions.
f. Results of destructive testing of test seams.
g. Results of non-destructive and destructive tests of field production seams.
h. Sketches of repair locations (with dimensions).
i. Survey locations of all seams and repair locations.

B. THORNTON:

1. ENGINEER will conduct visual observations of prepared surface beneath geosynthetic. Provide 24 hours notice to ENGINEER when prepared surface is complete so that ENGINEER can make arrangements for visual observation.

C. The testing laboratory, under direction of THORNTON and ENGINEER, will conduct field and laboratory quality control tests.

1.7 SCHEDULING AND SEQUENCING

A. Complete excavation, foundation preparation, and earthwork required for geosynthetic installation in accordance with Section 31 23 16: EXCAVATION, Section 31 23 13: SUBGRADE PREPARATION, and Section 31 23 23: FILL, respectively, prior to installing geosynthetics.

B. Notify ENGINEER a minimum of 24 hours prior to placement of geosynthetics.

C. Do not place geosynthetics without required, submittals, inspections, and approvals.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle geosynthetics in accordance with the manufacturer's recommendations and the requirements of ASTM D 4873 unless otherwise specified.

B. Each roll shall be marked with the following:

1. Manufacturer's name.
2. Product identification.
3. Lot or batch number.
4. Date of manufacture.
5. Roll number.
6. Roll dimensions.

C. Rolls shall be wound or folded in a manner that prevents damage to the geosynthetic.

D. Unload geosynthetic using appropriate equipment.

E. Store geosynthetic materials in a level, smooth, elevated, and dry (not wooden pallets) area.

F. Stack no more than 3 rolls high.

G. Protect geosynthetics from sunlight, precipitation or excessive moisture, petroleum-based solvents such as gasoline and diesel fuel, theft, vandalism, punctures, abrasions, excessive moisture, and dirt during storage. Cover geosynthetics with tarps or opaque plastic. Do not remove manufacturer's protective coating or wrapping until time of installation. Maintain the integrity of the label.

H. Preserve the integrity and readability of roll labels at all times.

I. Secure geosynthetics with sand bags or straps as necessary to prevent wind damage.

J. Inspect materials upon delivery. Verify that:

1. Quality assurance data is properly displayed on the labels of materials.
2. Label data indicates compliance with submitted quality assurance documentation.
3. No signs of physical damage are present. Rolls with damaged packaging shall be marked and set aside for further inspection.

PART 2 PRODUCTS

2.1 GENERAL

A. Geosynthetics shall consist of new products designed and manufactured specifically for the purpose of this Work.

2.2 GEOTEXTILE CUSHION

A. Geotextile materials shall consist of long-chain polymeric fibers composed of polypropylene, polyester, or polyethylene.

B. Geotextile shall be non-woven and needle punched to form a stable network such that the fines remain in their relative position.

C. Geotextile shall be free from defects or tears, and shall be mildew, insect, and rodent resistant, inert to chemicals commonly found in soil, and resistant to UV light exposure. They shall also be free from any treatment or coating that might adversely alter the hydraulic or physical properties of the material after installation.

D. Geotextiles manufactured from slit-film fibers and heat bonded geotextiles are unacceptable.

E. Prefabricated seams shall be certified by the fabricator and meet the requirements of GM19.

F. The geotextile shall conform to the requirements in Table 1.

G. Approved geotextile cushion manufacturing:

1. Tencate Geosynthetics, 365 South Holland Drive, Pendergrass, GA 30567, (706) 693-2226.

a. Mirafi: S2400.

2. Approved equivalent.

TABLE 1(1)
MINIMUM VALUES FOR GEOTEXTILE CUSHION

Property	ASTM Standard	Minimum Average Roll Value
Weight (oz/yd^2)	D 5261	24
Grab Tensile Strength (lbs)	D 4632	400
Trapezoidal Tear Strength (lbs)	D 4533	100
Puncture Strength (lbs)	D 6241	1,000
AOS – Max. (U.S. Sieve / mm)	D 4751	No. 100/0.15
UV Resistance after 500 hrs. (% strength)	D 4355	70
Permeability (cm/sec)	94491	0.10

Note:
1. Minimum value unless otherwise indicated.

2.3 SEPARATION GEOTEXTILE

A. Geotextile materials shall consist of long-chain polymeric fibers composed of polypropylene, polyester, or polyethylene.

B. Geotextile shall be non-woven and needle punched to form a stable network such that the fines remain in their relative position.

C. Geotextiles shall be free from defects or tears, and shall be mildew, insect, and rodent resistant, inert to chemicals commonly found in soil, and resistant to UV light exposure. They shall also be free from any treatment or coating that might adversely alter the hydraulic or physical properties of the material after installation.

D. The geotextile shall conform to the requirements in Table 2.

E. Approved geotextile manufacturing:

1. Tencate Geosynthetics, 365 South Holland Drive, Pendergrass, GA 30567, (706) 693-2226.

a. Mirafi S800.
b. Approved equivalent.

TABLE 2[1]
MINIMUM VALUES FOR SEPARATION GEOTEXTILE

Property	ASTM Standard	Minimum Average Roll Value
Weight (oz/yd^2)	D 5261	8
Grab Tensile Strength (lbs)	D 4632	230
Trapezoidal Tear Strength (lbs)	D 4533	95
Puncture Strength (lbs)	D 6241	600
AOS – Max. (U.S. Sieve / mm)	D 4751	No. 100/0.15
UV Resistance after 500 hrs. (% strength)	D 4355	70

Note:
1. Minimum value unless otherwise indicated.

2.4 TRENCH LINER (PVC)

A. Produced from new, first quality resin compounded and manufactured specifically for producing geomembrane.

B. Supply in rolls or pre-fabricated panels.

C. PVC Geomembrane Rolls or Panels:

1. Free of holes, pinholes, bubbles, blisters, contamination by foreign matter, and nicks and cuts on roll or panel edges.

D. Meet the minimum requirements shown in Table 3.

E. Approved trench liner manufacturing

1. U.S. Fabrics, Inc., 3904 Virginia Avenue, Cincinnati, OH 45227, (800) 518-2290.

a. 40 ml PVC membrane
b. Approved equivalent

TABLE 3
MINIMUM VALUES FOR TRENCH LINER

Property	Test Method	Requirement
Thickness (mil)	ASTM D 5199 (1593)	38
Specific Gravity (g/cc)	ASTM D 792	1.2
Dimensional Stability (%)	ASTM D 1204 (MD&TD)	3
Volatile Loss (%)	ASTM D 1203 (A)	0.5
Hydrostatic Resistance (psi)	ASTM D 751 (A)	120
Tensile Index Properties		
Break Strength (lbs/in)	ASTM D 882 Method A (MD&TD)	97
Elongation at Break (%)	ASTM D 882 (Method A (MD&TD)	430
Modulus at 100% (lbs/in)	ASTM D 822 Method A (MD&TD)	40
Tear Resistance (lbs/in)	ASTM D 1004, Die C	10
AVG. Plasticizer Molecular Weight	ASTM D 2124	400

F. Reuse of excavated geomembrane material is not permitted.

2.5 GEOMEMBRANE LINER

A. Geomembrane.

1. Polyethelyne shall be the linear-low density type.

B. Produced from new, first quality resin compounded and manufactured specifically for producing geomembrane.

C. Geomembrane shall generally have a uniform undulating appearance and shall be free of defects that mechanically affect the specified properties of the geomembrane.

D. Supply in rolls or pre-fabricated panels:

1. Free of holes, pinholes, bubbles, blisters, undispersed resins and carbon black, contamination by foreign matter, and nicks and cuts on roll or panel edges.

E. The geomembrane shall conform to the requirements in Table 3.

F. Approved geomembrane manufacturers and products:

1. Raven Industries, P.O. Box 5107, Souix Falls, SD 57117 (605) 335-0174.

a. HYDRAFLEX ULTRA HU40.

2. Approved equivalent.

TABLE 4
MINIMUM VALUES FOR GEOMEMBRANE LINER

Property	Test Method	Specified Value	Value Type
Nominal Thickness (mil)	N/A	40	Nominal
Minimum Thickness (mil)	ASTM D 5199	35	MARV
Weight (lbf)	N/A	200	MARV
Grab Tensile Strength at Break (lbf)	ASTM D 6693	168	MARV
Tensile Elongation at Break (%)	ASTM D 6693	800	MARV
Tongue Tear Strength (LBF)	ASTM D 5884	23	MARV
High Pressure Oxidation Induction Time (HPOIT) (minutes)	ASTM D 5885	400	MARV
Puncture Resistance (LBF)	ASTM D 4833	60	MARV
Manufacturer Rated Minimum and Minimum Use Temperature (°F)	--	-70 to 180	RANGE

2.6 GEOGRID REINFORCEMENT

A. Uniaxial geogrid produced from high density polyethylene.

B. Supply in rolls free of tears, nicks, cuts, or other damage.

C. Meet the minimum requirements shown in Table 5.

D. Approved manufacturers and products.

1. Tensar International, 2500 Northwinds Parkway, Suite 500, Alpharetta, GA 30009, 800-TENSAR-1.

a. UX1100 MSE.
b. Approved equivalent.

TABLE 5
MINIMUM AVERAGE ROLL VALUES FOR GEOGRID REINFORCING

Index Properties	Units	MARV[(1)]
Tensile Strength @ 5% Strain, ASTM D 6637	lb/ft	1,850
Ultimate Tensile Strength, ASTM D 6637	lb/ft	3,970
Junction Strength, GRI-GG2-05	lb/ft	3,690
Flexural Stiffness, ASTM D 5732	mg-cm	500,000
Durability		
Resistance to Long Term Degradation, EPA 9090	%	100
Resistance to UV Degradation, ASTM D 4355	%	95
Rated Load Capacity		
Maximum Allowable (Design) Strength for 120-year Design Life	lb/ft	1,450

Note:
1. Unless indicated otherwise, values shown are minimum average roll values determined in accordance with ASTM D 4759-02.

2.7 POLYURETHANE SEALANT

A. The elastomeric sealant used for penetration sealing shall be as recommended by the geomembrane manufacturer and meet the minimum values shown in Table 6.

B. Approved Polyurethane Sealant products:

1. Sikaflex 1A.
2. Other tested and approved equivalent.

TABLE 6
POLYURETHANE SEALANT

Property	Test Method	Minimum Value
Tensile Stress	ASTM D 412	175 psi
Adhesion to Concrete in Peel	TT-S-00230C	20 lbs

2.8 BUTYL TAPE

A. Preformed sealant tape used for penetration sealing shall be a compressible rubber material suitable for adhesion to geomembrane or concrete in wet conditions as recommended by the geomembrane manufacturer.

2.9 EPS FOAM BLOCKS

A. EPS-15 Blocks:

1. Minimum compressive strength at 1 percent strain is greater than or equal to 520 psf.
2. Minimum density is 0.9 lbs/ft^3.

B. Used below retaining wall mat foundation.

2.10 MECHANICAL CONNECTIONS

A. Anchors:

1. Bolts: Stainless steel, ASTM F 593, Alloy Group 1 or 2.
2. Nuts: Stainless steel, ASTM F 594, Alloy Group 1 or 2.
3. Washers: 316 Stainless steel.

2.11 MECHANICAL CONNECTIONS

A. Anchor Grout:

1. ASTM C 881, Type IV, Class B and C, Grade 3.
2. Grout shall come in two-chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The grout shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
3. Grout shall be capable of being used in submersed applications.

B. Structural Steel:

1. Shapes, plates, and bars: ASTM A 36.

PART 3 EXECUTION

3.1 GENERAL

A. Prepare the foundation upon which geosynthetics will be placed as specified in Section 31 23 13: SUBGRADE PREPARATION. Place geosynthetics only on prepared surfaces that are generally free of ruts, large rocks, debris, or vegetation, or other deleterious items that may damage the geosynthetic.

B. Layout and install geosynthetic according to approved submittal and as recommended by the manufacturer and ASTM D 6102.

C. A compatible seam and panel numbering system shall be used.

D. Unroll geosynthetic panels using methods that will not damage the geosynthetic and will protect the prepared surface from damage (i.e., spreader bar or protected equipment bucket).

E. Do not drag geosynthetic panels across the subgrade. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

F. Anchor or ballast geosynthetic into an anchor trench or attach to structure as shown on the Drawings and according to approved installation plan.

G. Do not entrap objects or moisture beneath geosynthetic materials.

H. Visually inspect liner for imperfections and mark faulty or suspect areas.

I. Install geosynthetic panels in uniform contact each other and with the foundation. Eliminate folds, wrinkles, and bridging over depressions.

J. The bottom layer of geosynthetic shall be free of dirt and debris before placement of an overlying geosynthetic.

K. Do not install the geosynthetic during periods of precipitation in areas containing ponded water or on frozen or disturbed subgrade.

L. Personnel walking on geosynthetic shall not damage the geosynthetic. Smoking is not permitted on the geosynthetic.

M. Protect the geosynthetic from leakage from motors and equipment.

N. At least 1 foot of fill shall be placed over all completed panels of geosynthetic at the end of each workday except within 4 feet of unseamed edges.

O. Seams and overlaps shall be constructed in accordance with the manufacturer's recommendations and these specifications.

P. Place and compact fill over the geosynthetic as specified in Section 31 23 23: FILL, and protect the geosynthetic from damage during installation of overlying fill.

Q. Ensure that the geosynthetic material does not shift, wrinkle, or tear during placement of the overlying materials.

R. Repair any damage to the geosynthetic.

3.2 PLACING RIPRAP OVER GEOSYNTHETICS

A. General:

1. Place riprap over geosynthetics so that geosynthetic is not damaged.
2. Do not operate heavy equipment or machinery directly on installed geosynthetics or on riprap placed over geosynthetics.
3. Do not push riprap over geosynthetics.

B. Geosynthetic Damage:

1. Mark punctures, tears, or other damages to geosynthetics so repairs may be made.
2. Clear overlying fill as necessary to repair damage.

3.3 SEQUENCE OF GEOSYNTHETICS INSTALLATION

A. Installation of Liner materials:

1. Install and seam liner above prepared and approved subgrade.
2. Repair damaged areas of liner.
3. Seal penetrations through the liner.
4. Perform quality control testing.
5. Install cushion geotextile.

B. Installation of geogrid:

1. In accordance with Section 31 66 16: SPECIAL FOUNDATION WALLS (MSE).

3.4 GEOMEMBRANE LINER INSTALLATION

A. Geosynthetic for this section shall refer to apron liner and geotextile.

B. Vehicles and equipment are not permitted to operate directly on the geosynthetic.

C. Plate compactors may operate over the geosynthetic after a minimum of 6 inches of fill has been placed.

D. Plate compactors and skid-steer-type equipment may operate over the geosynthetic after a minimum of 12 inches of fill has been placed.

E. No equipment is permitted to turn until at least 24 inches of fill has been placed above the geosynthetic.

F. Vehicles and larger equipment are permitted to operate over geosynthetic materials after 24 inches of fill has been placed over the geosynthetic.

G. Do not allow the liner to be in tension at any time during placement of overlying fill.

3.5 SEAMS AND OVERLAPS

A. General

1. Seams shall be made transverse to the slope for grades steeper than 10H:1V.
2. Seams shall be overlapped with the upslope material shingled over the downslope material.

B. Geotextile seaming

1. Unseamed joint:

   a. Overlap minimum 18 inches.

2. Adhesive seamed joint procedure:

   a. Use a heat gun to lightly adhere overlaps.
   b. Prevent geotextile burn-through. Burn-through areas will be repaired as specified herein to the satisfaction of ENGINEER.
   c. Prevent scorching or damage to underlying geomembrane during seaming.

C. Geomembrane seaming:

1. Seams shall consist of extrusion fillet and double hot wedge seams.
2. Extrusion fillet seams shall be oriented transverse to the slope and will only be allowed at locations approved by ENGINEER.
3. All other seams shall be double hot wedge seams.
4. Seams shall be overlapped 4 to 6 inches.
5. Perform welding in accordance with manufacturer's recommendations and these specifications.
6. Welding shall not be performed during unfavorable weather conditions unless the material to be welded is appropriately protected from the elements. Unfavorable weather conditions include:

   a. Periods of excessive moisture or blowing dust.
   b. In the presence of excessive winds or ponded water.
   c. Rain, snow, or other precipitation.
   d. Ambient temperature below 35^{o}F.
   e. Liner temperature greater than 165^{o}F.

7. Weld quality, liner temperature, and number of test welds will be increased during seaming operations when the ambient temperature is above 100^{o}F or below 35^{o}F.
8. Cold weather seaming procedures may include:

   a. Storing fabricated product in a heated space prior to deployment.
   b. Applying preheat, as necessary, immediately in front of area to be welded.
   c. Performing additional test welds as directed by ENGINEER to verify that field seams meet the requirements of these Specifications.

9. High temperature seaming procedures may include:

   a. Continuously monitoring seaming operations to verify that field seams meet the requirements of these specifications.
   b. Suspending work if temperatures create a dangerous work atmosphere for the installation crew and inspectors.
   c. Performing additional test welds, as directed by ENGINEER, to verify that field seams meet the requirements of these specifications.

10. Prior to seaming, ensure the seam area is clean and free of moisture, dirt, and debris, and the number of wrinkles or fishmouths are minimized. If fishmouths form, cut and re-seam so as to effect a flat overlap. Place a patch over repaired fishmouths, as necessary.
11. Within 1 hour prior to extrusion fillet seaming, the area to be seamed shall be lightly and evenly ground to roughen the surface and remove all surface shine and remove asperities. The grinding shall not extend more than 0.25 inch outside the area of the weld bead.
12. If ENGINEER deems necessary, collect and test destructive seam samples at locations determined by ENGINEER. Repair destructive sample areas as specified herein.
13. Clean welding machinery at least daily.
14. Place a smooth insulating plate or fabric beneath the welding apparatus before and after usage.

D. Trench Liner Seaming

1. Minimum weld overlap: 8 inches.
2. Minimum continuous weld path: 6 inches.
3. Welding procedures:

    a. Perform test seams prior to production welding.
    b. Clean all weld surfaces prior to seaming.
    c. Apply solvent on both sheets of the PVC geomembrane with either a squeeze bottle or paintbrush.
    d. Roll seam with a seam roller to remove all air bubbles.
    e. Inspect all seams and re-adhere, re-roll, or replace all non-bonded weld areas as necessary to form a continuous seam.
    f. Minimize fishmouths. If fishmouths form, cut and re-seam so as to effect a flat overlap. Place a patch over repaired fishmouths, as necessary.
    g. If ENGINEER deems necessary, collect and test destructive seam samples at locations determined by ENGINEER. Repair destructive sample areas as specified herein.
    h. Other welding procedures, including hot wedge welding, may be proposed by Installer. Alternative procedures must be approved by ENGINEER.

4. Cold weather seaming procedures may include:

    a. Storing fabricated product in a heated space prior to deployment.
    b. Applying preheat, as necessary, immediately in front of area to be welded.
    c. Performing additional test welds as directed by ENGINEER to verify that field seams meet the requirements of these specifications.
    d. Suspending work if temperatures create a dangerous work atmosphere for the installation crew and inspectors.
    e. Performing additional test welds as directed by ENGINEER to verify that field seams meet the requirements of these specifications.

E. Geogrid

1. Install in accordance with Section 31 66 16: SPECIAL FOUNDATION WALLS (MSE).

3.6 REPAIR PROCEDURES

A. General

1. Repair all geosynthetic areas that are torn, punctured, flawed, deteriorated, or otherwise damaged during construction.

2. Perform repairs in accordance with manufacturer recommendations and the specifications herein.

B. Geotextile repair procedures:

1. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.
2. Repair procedures:

a. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
b. Remove interfering material, as necessary, to expose damaged geotextile for repair.
c. The patch shall consist of material obtained from a new roll, and shall be the same product as the geotextile to be repaired.
d. Secure patches as specified herein.

C. Geomembrane repair procedures:

1. Cover each damaged area of geomembrane using a patch that extends at least 6 inches beyond the damaged area.
2. The patch shall consist of material obtained from a new geosynthetic roll, and shall be the same product as the geomembrane to be repaired.
3. Seam the perimeter of the patch using a geomembrane fillet extrusion weld.

D. Trench liner repair:

1. Repair procedures:

a. Place patch of undamaged geomembrane over damaged area and at least 18 inches in all directions beyond damaged area.
b. Field seam patch to geomembrane as specified herein.
c. Perform non-destructive testing as specified herein.

2. If a patched area fails non-destructive testing, completely remove the patch and all surrounding damaged geomembrane as directed by ENGINEER. Replace with new geomembrane material and repeat non-destructive or destructive testing as directed by ENGINEER.

E. Repair verification:

1. Number and log each patch repair.
2. Sketch the location of each patch repair in the installer's daily log.
3. Record the results of non-destructive testing on each repair using methods specified herein in the installer's daily log.
4. If a patched area fails non-destructive testing, completely remove the patch and all surrounding damaged geosynthetic materials as directed by ENGINEER. Replace with new geosynthetic materials and repeat non-destructive or destructive testing as directed by ENGINEER.

3.7 PENETRATIONS

A. General

1. Seal the liner around pipes, concrete structures, or other penetrations.
2. Seal penetrations following manufacturer recommendations and as shown on the drawings.

B. Penetrations:

1. Seal the geomembrane against pipe penetrations using a pre-fabricated or field manufactured pipe boots and stainless steel hardware as shown on the drawings.

a. The pipe boot shall be constructed of the same material as the liner.
b. Connect the pipe boot to the liner using a liner fillet extrusion weld or chemical weld as shown on the Drawings and specified herein.

3.8 MECHANICAL CONNECTIONS

A. Geomembrane mechanical connections:

1. Seal the geomembrane against concrete structures using Butyl tape, batten strips, and stainless steel hardware as shown on the Drawings.
2. Tighten bolts at mechanical connections according to manufacturer guidelines.

3.9 FIELD QUALITY CONTROL

A. Liner non-destructive testing:

1. Geomembrane installer shall perform non-destructive testing over the full length of the seams before the seams are covered. Each seam shall be numbered or otherwise designated. The location, date, test unit, name of QC person, and outcome of all non-destructive shall be recorded and submitted to ENGINEER.
2. Perform testing as the seaming progresses, not at the completion of all field seaming. Repair all defects then re-test and re-mark area to indicate acceptable completion of repair.
3. All geomembrane hot wedge double track fusion welds shall be tested by a pressurized air channel evaluation in accordance with ASTM D 5820.

a. The test pressure shall be 20 psi.
b. The maximum allowable pressure drop shall be 4 psi in 5 minutes.
c. If the maximum allowable pressure drop is exceeded, the defective area shall be located and repaired as specified herein and re-tested until passing results are obtained.

4. Mark all seams with the date tested, name of the technician, length of the seam, and test results.

B. Liner test welds:

1. Each seam crew shall prepare one 6-foot-long weld for testing at the location of the patch.
2. Test apron liner in accordance with ASTM D 7749.
3. Perform an additional test weld if the initial test weld fails.
4. Do not proceed with production welding and notify ENGINEER immediately if the additional test weld fails.
5. Label with the date, panel identification, seam number or test location, and technician performing the weld and pass or fail description.

C. Liner destructive testing: as required by ENGINEER.

TABLE 7
GEOMEMBRANE LINER SEAM STRENGTH

Geomembrane Nominal Thickness	40 mils
Hot Wedge geomembrane Seams	
Shear strength(1), lb/in	200
Peal strength(1), lb/in	20
Extrusion geomembrane Fillet Seams	
Shear strength(1), lb/in	200
Peel strength(1), lb/in	20

Note:
1. Value listed for shear and peel strengths are for four out of five test specimens, not the average; the fifth specimen can be as low as 80 percent of the listed values.

1. Destructive testing: At locations identified by ENGINEER. The minimum number of tests are provided below. The ENGINEER may increase the number of tests at their discretion.

   a. One destructive field seam sample shall be taken every 2,000 lineal feet of seam length or as required by ENGINEER.
   b. Test samples in accordance with ASTM D 4437.

END OF SECTION

SECTION 31 11 00
CLEARING AND GRUBBING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Site clearing and grubbing work areas. Work areas and stockpile areas within the limits of site disturbance approved by ENGINEER. The general work areas include the following:

1. CONTRACTOR work areas and stockpile areas within the limits of site disturbance approved by ENGINEER.
2. Landscaped areas within limits of excavation.

B. Dispose of all cleared and grubbed material in accordance with the requirements of Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS.

1.2 SUBMITTALS

NONE

1.3 SCHEDULE AND SEQUENCE

A. Begin site clearing and grubbing only after erosion and sediment control provisions are in place.

B. Haul roads, access roads, and additional work areas needed by CONTRACTOR not shown on the Drawings may be cleared upon approval of THORNTON and after CONTRACTOR submits and implements a revised Erosion and Sediment Control Plan.

C. The areas to be cleared within the limits of site disturbance shall be finalized based on the information provided by CONTRACTOR in the Staging & Stockpile Area Plan outlined in Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that existing plant life and features designated to remain or to be protected are tagged or identified.

B. Provide sediment and erosion control measures according to Section 31 25 00: EROSION AND SEDIMENTATION CONTROLS, prior to any clearing and grubbing operations.

3.2 PROTECTION

A. Protect any trees, plant growth, and features not requiring removal for the Work.

B. Protect benchmarks and survey monuments from damage or displacement. Repair or replace all benchmarks and survey monuments damaged during clearing and grubbing.

C. The limits of site disturbance to install measures such as silt fences and diversions shall be held to a minimum and be in accordance with the approved submittal.

D. The limits of site disturbance shall be no more than 10 feet outside of required work areas except as shown on the Drawings or otherwise approved by ENGINEER.

3.3 CLEARING

A. Clearing shall mean removing, hauling, and disposing of all trees, shrubs, grasses, weeds, debris, trash, rubble, downed timber, branches, and other materials on the surface.

3.4 GRUBBING

A. No grubbing is required.

3.5 DISPOSAL

A. Dispose of all brush, tree trunks, stumps, roots, and debris from clearing operations as required by Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS.

3.6 MAINTENANCE OF CLEARED AREAS

A. Maintain cleared work areas in a condition free from additional vegetation growth for the duration of the project. Use of herbicides to discourage plant growth shall not be allowed. CONTRACTOR shall be compensated for clearing each work area only once.

END OF SECTION

SECTION 31 22 19
FINISH GRADING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Placing topsoil including placing, spreading, grading, and final contouring.

PART 2 PRODUCTS

2.1 TOPSOIL

A. Topsoil shall be selectively excavated or imported material meeting the following requirements:

1. Maximum particle size of 3 inches.
2. Minimum 25 percent fines content.
3. Not more than 25 percent gravel.
4. Organic content of at least 3 percent and not more than 20 percent.
5. Free from deleterious materials.
6. Containing no toxic materials harmful to grass growth.

PART 3 EXECUTION

3.1 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Scarify the subgrade to a depth of 3 inches where topsoil is required.

3.2 PLACING

A. Place topsoil to a depth of 6 inches.

B. Grade uniformly to eliminate low or uneven areas and ensure positive drainage. There shall not be any localized low spots that will allow water to accumulate.

C. Remove all clods, roots, sticks, stones over 3 inches, and other foreign matter when spreading topsoil. Hand rake areas that are not accessible to spreading equipment.

D. Make grade changes gradual and blend slope into level areas. Round surfaces at tops or bottom of grade changes.

E. Do not place topsoil in a frozen or muddy condition.

F. Compact topsoil by making at least four coverages with a CAT D6 bulldozer or equal size track mounted equipment.

3.3 TOLERANCES

A. Top surface of subgrade: Plus or minus 0.1 foot in 10 feet.

3.4 PROTECTION

A. Protect completed topsoil from erosion or other damage. Repair eroded or damaged areas.

END OF SECTION

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SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.1 WORK INCLUDES

A. Preparing the finished excavated surface for placement of overlying fill, backfill, geosynthetic, or structures.

B. Protection of subgrade until foundation preparation is completed and placement of overlying fill, backfill, geosynthetic, or structures begins.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Concrete Institute (ACI):

a. 506.2, Specification for Materials, Proportioning, and Application of Concrete.

1.3 DEFINITIONS

A. Refer to applicable definitions of Section 31 23 16: EXCAVATION, and Section 31 23 23: FILL.

B. Prepared Foundation: Subgrade surface after completion of foundation preparation activities as specified prior to placement of overlying fill, backfill, or structure.

C. Structure Foundation: Finished excavated surface, after foundation preparation, upon which a structure will be placed. Approximate structure foundation elevations are shown on the Drawings; actual elevations will be determined by ENGINEER based on the material encountered.

D. Subgrade: Ground surface after completion of required clearing, grubbing, stripping, and excavation prior to placement of fill or structure.

E. Temporary Cover: Native material left in place over final foundation subgrade to protect subgrade from damage by wetting, drying, freezing, erosion, and physical disturbance by construction equipment traffic and personnel until the time of final foundation excavation and preparation.

1.4 QUALITY CONTROL

A. Notify ENGINEER when excavation has reached the designated subgrade elevation.

B. Notify ENGINEER when soft, loose, or wet subgrade zones are detected.

1.5 SEQUENCING AND SCHEDULING

A. Perform subgrade preparation only when subgrade is unfrozen, and free of ice, snow, and surface water.

PART 2 PRODUCTS

2.1 BACKFILL CONCRETE

A. Conform to the requirements of Class B concrete as specified in Section 03 30 50: BASIC CONCRETE MATERIALS.

PART 3 EXECUTION

3.1 GENERAL

A. Shape excavation to produce as uniform and regular profile as possible, with no abrupt changes in slope, sharp projections, steps, overhangs, or benches except as shown on the Drawings or as approved by ENGINEER.

B. Preserve the foundation below and beyond the lines of excavation in the soundest possible condition. Repair any damage from CONTRACTOR's operations, including fracturing of material beyond the required excavation lines, as directed by ENGINEER.

C. Keep subgrade free of ponded water and deleterious materials during foundation preparation.

D. Maintain prepared foundation in finished condition until overlying fill, backfill, or structure is placed.

1. Foundation preparation shall be completed a maximum of 24 hours prior to placement of the overlying fill, backfill, or structure unless otherwise approved by the ENGINEER.

3.2 PREPARED FOUNDATIONS

A. Subgrade Compaction: Scarify, moisture condition, and compact top 8 inches of subgrade in accordance with requirements of Section 31 23 23: FILL.

1. Proof-roll prepared subgrade below concrete paving to identify soft pockets and area of excess yielding.
2. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
3. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
4. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm).

B. Correction for Soft or Loose Subgrade: Where subgrade cannot be compacted as specified, or in areas identified by ENGINEER that display yielding or excessive rutting during construction activities, adjust moisture content and recompact, or overexcavate as specified in Section 31 23 16: EXCAVATION, and replace over-excavated material as specified in Section 31 23 23: FILL.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.1 WORK INCLUDES

A. Stripping and stockpiling topsoil.

B. Required excavation for the geomembrane, retaining wall, and utility repairs.

C. Excavation necessary for miscellaneous facilities, including: pipe and utility trenches, miscellaneous structure foundations, and site drainage.

1.2 DEFINITIONS

A. Refer to applicable definitions of Section 31 23 13: SUBGRADE PREPARATION, and Section 31 23 23: FILL.

B. Unclassified Excavation: All materials to be encountered in excavations, including soil and rock.

C. Unsuitable Foundation Soils: Soils that display yielding, excessive rutting, excessive water content, or have desiccated.

1.3 SUBMITTALS

A. Administrative:

1. Copy of excavation permit(s) as required by law.
2. Certified design of sloping, bracing, or shoring of temporary excavation slopes as required by Occupational Safety and Health Administration (OSHA).

1.4 QUALITY CONTROL

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.5 EXCAVATION SAFETY

A. CONTRACTOR is solely responsible for making all excavations in a safe manner. Provide appropriate measures to ensure that persons in or near the excavation are protected. Shore, sheet, or brace excavation to conform to all applicable regulations.

B. Install and maintain shoring, sheeting, or bracing to support the sides of the excavation, to keep and prevent any movement that may damage adjacent structures or foundation, damage or delay the Work, or endanger life and health. Install and maintain shoring, sheeting, or bracing as required by OSHA and other applicable governmental regulations or agencies.

1.6 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32ºF shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently or is appropriately moisture conditioned for proper compaction.

1.7 SEQUENCING AND SCHEDULING

A. Dewatering: Conform to applicable requirements of Section 31 23 19: DEWATERING, prior to initiating excavation and maintain in a dewatered state throughout the period of excavation so excavation is completed in the dry.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

B. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular fill, drain material, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete or asphalt is to be deposited against earth.

C. Do not excavate to beyond the lines and grades shown without written authorization of ENGINEER.

D. Excavation shall be performed in the dry.

E. Import or selectively excavate, handle, haul, stockpile and process excavated materials as necessary to yield suitable types and sufficient quantities of the various fill and backfill materials required for construction of the Work.

3.2 FINAL EXCAVATION

A. Take all necessary precautions to preserve the material below and beyond the established lines of all excavation in the soundest possible condition. Repair any damage to foundation material beyond the required excavation lines due to frost, wetting, drying, erosion, physical disturbance, ineffective dewatering, or CONTRACTOR's operations.

3.3 TRENCH WIDTH

A. Minimum width of trenches, unless otherwise shown or specified:

1. Single pipes, conduits, direct-buried cables, and duct banks:

a. Less than 4 inches outside diameter or width: 18 inches.
b. Greater than 4 inches outside diameter or width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.

2. Multiple pipes, conduits, cables, or duct banks in single trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.

B. Maximum trench width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.4 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Confine stockpiles to within approved work areas.

C. Do not stockpile excavated material adjacent to trenches and other excavations unless excavation sideslopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

D. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce settlement.

3.5 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATION

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, off-site in a waste disposal facility approved by THORNTON.

B. Moisture content of excavated materials alone shall not be reason for wasting material. Moisten or dry material to the specified moisture content and use in permanent construction as specified in Section 31 23 23: FILL.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS.

3.6 OVEREXCAVATION OF UNSUITABLE FOUNDATION SOILS

A. Unsuitable foundation materials shall be removed. Excavate down to the top of suitable foundation material as determined by ENGINEER. Backfill the excavated area using materials and placement procedures for common fill.

END OF SECTION

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SECTION 31 23 19
DEWATERING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Design dewatering systems for the control, collection, and disposal of groundwater or surface water for the proper construction of all Work.

B. Install and maintain pumps, piping, drains, well points, wells, and other facilities for the control, collection, and disposal of groundwater for the proper construction of all Work.

C. Maintain prepared foundations and all other parts of the Work free from seepage or standing 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 and disposal of collected water.

E. Remove all components of the dewatering systems when no longer required.

1.2 SUBMITTALS

A. Administrative:

1. Dewatering Plan. Submit a Dewatering Plan at least 10 days prior to the start of excavation. The Dewatering Plan shall be prepared and stamped by a Registered Professional Engineer registered in the State of Colorado with experience in the design of dewatering systems. The plan shall include, as a minimum, the following:

    a. Drawings and narrative that provides details regarding the anticipated types, sizes, capacities, and locations of various dewatering facilities and calculations to substantiate the designs and selected facilities.
    b. Drawings and narrative that describes all items of Work including such items as sedimentation pond (if required) and silt barriers.
    c. Expected discharge volumes from each isolated system and points of discharge.
    d. Methods and procedures to fill openings and voids left by removal of the dewatering system.

2. Discharge permits.

B. Well Permit Documents:

1. Completed Notice of Intent to Construct Monitoring Hole(s) for all wells in each 1/4 of the 1/4 section designation (i.e., NW 1/4 of the SE 1/4 of Section 3).
2. Completed Monitoring/Observation Water Well Permit Application for each well.
3. Completed Well Construction and Test Report for each well.
4. Completed Well Abandonment Report for each well.
5. Copies of State forms are attached.

C. Approval by ENGINEER of the dewatering systems proposed by CONTRACTOR will only be with respect to the basic principles CONTRACTOR intends to employ. Approval by ENGINEER does not relieve CONTRACTOR of the full responsibility for the adequacy of the dewatering systems.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. 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 the excavations firm and free of standing water until the liner and collection pipe has been installed and backfilled or the structures to be built therein are completed and the backfill to be placed therein has been placed.

B. Perform dewatering operations so that no disturbance to the bearing soil or rock, or to soil or rock supporting any other work will result.

C. The dewatering system shall be operated continuously as necessary to prevent flotation of partially completed structures or other work.

D. Discharge water so that it shall not cause siltation, erosion, or other negative environmental impacts.

3.2 DEWATERING REQUIREMENTS

A. Dewatering systems shall prevent loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of excavation slopes and bottom of excavation so that every phase of the Work can be performed in the dry.

B. Maintain the water level a minimum of 3 feet below the bottom of the excavation for SW, SP, SM, and SC soils and a minimum of 6 feet below the bottom of the excavation for CL, ML, CH, MH, and OL/OH soils.

C. The dewatering operations shall be such that the bottoms of all excavations shall be kept firm at all times, and in all respects acceptable to ENGINEER.

3.3 INSTALLATION AND OPERATION

A. Construct wells in accordance with Colorado Office of the State Engineer (SEO) Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction (2 CCR 402-2, 2000).

B. Locate every element of dewatering systems to avoid interference with excavation and construction activities.

C. Prior to any excavation below the hydrostatic groundwater level, operate to lower the water levels as required and operate the dewatering system 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 sufficiently above the hydrostatic groundwater level so that the presence of groundwater does not impact fill placement.

D. Maintain the water levels as required and do not allow the water level to rise until the constructed facilities are sufficiently complete that the water can rise without damaging the facilities, their foundations, or surrounding areas and structures.

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 occur, restore foundation, fill soil, slopes, or structures, to the satisfaction of ENGINEER.

3.4 REMOVAL

A. Abandon wells in accordance with SEO Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction (2 CCR 402-2, 2000).

B. All elements of the dewatering systems shall be removed from the site at the completion of the dewatering work.

C. All voids left as a result of the dewatering system shall be grouted.

END OF SECTION

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SECTION 31 23 23
FILL

PART 1 GENERAL

1.1 WORK INCLUDES

A. Fill over geosynthetics.

B. Fill and backfill around structures and in over-excavated areas beneath structures.

C. Mechanically Stabilized Earth Wall (MSEW) Fill.

D. Pipe bedding.

E. Riprap.

F. Miscellaneous fill or backfill not specifically covered in other sections.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

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

a. C 117 - Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
b. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
c. C 33 - Standard Specification for Concrete Aggregates.
d. C 88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
e. D 75 - Standard Practice for Sampling Aggregates.
f. D 422 - Standard Test Method for Particle-Size Analysis of Soils.
g. D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
h. D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
i. D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
j. D 2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
k. D 2488 - Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
l. D 2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
m. D 3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
n. D 4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
o. D 4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.

p. D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
q. D 4643 - Standard Test Method for Determination of Water (Moisture) Content of Soils by Microwave Oven Heating.
r. D 4959 - Standard Test Method for Determination of Water Moisture Content of Soil by Direct Heating.
s. D 5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
t. D 6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
u. D 6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. American Association of State Highway and Transportation Officials (AASHTO):

a. T272 - Standard Method of Test for Family of Curves-One Point Method, in the Standard Specifications for Transportation Materials and Methods of Sampling and Testing, Part II Tests.
b. M6 - Standard Specficiation for Fine Aggregate for Hydraulic Cement Concrete.

3. Colorado Department of Transportation, Standard Specifications for Road and Bridge Construction (CDOT Standard Specifications).
4. American National Standards Institute (ANSI): Z535.
5. American Public Works Association (APWA): Uniform Color Code for Temporary Marking of Underground Utility Locations.

1.3 DEFINITIONS

A. Refer to applicable definitions of Section 31 23 16: EXCAVATION, and Section 31 23 13: SUBGRADE PREPARATION.

B. Backfill: Fill materials placed in trenches, overexcavated areas, and around structures, pipes and other facilities.

C. Certified/Certification: Review, approved, stamped, and signed by a Professional Engineer registered in the State of Colorado.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Coverage: One coverage is defined as the requirement for successive trips of a piece of compaction equipment, which by means of sufficient overlap, will ensure contact on the entire surface of the layer by the equipment.

F. Deleterious Materials: Organic matter, trash, rubbish, debris, oversize materials, and soluble materials.

G. Fill: All materials used to raise existing grade where not defined as backfill.

H. Fines: Material passing the No. 200 sieve as determined in accordance with ASTM D 422.

I. Geosynthetics: Geotextiles, geogrids, or geomembranes.

J. Imported Material: Material obtained from sources off site.

K. Lift: Loose (uncompacted) layer of material.

L. Optimum Water Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field water content on basis of fraction passing 3/4-inch sieve.

M. Oversize Materials: Soil particles, soil clods, sedimentary fragments, rocks, and other materials having a maximum dimension in excess of the specified limits.

N. Particle Size: The size of a particle before compaction measured parallel to its longest dimension.

O. Period of Inactivity or Extended Shutdown: Four days.

P. Prepared Foundation: Ground surface after completion of required clearing and grubbing, stripping of topsoil, excavation to grade, and foundation preparation.

Q. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D 698 or ASTM D 1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by ENGINEER.

R. Relative Density: Calculated in accordance with ASTM D 4254 based on maximum index density determined in accordance with ASTM D 4253 and minimum index density determined in accordance with ASTM D 4254.

S. Structural Backfill: Fill materials as required adjacent to structures and other facilities.

T. Structural Fill: Fill materials as required under structures and other facilities.

U. Well-Graded:

1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
2. Does not define numerical value that must be placed or coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1.4 SUBMITTALS

A. Administrative

1. Work plan including:

a. Proposed schedule and sequencing for shoring and excavation activities that includes a breakdown of high- and low-impact work activities with respect to the operation of the Police Building and Courts Building.
b. Proposed methods for dewatering nuisance flows and for lowering the groundwater table below the excavation, if needed.
c. Proposed methods for installing and backfilling around manholes.
d. Proposed methods for placing fill around slotted drainage pipe and above apron liner.
e. Anticipated problems and proposed solutions.

B. Samples:

1. Imported material taken at source.

C. Quality Control Submittals:

1. Certified test results documenting conformance with all Specification requirements for:

a. Imported materials.

1.5 CONTRACTOR QUALITY CONTROL

A. Certified quality control test results for all imported material. Provide submittal prior to importing materials. Provide tests as specified during production.

B. Perform water content, field density, gradation, and other tests as needed to develop and manage operations and produce consistent fill and backfill meeting the Specifications.

C. Notify ENGINEER when any one of the following occur:

1. Fill is about to be placed on prepared foundation, or fill operations are about to be resumed after a period of inactivity.
2. Structures are ready for backfilling, or backfilling operations are about to be resumed after a period of inactivity.
3. Soft or loose surface is encountered where fill or backfill is to be placed.
4. Materials appear to be deviating from the Specifications.
5. Initial sampling of imported material is to be conducted or importing of a material to the site is about to begin.

D. Certified quality control tests for all fine drain material and coarse drain material.

1.6 THORNTON QUALITY CONTROL

A. THORNTON will perform field quality control tests to measure density and water content of soil in place, laboratory full compaction and associated one-point compaction tests, and gradation or index tests to confirm that materials placed meet the requirements of these Specifications.

B. THORNTON's tests will be performed on materials taken at the place of excavation, stockpiles, conveyors, and on the fill. CONTRACTOR shall remove surface material and provide assistance as necessary with sampling and testing.

1.7 SEQUENCING AND SCHEDULING

A. Place backfill against concrete structures only after concrete has attained compressive strength specified in Section 03 30 50: BASIC CONCRETE MATERIALS. Obtain ENGINEER's acceptance of concrete work and attained strength prior to placing backfill.

PART 2 PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Source(s) of imported material must be approved by ENGINEER before material is imported to the site.

B. Samples:

1. Provide one 50-pound sample of each imported material, collected in accordance with ASTM D 75, at least 28 days before importing to the site.
2. Clearly mark to show source of material and intended use.
3. Provide certified test results to document conformance with Specification requirements.

C. Tests:

1. As necessary to locate acceptable sources of imported material.
2. During production of imported material, perform gradation test and Atterberg limits test in accordance with ASTM C 117, ASTM C 136, and ASTM D 4318, respectively, as applicable, as follows:

   a. Fine Drain material: one test per 250 tons delivered to site.
   b. Coarse Drain material: one test per 50 tons delivered to site.

3. Provide gradation test results to ENGINEER within 48 hours of sampling; provide all other test results to ENGINEER upon test completion.

2.2 STRUCTURAL FILL

A. Select or processed borrow or imported material consisting of sands and clay derived from excavations, well graded, and having a maximum particle size of 2 inches, fines and plasticity characteristics noted below, and free of deleterious materials.

B. Maximum Fines Content: 12 percent.

C. Maximum plasticity index: 10.

D. Allowable Unified Soil Classification System (USCS) classifications: SP, SW, SW-SC, SP-SC, SW-SM, and SP-SM.

E. Blend adequately during placement such that the compacted material forms a uniform, homogeneous, dense, void free, and relatively pervious compacted fill.

F. Remove cobbles, boulders, hard bedrock fragments, or other particles larger than 2 inches.

2.3 FILTER SAND

A. Imported sand material, well graded, within the specified gradation limits for ASTM C33 fine aggregate, and conforming to the requirements of ASTM C 33 for soundness and deleterious substances.

B. Gradation as determined in accordance with ASTM C 117 and C 136:

Sieve Size	Percent Passing by Weight
3/8 inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	5 - 30
No. 100	0 - 10
No. 200	0 - 3

2.4 COARSE DRAIN

A. Imported gravel material, within the specified gradation limits for ASTM C33 No. 67 aggregate, and conforming to the requirements of ASTM C 33 for soundness and deleterious substances.

B. Gradation as determined in accordance with ASTM C 117 and C 136:

Sieve Size	Percent Passing by Weight
1 inch	100
3/4 inch	90 - 100
3/8 inch	20 - 55
No. 4	0 - 10
No. 8	0 - 5
No. 200	0 - 3

C. The material passing a No. 40 sieve shall be nonplastic when testing in accordance with ASTM D 4318.

2.5 PIPE BEDDING

A. Imported sand, within the specified gradation limits for AASHTO M6, Class A fine aggregate.

1. Gradation as determined in accordance with ASTM C 117 and C 136:

Sieve Size	Percent Passing by Weight
3/8 inch	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 – 60
No. 50	10 - 30
No. 100	2 - 10

B. The minimum sand equivalent, as tested in accordance with Colorado Procedure 37 shall be 80 unless otherwise specified.

C. The fineness modulus as determined by AASHTO T27, shall not be less than 2.50 or greater than 3.5 unless otherwise specified.

2.6 RIVER ROCK

A. Imported or salvaged, hard, durable, natural rounded stone within the specified gradation limits, and conforming to the requirements of ASTM C 33 for soundness and deleterious substances. Material that is salvaged must be clean of all debris, deleterious materials, and fines and be approved by the ENGINEER prior to placement.

B. Gradation as determined in accordance with ASTM C 117 and C 136:

Sieve Size	Percent Passing By Weight
12 inch	100
9 inch	80-90
6 inch	40-70
3 inch	0-10
No. 8	0-3

C. The material passing a No. 40 sieve shall be nonplastic when testing in accordance with ASTM D 4318.

D. Multi-colored rocks.

2.7 COMMON FILL

A. Select or processed borrow or imported material consisting of sands and clay having a maximum particle size of 2 inches and fines and plasticity characteristics noted below, and free of deleterious materials.

B. Fines Content – 40 to 70 percent.

C. Allowable USCS Classifications: SC, CL, CH.

2.8 TOPSOIL

A. Obtain topsoil that generally meets the following requirements:

1. A maximum particle size of 1 inch.
2. At least 25 percent fines.
3. Not more than 5 percent gravel.
4. Organic content of at least 2 percent and not more than 50 percent.
5. Free from deleterious materials.

2.9 BACKFILL CONCRETE

A. Conform to the requirements applicable for the material shown; refer to Section 03 30 50: BASIC CONCRETE MATERIALS, and Section 03 30 00: CAST-IN-PLACE CONCRETE.

2.10 MARKING TAPE

A. Metallic:

1. Solid aluminum foil, visible on unprinted side, encased in a protective, high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 5.5 mils.
3. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
4. Joining Clips: Tin or nickel-coated, furnished by tape manufacturer.
5. Color: Use color recommended for specific buried utility, as specified in ANSI Z535 and APWA.
6. Manufacturers and Products:

a. Reef Industries; Terra “D”.
b. Allen: Detectatape.

2.11 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.12 MOISTURE CONDITIONING EQUIPMENT

A. Provide water trucks and other supplemental equipment necessary to uniformly apply water for proper compaction and for watering of completed courses until overlying courses are placed.

B. Watering equipment shall be equipped with pressurized distributor bars or other means necessary to assure uniform application or water.

2.13 COMPACTION EQUIPMENT

A. Provide dedicated compaction equipment of suitable type, capable of achieving the requirements of the Specifications, and which provide a satisfactory uniform, homogeneous fill.

B. Hauling or placement equipment shall not be considered compaction equipment except under special circumstances as specified below.

C. Provide hand-operated equipment for use in confined areas not accessible to regular compaction equipment or where regular compaction equipment might damage structures or piping. Compaction equipment shall be subject to the approval of ENGINEER.

D. Equipment used for compaction of Structural Fill shall consist of a self-propelled, sheepsfoot or tamping foot roller capable of kneading material into a uniform fill.

E. Equipment used for compaction of fine drain, coarse drain and other granular materials shall consist of a vibratory plate compactor. Vibratory plate compactors shall have a minimum static weight of 270 pounds and a minimum dynamic force of 1,000 pounds.

PART 3 EXECUTION

3.1 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness in a manner that avoids segregation.

C. Compact each lift at the specified moisture content, using the specified equipment, and to specified densities, prior to placing succeeding lifts.

D. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

E. Process by blading, disking, harrowing, or other ENGINEER-approved methods as necessary to provide sufficient disaggregation and blending of fill and backfill.

F. Maintain moisture content of delivered materials and compact materials in the lift to produce the specified fill characteristics.

G. During filling and backfilling around structures, keep level of fill and backfill even on all sides of structure.

H. Do not place fill or backfill if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

I. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1-foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

J. Settlement: Correct and repair any subsequent damage to structures, slabs, piping, and other facilities caused by settlement of fill or backfill.

3.2 MOISTURE CONDITIONING AND PROCESSING

A. Moisture condition and process material prior to delivery to the fill area so that material is within the specified moisture content and particle size limits at the time it is delivered to the site.

B. Provide supplemental sprinkling on the fill to keep material within specified moisture content limits throughout the placement and compaction process, and to preserve moisture in completed courses until placement of overlying courses.

C. Blend material by disking, blading, or harrowing to maintain uniform moisture content throughout the lift.

D. Do not attempt to compact material that contains excessive moisture. Material that becomes too wet shall be removed or reworked. Aerate material by blading, disking, harrowing, or other methods to hasten the drying process.

E. Maintain moisture conditions of the fill surface during nights, weekends, holidays, and other periods of temporary work stoppage.

3.3 COMPACTION

A. Compact all material by mechanical means. If tests indicate that compaction or moisture content is not as specified, or if compaction equipment being used is not as specified, terminate material placement and take corrective action prior to resuming material placement.

B. Operate compaction equipment in strict accordance with manufacturer's instructions and recommendations. Maintain equipment in such condition that it will deliver the manufacturer's rated compactive effort.

C. Where a minimum number of coverages is specified, provide 20 percent overlapping roller passes for each complete roller coverage per lift.

3.4 FILL AND BACKFILL

A. Construct fill and backfill to the lines and grades shown.

B. Maintain the fill, including sloping the surfaces to drain, preventing or repairing gullies, and maintaining surfaces free of weeds or other vegetation until final completion and acceptance of all Work.

C. Protect fill during periods of inactivity or extended shutdown. Grade surfaces to facilitate runoff away from buildings and wheel roll or compact with a smooth drum roller to reduce infiltration and softening.

D. After periods of inactivity or extended shutdowns, prepare the fill surface prior to resumption of fill and backfill activities:

1. For Structural Fill and Common Fill: recondition the surface by scarifying to a minimum depth of 8 inches, moisture conditioning, and recompacting. If previously placed fill has become damaged by saturation, frost, or desiccation to a depth greater than 8 inches, overexcavate damaged material and replace/recompact.
2. For Filter Sand and Coarse Drain material: remove and replace contaminated material, as determined by ENGINEER.
3. No separate payment will be made for fill restoration after periods of inactivity or shutdown.

E. Structural Fill and Common Fill:

1. Maximum Lift Thickness: 8 inches, except first 6- to 12-inch lift over liners.
2. Compaction: Not less than 97 percent relative compaction (ASTM D 698).
3. Compaction Moisture: Between 2 percent below and 2 percent above optimum water content.

F. Filter Sand and Coarse Drain material

1. Maximum Lift Thickness: 6 inches.
2. Compaction: Four coverages of a vibratory plate compactor.
3. Compaction Moisture: Compact at in-situ or stockpile water content.

3.5 COLLECTION TRENCH BACKFILL

A. Hand grade to a uniform surface and check grade and correct irregularities in the Coarse Drain material.

B. Restrain pipe as necessary to prevent movement during backfilling. Placing and compacting material in maximum 6-inch lifts on both sides of pipe and, if applicable, between pipes installed in the same trench.

3.6 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of all buried conduits cables, and pipes, as follows:

1. Pipe and conduit less than 12 inches in diameter: 6 inches above the top of pipe or conduit or as designated by ENGINEER.
2. Pipe and conduit more than 12 inches in diameter: install within 12 to 24 inches below finished grade or as designated by ENGINEER.

B. Marking tape is not required for culverts below roads or where piping is encased in concrete.

3.7 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown using Common Fill.

3.8 PLACING FILL OVER GEOSYNTHETICS

A. General:

1. Refer to Section 31 05 19: GEOSYNTHETICS for placement of geosynthetic elements.
2. Place fill over geosynthetics so that geosynthetic is not damaged.
3. Place fill over apron geosynthetics by back dumping and spreading only.
4. Dump fill only on previously placed fill.
5. While operating equipment, avoid sharp turns and sudden starts or stops that could damage geosynthetics.

B. Hauling: Do not operate hauling equipment on geosynthetics.

C. Spreading:

1. Spreading equipment shall be track mounted, low ground pressure.
2. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
3. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
4. Flatten wrinkles of geosynthetics in direction of spreading.
5. Maintain proper overlap of unseamed geosynthetics.

6. Avoid overstressing geosynthetics and seams.

D. Compaction: Compact fill only after uniformly spread to full thickness shown.

E. Geosynthetic Damage:

1. Mark punctures, tears, or other damage to geosynthetics so repairs may be made.
2. Clear overlying fill as necessary to repair damage.

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SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Install and maintain erosion protection and sediment control.

1. Erosion protection and sediment control measures shall comply with the Drawings and all requirements for other local, state, and federal permits associated with erosion protection and sediment control. This shall include, but may not be limited to, the permits described in Section 01 57 19: TEMPORARY ENVIRONMENTAL CONTROLS.

1.2 REFERENCES

A. Adams County Development Standards and Regulations.

B. Colorado Department of Transportation's (CDOT) Standard Specifications for Road and Bridge Construction.

C. CDOT Erosion Control and Stormwater Quality Field Guide.

1.3 DEFINITIONS

A. Sediment and Erosion Control devices as defined herein shall mean silt fences, sediment control logs, sandbag cofferdams, sediment ponds, sediment traps, inlet protection, or other devices approved by ENGINEER.

1.4 SUBMITTALS

A. Administrative Submittals:

1. Erosion Protection and Sediment Control Plan (EPSCP). EPSCP at least 10 days before mobilization. The EPSCP shall include, at a minimum, the following information:

a. Facilities, products, and procedures to meet the requirements of erosion protection and sediment control requirements of all required project permits and requirements in these Specifications.
b. Procedure, installation details of constructing all required erosion protection and sediment control facilities.
c. Procedures and schedule to inspect, maintain, monitor, and repair erosion protection and sediment control facilities.
d. Product data of proposed materials to be used to control erosion and sediment.
e. Drawings that clearly show erosion and sediment control measures to be used for each stage of construction.
f. Schedule of removal of sediment and erosion control devices.

PART 2 PRODUCTS

2.1 SILT FENCE

A. Pervious Sheet: Polyester, polypropylene, or nylon filaments, woven into a uniform pattern, distinct and measurable openings.

B. In accordance with requirements of Table 1:

TABLE 1

Physical Property	Required Value	Test Method
Weight, oz./sq.yd., minimum	4	ASTM D 3776
Equivalent Opening Size, maximum	50 - 70	U.S. Standard Sieve
Grab Tensile Strength, lb., minimum	120	ASTM D 4632
Elongation, % maximum	15	ASTM D 4632
Mullen Burst Strength, psi, minimum	300	ASTM D 3786
Ultraviolet Radiation Resistance, % Strength Retention	70	ASTM D4355
Flow Rate, gal/minute/sq.ft, minimum	10	ASTM D 4491
Ultraviolet Radiation Stability, % minimum	90	ASTM G 26

C. Support Fence:

1. Wire Mesh Material: As recommended by manufacturer of geotextile; strong enough to support applied loads.
2. Support Posts: As recommended by manufacturer of geotextile.
3. Fasteners: Heavy-duty wire stables at least 1 inch long, tie wires or hog rings, as recommended by manufacturer of geotextile.

2.2 SEDIMENT CONTROL LOGS

A. Straw-filled tube of flexible netting material. Machine-produced tube of compacted rice straw that is Certified Weed Free Forage. Netting shall consist of seamless, high-density polyethylene and ethyl vinyl acetate and contain ultraviolet inhibitors.

B. Meet the minimum performance requirements in Table 2.

TABLE 2

Physical Property	Test Method	Required Value
Mass per Unit Weight, lbs/ft	Field Measured	1.6
Dimension, inch diameter	Field Measured	8.0 - 9.0
Net Strand Thickness, inch	Field Measured	0.030
Netting Unit Weight, ounces/ft.	Certified	0.35
Sediment Retention Capacity, lbs/ft	Rainfall Sim.(1)	30
Installed Free-Board Ht., inches	Field Measured	6.0 - 7.0
Soil Loss(1), % effectiveness	Rainfall Sim.(1)	58(2)
De-Stabilizing Moisture, % Retained (max.)	Rainfall Sim.(1)	11

Notes:
1. Minimum of three 10-year predicted storm events on 3H:1V slope with clayey sand type soil.
2. Minimum sediment yield reduction value.

2.3 DRAINAGE CHANNELS

A. Temporary drainage channels shall be excavated and stabilized to provide for controlled collection and routing of sediment laden water to sediment and evaporation ponds or for diversion of clean water away from construction or disturbed site area.

B. Such temporary drainage channels shall be designed to minimize overtopping and erosion concerns in accordance with project permit requirements.

2.4 STORM DRAIN INLET PROTECTION

A. Storm drain inlet protection shall be in accordance with the drawings, THORNTON Standards and Specifications, and CDOTs Standard Specifications for Road and Bridge Construction.

PART 3 EXECUTION

3.1 SEDIMENT AND EROSION CONTROL

A. Install erosion control facilities to the required lines, levels, contours, and datums shown on the Drawings.

B. Install sediment and erosion control facilities prior to work involving site clearing, stripping and stockpiling topsoil, excavation, and earthwork.

C. Maintain and repair sediment and erosion controls during course of construction.

3.2 SILT FENCE

A. Silt fence shall be one-piece or continuously sewn to make one-piece geotextile for full height of the fence, including portion buried in the toe trench.

B. When joints are necessary, splice geotextile together only at a support post, with a minimum 6-inch overlap, and securely fasten both ends to support post.

C. Geotextile shall not extend more than 24 inches above the ground surface. Securely fasten to up slope side of each support post using ties or staples. Bottom portion of geotextile shall be securely backfilled in toe trench such that it is not easily pulled out by hand. Geotextile shall not be stapled to existing trees.

D. Fasten wire mesh material support fence securely to up slope side of post fasteners. Extend wire into the trench a minimum of 4 inches, and not more than 36 inches above the ground surface.

E. Take precaution not to puncture geotextile during installation. Repair or replace damaged area.

3.3 SEDIMENT CONTROL LOGS (SCL)

A. Excavate a small trench, 2 to 3 inches in depth on the slope contour and perpendicular to water flow. Soil from the excavation should be placed down slope next to the trench.

B. Install the SCL in the trench, ensuring that no gaps exist between the soil and the bottom of the SCL. The ends of adjacent SCLs should be tightly abutted so that no opening exists for water or sediment to pass through.

C. Wooden stakes should be used to fasten the SCL to the soil. Place stakes at 4 feet o.c.

D. Terminal ends of SCL should be doglegged upslope to ensure containment and prevent channeling of sedimentation.

3.4 STORM DRAIN INLET PROTECTION

A. Install storm drain inlet protection in accordance with CDOT Standard Specification and CDOT Erosion Control and Stormwater Quality Field Guide.

B. Prior to installation, sweep the surface area in which the storm drain inlet protection devices are to be installed such that the pavement is free of sediment and debris. The ends of erosion logs shall extend a minimum of 1 foot past each end of the inlet.

C. Remove all accumulated sediment and debris from the surface surrounding all storm drain inlet protection devices after each rain event or as directed. Remove accumulated sediment from each containment area when it is more than half full of sediment, or as directed.

D. Protect storm drain facilities adjacent to locations where pavement cutting operations involving wheel cutting, saw cutting, sand blasting, or abrasive water jet blasting are to take place.

3.5 REMOVAL OF TEMPORARY FACILITIES

A. Do not remove erosion control facilities without written approval from ENGINEER.

B. All erosion control facilities will be the property of CONTRACTOR, and shall be removed and disposed of offsite after all Work is complete.

C. Remove and dispose of sediments collected in the sediment control systems in accordance with Section 01 50 00: TEMPORARY FACILITIES AND CONTROLS.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.1 WORK INCLUDES

A. Riprap.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

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

a. C 94 - Standard Specification for Ready-Mixed Concrete.
b. C 127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
c. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
d. C 150 - Standard Specification for Portland Cement.
e. C 535 - Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
f. D 7012 - Standard Test method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens Under Varying States of Stress and Temperatures.

2. Colorado Department of Transportation (CDOT):

a. Standard Specifications – Section 506.

1.3 DEFINITIONS

A. Refer to applicable definitions in Section 31 23 23: FILL.

1.4 SUBMITTALS

A. Samples:

1. General:

a. Notify ENGINEER at least 48 hours prior to the date of sampling to allow optional observation of sampling by ENGINEER.
b. Deliver to site at location designated by ENGINEER.
c. Incorporate samples into Work after material placement is nearly complete.
d. Be representative of material to be furnished for incorporation into Work.

B. Administrative:

1. Submit the following:

a. Description and location of proposed sources of riprap bedding and riprap.

b. Description and location of three projects where proposed riprap has been successfully used for minimum 3 years duration under similar service conditions.
c. Report of petrographic examination of the riprap and riprap bedding by an ENGINEER-approved geologist to confirm absence of shale partings, laminations and other deleterious features.
d. Certificates of Compliance, that the riprap and riprap bedding meet the Specification requirements.

2. Trip tickets showing source, type, and weight of each load of material delivered to site.

C. Quality Control:

1. Certified Test Results:

a. Riprap: Provide test results prior to importing, and during production on request of ENGINEER.

1) Gradation.
2) Abrasion resistance.
3) Bulk density.
4) Unconfined Compressive Strength.

1.5 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 5 years.

1.6 SCHEDULING AND SEQUENCING

A. Complete subgrade preparation as specified in Section 31 23 13: SUBGRADE PREPARATION, prior to placing riprap bedding and riprap.

PART 2 PRODUCTS

2.1 RIPRAP

A. Imported, hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.

B. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.

C. Abrasion Resistance: Maximum 35 percent wear as determined in accordance with ASTM C 535.

D. Unconfined Compressive Strength: Minimum 2,500 psi measured in accordance with ASTM D 7012 on drilled core specimen.

E. Bulk Density: Minimum 165 pounds per dry cubic foot (minimum specific gravity of 2.65 per ASTM C 127).

F. Gradation: Smaller pieces shall generally fill voids between larger pieces without either excess or deficiency of one or more sizes of stone. The gradations listed below generally meet the requirements of CDOT Standard:

Type	D_{50} Stone Size (Inches)	Weight (Pounds)	% Smaller by Weight
L	9	160 85 35 1.3	70 - 100 50 - 70 35 - 50 2 - 10
VL	6	85 35 10 0.4	70 - 100 50 - 70 35 - 50 2 - 10

G. Free from dirt and deleterious materials.

PART 3 EXECUTION

3.1 PLACING RIPRAP

A. Place riprap over separation geotextile to the lines, grades and thickness shown.

B. No mechanical compaction of riprap is required.

C. Intermix different sizes of riprap to eliminate segregation, to interlock pieces, and to fill voids between larger pieces with smaller pieces in such a manner as to form a smooth, uniform, well-graded layer.

D. Use placement and intermixing methods that avoid disturbing riprap bedding or damaging existing facilities, completed work, or adjacent property.

E. Placement tolerance for riprap is 0.25 foot above established grade. No tolerance below established grade will be allowed.

END OF SECTION

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SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.1 WORK INCLUDES

A. Excavation support and protection.

B. Support of existing north side of MSEW-1.

1.2 SUBMITTALS

A. Shop Drawings:

1. Excavation Support Plan. Prepare an excavation support plan including the following:

a. Details of shoring, sheet piling, bracing, sloping, or other provisions for worker protection from the hazards of caving ground.
b. Design assumptions and calculations.
c. Methods and sequencing of installing and removing excavation support.
d. Proposed locations of stockpiled excavated material.
e. The minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
f. Anticipated difficulties and proposed resolutions.
g. Methods, procedures, and sequence of integration of dewatering and excavation.
h. Plans, and sections for all shoring and excavation support systems. Calculations and plans shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
i. Anticipated deformation of the system and movement of the existing ground and facilities and details on precautions to protect existing facilities.
j. Plans and sections showing sloping or shoring of temporary slopes as necessary for construction.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing to support the sides of excavations and to prevent the detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work, to provide an adequate safety system meeting the requirements of applicable state and local construction safety orders, and federal requirements.

3.2 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as the excavation is backfilled and will not leave voids in the backfill.

B. Do not begin to remove the excavation support until support can be removed without damage to the existing facilities, completed Work, or adjacent property.

3.3 TRENCHES

A. Utilize sheeting and shoring where required to prevent the excessive widening or sloughing of the trench which may be detrimental to worker safety, to the pipe or structure being installed, to existing utilities, to existing structures, existing trees, or to other existing facility or items.

B. Do not stockpile material near the sides of the trench or excavation limits unless the trench is adequately braced.

END OF SECTION

SECTION 31 63 29
DRILLED PIERS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Drilled piers at the Mechanically Stabilized Earth Wall (MSEW)-2 foundation.

1.2 REFERENCES

A. Association of Drilled Shaft Contractors (ADSC):

1. Standards and Specifications for the Foundation Drilling Industry.

B. American Concrete Institute (ACI):

1. 336.1: Reference Specification for the Construction of Drilled Piers.

1.3 1.3 SUBMITTALS

A. Shop Drawings:

1. Work Plan: Describe equipment and methods for completing the following items:

a. Experience record of supervisory personnel and drillers.
b. Procedures used for maintaining correct horizontal and vertical alignment of the excavation.
c. Description of drilling equipment including but not limited to power rating, torque, downward thrust, and type and size of drilling tools to be used.
d. Details to minimize over-excavation beyond the limits of the drilled pier.
e. Details to prevent cave-in of the excavation to control groundwater, and to clean pier excavation.
f. Procedures for installation and removal of temporary casing.
g. Details of installing the reinforcing steel assembly including splices, laps, clear distances between bars, and procedures and materials for maintaining clear distances from soil and rock.
h. Procedures for cleaning bottom of the excavation.
i. Procedures for placing concrete.
j. Mix designs for drilling and/or chemical stabilizers for use in maintaining excavation stability.
k. Procedures to record and monitor depth and vertical alignment.

B. Quality Control:

1. Records and Reports: Daily reports and pier record reports or logs as required by ADSC's Standards and Specifications, using ADSC formats for forms.
2. Mill test certificates for reinforcing steel, indicating physical and chemical analysis, with each load of reinforcement delivered to the site.

1.4 QUALITY ASSURANCE

A. Design Criteria:

1. Drilled piers shall consist of 36-inch-diameter monolithically cast-in-place concrete backfill columns.

2. Piers shall be straight cylindrical pier type as indicated.
3. Piers shall be continuous from the design top elevation to the bottom elevation shown on the Drawings and shall extend a minimum of 15 feet into bedrock.

B. Tolerances:

1. Maximum variation of the center of any pier foundation from the required location: 3 inches, measured at the ground surface.
2. Bottom Diameter: minus zero, plus 6 inches, measured in any direction.
3. Maximum variation from plumb: 1 percent of depth of pier.
4. Maximum bottom level tolerance: ±2 inches.

C. Observation of Pier Excavations:

1. CONTRACTOR shall provide equipment for checking the dimensions and alignment of each pier excavation. Dimensions and alignment shall be determined jointly by CONTRACTOR and ENGINEER. Final pier depths shall be measured with an appropriate weighted tape measure or other approved methods after final cleaning.
2. A minimum of 50 percent of the base of each pier shall have less than 1/2 inch of sediment at the time of placement of concrete. Maximum depth of sediment or debris at any place on the base of the pier shall not exceed 1 inch. Pier cleanliness will be determined by ENGINEER by visual observation. All on-site work on piers shall be performed in the presence of ENGINEER.

1.5 QUALIFICATIONS

A. On-Site Superintendent:

1. Current full-time employee of pier installation company.
2. Supervision of at least three pier installation projects with similar depths and diameters within the last 5 years. Provide project names and contacts.
3. Supervision of a minimum of 100 drilled piers.

1.6 SEQUENCING AND SCHEDULING

A. Schedule drilling and placement of concrete so that each excavated pier is completed the same day that the drilling is performed.

B. Do not permit vibration of excessive wheel loads within the immediate vicinity of any pier excavation until placement of concrete is complete. Maintain excavation stability at all times.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete: Conform to the requirements for Class B concrete as specified in Section 03 30 50: BASIC CONCRETE MATERIALS.

B. Steel Casing:

1. Provide temporary steel casing to stabilize the pier wall.
2. Inside diameter of the casing shall be a full diameter of the drilled pier foundation, plus or minus 1/2 inch.
3. Steel casing shall have adequate strength to withstand the pressure of the soil and water around the casing and the pressure of the concrete placement without distortion.
4. Inside surfaces of steel casing shall be smooth and coated to facilitate easy lifting and removal during placement of concrete.

C. Sonotube:

1. Provide round Sonotube concrete forms for the upper 3.0 feet of all drilled piers.
2. Provide size as shown on Drawings.
3. Products:

    a. Sonotube round concrete form, Sonoco Products Company; Telephone: 1-800-377-2692.

D. Concrete Reinforcement: Conform to Section 03 20 00: CONCRETE REINFORCEMENT.

2.2 EXCAVATING AND DRILLING EQUIPMENT

A. Excavating and drilling equipment shall have adequate capacity, including power, torque, and down thrust to excavate a hole in the maximum diameter and to a depth of 20 percent beyond the depth indicated. Excavation tools shall be of adequate design, size, and strength to perform the work indicated.

PART 3 EXECUTION

3.1 EXCAVATION

A. General:

1. Excavate for pier foundations by drilling to advance the excavation to the required bottom elevation. Avoid over-excavation. Excavation shall be performed through whatever materials are encountered to the dimensions, depths, and tolerances indicated. Bottoms of excavations shall be level and flat.
2. Protect excavated walls with temporary steel casing to prevent cave-ins, displacement of the surrounding earth, water incursion, injury to personnel, and damage from construction operations. Maintain indicated neat lines of excavation for cased areas.
3. Make bottom surfaces level within the tolerances specified herein. Remove loose material, debris, and muck with cleaning buckets.
4. Install Sonotube concrete forms per manufacturer's written instructions.

B. Groundwater Control:

1. Notify ENGINEER immediately when groundwater is encountered.
2. Suitable steel casing shall be furnished and placed to control water. Approved drilling mud or chemical stabilizers may be used.

C. Observation: After completion of excavation and prior to placement of reinforcing steel and concrete, the condition of the excavation will be observed by ENGINEER. Use clean-out buckets or air-lifts to remove any sloughage or other loose material from the pier prior to placing reinforcing steel and concrete.

D. Obstructions: Surface and subsurface obstructions shall be removed. Special procedures and/or tools shall be employed if the hole cannot be advanced using conventional augers or drilling buckets. Blasting shall not be permitted.

3.2 INSTALLATION OF REINFORCING STEEL

A. Reinforcement shall be cleaned thoroughly before being placed and be free of mud, oil, debris, or other surface contaminants or corrosion at the time of concrete placement.

B. Size and configuration of vertical and tie reinforcement shall be maintained during placement of reinforcement cage and concrete.

C. Place reinforcement prior to placement of pier concrete.

D. Vertical movement of reinforcement shall not exceed 6 inches during casing withdrawal.

E. Place and support reinforcing steel to maintain a minimum of 4 inches clear cover to bottom and 3 inches to sides of pier excavation.

3.3 CONCRETE BACKFILL

A. Place concrete in dry excavations whenever practicable. Use all practicable means to obtain a dry excavation before and during concrete placement.

B. Secure reinforcing steel so that required clear distances are maintained during concrete placement.

C. Bottom of pier excavation shall be clean and acceptable to ENGINEER when concrete placement begins.

D. Concrete shall be placed as soon as possible after completion of excavation and in no case shall the excavation not be backfilled within 10 hours of being drilled. Concrete placement shall be continuous from the bottom to the top elevation of the pier. Concrete shall be placed through a tremie.

E. Place concrete using a tremie. Tremies shall consist of tube of sufficient length, weight, and diameter to discharge concrete at the pier base elevation. The tremie inside diameter shall be at least 6 times the maximum size of aggregate used in the concrete but shall not be less than 10 inches. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The wall thickness of the tremie shall be adequate to prevent crimping or sharp bends, which restrict concrete placement.

F. Free fall height during initial concrete placement shall not exceed 4 feet.

G. Following placement of the bottom 4 feet of concrete backfill, maintain tremie discharge at least 2 feet below the top of the concrete in the pier. If at any time during concrete placement the tremie line discharge is above the surface of the concrete and discharges concrete above the rising concrete backfill level, the pier shall be considered defective. In such case, CONTRACTOR shall remove the concrete, complete any necessary sidewall removal directed by ENGINEER and replace the concrete starting at the bottom of the pier.

3.4 WITHDRAWAL OF TEMPORARY STEEL CASING

A. Withdraw the casing as the concrete is being placed. Remove the steel casing in such a manner so that the lower edge of the steel casing will always remain a minimum of 5 feet below the surface of the placed concrete to prevent water and debris from entering the excavation.

3.5 SONOTUBE

A. Strip the Sonotube no earlier than 48 hours after pier concrete placement and before placement of grout.

3.6 FIELD QUALITY CONTROL

A. Records and Reports: Keep a record, on an approved form, for each drilled pier installed. Record on the form the location, dimensions, elevations of top and bottom, depth or stratum penetration, condition of bottom of excavation, concrete placement data, a continuous record of actual concrete volume placed versus theoretical volume, and any other data called for on the approved report form or pertinent to the foundation.

END OF SECTION

SECTION 31 66 16
SPECIAL FOUNDATION WALLS (MSE)

PART 1 GENERAL

1.1 WORK INCLUDES

A. Mechanically Stabilized Earth (MSE) retaining wall.

1.2 REFERENCES

A. American Society for Testing Materials (ASTM):

1. As referenced in Section 04 05 00: BASIC MASONRY MATERIALS.
2. C 140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
3. C 1157, Standard Performance Specification for Hydraulic Cement.
4. C 1372, Standard Specifications for Dry-Cast Segmental Retaining Wall Units.
5. D 698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
6. D 4595, Standard Test Method for Tensile properties of Geotextiles by the Wide Width Strip Method.

B. American Association of State Highway Transportation Officials (AASHTO):

1. M-194, Chemical Admixtures for Concrete.

C. National Concrete Masonry Association (NCMA), Design Manual for Segmental Retaining Walls:

1. SRWU-1 Test Method for Determining Connection Strength of Segmental Retaining Wall.
2. SRWU-2 Test Method for Determining Shear Strength of Segmental Retaining Wall.

1.3 DEFINITIONS

A. Standard Specifications: When referenced in this Section, shall mean Colorado Department of Transportation Standard Specifications for Road and Bridge Construction.

B. Refer to applicable definitions of Sections 31 23 23: FILL, and 31 23 13: SUBGRADE PREPARATION.

1.4 SUBMITTALS

A. Shop Drawings:

1. Geogrid reinforcement supplied long term design strength and standard Specifications required long term design strength.
2. Certified geogrid minimum average roll values determined in accordance with ASTM D 4595.

B. Samples:

1. One complete unit of each type of masonry unit to be used.

2. Samples of manufacturer's standard masonry unit colors and face finish for selection by ENGINEER.
3. Geogrid: Refer to Section 31 05 19: GEOSYNTHETICS.

C. Administrative:

1. Manufacturer qualifications.
2. Installed qualifications.
3. Warranty.
4. Manufacturer's literature including recommendations for storage and installation.

D. Quality Control:

1. Certified Test Results:

a. Concrete modular block unit compressive strength test data.
b. Concrete modular block unit oven dry weight and maximum water absorption rate by weight.
c. Manufacturer's certified test reports and certificates of compliance demonstrating that both raw materials used in manufacture of the geogrids and the final products conform to the requirements specified.
d. Submit samples of concrete modular block units as follows:

Lot Size	Samples
1 - 10,000	2 units
10,000 - 100,000	4 units
Greater than 100,000	6 units

e. Provide additional samples if required by ENGINEER.

1.5 DESCRIPTION

A. Furnish and install MSE walls using geogrid soil reinforcing elements and modular block units, masonry unit fill, and backfill to the lines and grades shown.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials with sufficient information attached to identify it for inventory and quality control.

B. Handle products in a manner that maintains undamaged condition.

C. Store geosynthetic in accordance with Section 31 05 19: GEOSYNTHETICS.

D. Prevent mud, wet concrete, epoxy, and other contaminants from contacting geosynthetics.

E. Protect modular block units from damage.

F. Damaged materials shall be replaced immediately.

1.7 QUALITY CONTROL

A. Perform at least one gradation test and Atterberg tests for each 300 cubic yards (cy) of fill placed.

B. Perform one field density test to determine relative compaction for a minimum of every three lifts. Perform test at random locations. Density determinations are not required within 3 feet of the back of the wall.

PART 2 PRODUCTS

2.1 MSE RETAINING WALL

A. Provide concrete block facing MSE retaining wall to match existing block facing units and conform to requirements of Standard Specifications Revision of Section 206 and 504 Concrete Block Facing MSE Walls, dated February 3, 2011.

1. Salvaged block from existing MSE wall can be reused if approved for re-use by ENGINEER.

B. Approved MSE retaining wall manufacturers:

1. Tensar North America, 2500 Northwinds Parkway, Suite 500, Alpharetta, GA 30009, 770-344-2090.

a. Mesa System.

2. Engineer accepted comparable product.

2.2 GEOGRID REINFORCEMENT

A. Provide geogrid reinforcement in accordance with Section 31 05 19: GEOSYNTHETICS.

2.3 MSE WALL AND MODULAR BLOCK BACKFILL

A. Backfill as follows unless otherwise recommended by the manufacturer of the MSE wall system and approved by ENGINEER.

1. Modular block units: drain gravel.
2. Reinforced zone: structural fill.
3. Reinforced concrete.

B. Place and compact fill as specified in Section 31 23 23: FILL.

2.4 CONCRETE MODULAR BLOCK UNITS

A. Concrete modular block materials shall conform to the requirements of ASTM C 1372.

B. Drycast concrete wall units shall have a minimum net 28-day compressive strength of 4,500 pound per square inch (psi).

C. Minimum oven dry weight of concrete block shall be 125 pounds per cubic foot (pcf) with a maximum water absorption rate by weight of 6 percent determined in accordance with ASTM C 140.

D. Blended cement shall meet the requirements of ASTM C 1157, Type HS.

E. Chemical admixtures shall meet the requirements of AASHTO M-194.

F. Aggregate shall be normal weight aggregates meeting the requirements of ASTM C 33.

G. Provide concrete block units having angled sides capable of producing alignment curves with a minimum radius of 3 feet at wall alignment bend locations as shown.

H. Architectural Requirements: Face finish shall be simulated sculptured rock face that matches existing blocks in size, texture, and color.

2.5 BLOCK/REINFORCEMENT CONNECTION

A. Service state connection strength at the 0.75-inch limit in accordance with NCMA Methods SRWU-1 and SRWU-2.

PART 3 EXECUTION

3.1 GENERAL

A. Construct MSE retaining wall to the lines and grades shown.

B. Salvage and re-use existing concrete masonry units (CMU) where possible. Salvaged materials shall be properly stored and covered during construction to prevent damage.

3.2 EXCAVATION AND FOUNDATION PREPARATION

A. Excavation shall be in accordance with Section 31 23 16: EXCAVATION.

B. Foundation preparation shall be in accordance with Section 31 23 13: SUBGRADE PREPARATION.

C. Excavate the foundation soil to the lines and grades shown.

3.3 MODULAR BLOCK UNIT

A. Place the first course of concrete wall units on the structural slab leveling pad. Check the wall units for level and alignment.

B. For block units requiring fill material, fill all voids in block units with modular block unit fill. Tamp fill. Ensure each wall course is completely filled, backfilled, and compacted prior to proceeding to the next wall course.

C. Install block/reinforcement connections in accordance with manufacturer's recommendations. Pull each block unit forward, away from the embankment, against connections in the previous course and backfill as the course is completed. Repeat procedure to the extent of the wall height.

D. Where the wall changes elevation, units can be stepped with grade or turned into the embankment with a convex return end. Provide leveling pad for buried units in the area of the convex return end.

E. Construct wall plumb to within 1 inch per 10 feet of wall height.

F. Wall batter: Within 2 degrees of design batter.

G. Horizontal alignment: Within 1.5 inches over any 10-foot horizontal distance. Corners, bends, and curves shall be within 0.5 foot of design location.

H. Maximum horizontal gap between masonry wall units shall be 1/2 inch.

I. Maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement and compaction, shall not exceed two courses.

3.4 WALL CAP

A. Provide a permanent connection between wall cap units and the top course of the wall units. Use suitable construction adhesive or epoxy for the connection. Provide reinforcement at the connection as necessary.

3.5 GEOGRID

A. Lay the geogrid soil reinforcement horizontally on compacted backfill. Connect to the concrete wall units by hooking the geogrid over the connecting pins. Pull the geogrid taut, and anchor it before backfill is placed on the geogrid.

B. Soil reinforcing elements shall be oriented with the highest strength axis normal to wall alignment.

C. Geogrid reinforcement shall be continuous throughout their embedment lengths and provide minimum 4 inches overlap of adjacent geogrid panels. Panels shall be placed full width.

D. Remove the slack in the geogrid at the wall unit connections.

E. Lay the geogrid at the proper elevations as indicated on the drawing.

F. Verify the correct orientation (roll direction) of the geogrid.

G. Pull the pinned geogrid taut to eliminate loose folds and pre-tension the geogrid. Stake or secure the back edge of the geogrid before and during backfill and compaction.

H. Follow the manufacturer’s guideline relative to overlap requirements of uniaxial and biaxial geogrids.

3.6 MSE WALL BACKFILL

A. Place MSE wall backfill in maximum 8-inch lifts and compact to a minimum of 97 percent relative compaction (ASTM D 698) at a moisture content between 2 percent below and 3 percent above optimum moisture content.

B. Place, spread, and compact the backfill in a manner that minimizes the development of slack in the geogrid and damage to the geogrid.

C. Place the backfill starting at the wall and proceed into the excavated slope to ensure the geogrid remains taut.

D. Only operate lightweight hand-operated equipment within 3 feet of the back of the masonry wall units.

E. Do not operate tracked construction equipment directly on the geogrid. Before operation of tracked vehicles, a minimum backfill thickness of 8 inches is required over the geogrid. Minimize turning tracked vehicles to prevent tracks from displacing the fill and damaging the geogrid.

F. Rubber-tired equipment may travel over the geogrid reinforcement at slow speeds, less than 5 miles per hour (mph). Avoid sudden braking and sharp turning.

G. At the end of each day’s operations and at the completion of contract, the top surface of select materials shall be shaped such that runoff from rain will drain away from the wall.

H. Slope the top of the backfill along the wall such that the top reinforcing element is covered with at least 12 inches of material.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 WORK INCLUDES

A. Aggregate base used for fill, roads, and parking areas.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society of Testing Materials (ASTM):

a. C 117, Standard Test Method for Materials finer than 75 microns (No. 200) Sieve in Mineral Aggregates by Washing
b. C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
c. C 136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
d. D 75, Standard Practice for Sampling Aggregates
e. D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
f. D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

2. Colorado Department of Transportation, Standard Specifications for Road and Bridge Construction (CDOT Standard Specifications).

a. Section 703.03 Aggregate for Bases

1.3 DEFINITIONS

A. Refer to applicable definitions of Section 31 23 23: FILL, and Section 31 23 13: SUBGRADE PREPARATION.

1.4 SUBMITTALS

A. Quality Control:

1. Certified test results documenting conformance with all Specification requirements.

1.5 QUALITY CONTROL

A. Notify ENGINEER when prepared foundation is ready for placement of overlying aggregate surfacing.

1.6 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Sections 31 23 23: FILL, and 31 23 13: SUBGRADE PREPARATION, prior placement of aggregate surfacing.

PART 2 PRODUCTS

2.1 AGGREGATE BASE COURSE

A. Imported, hard, durable, natural crushed stone or crushed gravel with sand and sufficient finer material for proper compaction, well-graded, and free from deleterious materials.

B. Gradation as determined in accordance with ASTM C 117 and C 136:

Sieve Size	Percent Passing by Weight
3/4-inch	100
No. 4	30 - 65
No. 8	25 - 55
No. 200	3 - 12

C. Liquid Limit not exceeding 30 and Plasticity Index not exceeding 6 as determined in accordance with ASTM D 4318.

D. Percentage of wear by LA abrasion test less than 50 percent as determined in accordance with ASTM C 131.

E. Material meeting the requirements of Class 6 Aggregate Base Course Material as specified in CDOT Section 703.03 may meet the requirements specified herein except that crushed slag, crushed reclaimed concrete, and crushed reclaimed asphalt will not be allowed.

PART 3 EXECUTION

3.1 PREPARING SUBGRADE

A. Prepare previously placed fill or excavated surface to receive overlying aggregate surfacing. Moisture condition and compact the underlying material as specified in Section 31 23 13: SUBGRADE PREPARATION.

B. After compaction, trim subgrade with a motor grader to firm, moist compacted material, and to the cross-section shown.

C. Grade subgrade with uniform slope between points where elevations are given.

D. Protect surface until placement of overlying aggregate surfacing.

E. Do not place on wet or muddy subgrade.

F. Fill and compact any depressions and remove loose material to finish true to line and grade, presenting a smooth, compacted and unyielding surface, except where indicated otherwise.

3.2 PLACING AGGREGATE SURFACING

A. Do not haul over completed subgrade.

B. Spread base in an even distribution of material without segregation.

C. Place in maximum 12-inch-thick lifts. Compact with a vibratory steel drum roller.

D. Moisture condition each lift to within plus or minus 2 percent of optimum water content and maintain water content during compaction.

E. Compact to at least 95 percent relative compaction (ASTM D 1557).

F. Place each layer of base course and compact to the specified density before a succeeding layer is placed.

G. Grade final surface to provide a smooth, uniform surface that drains.

H. Correction of Surface Defects: Should irregularities develop in any surface during or after rolling, they shall be remedied by loosening the surface and correcting the defects, after which the entire area, including surrounding surfaces, shall be rerolled until thoroughly compacted. Finished surfaces shall be true to grade and crown before proceeding with surfacing.

I. Final Lines and Grades: Plus or minus 0.1-foot unless dimensions or grades are shown or specified otherwise.

END OF SECTION

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SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Replace asphalt pavement for portions of the lower parking area for the Police building, and other areas that are impacted by the Work.

B. Re-pave parking areas beyond areas impacted by the Work. Re-paving will be made at the discretion of THORNTON.

1.2 RELATED WORK

A. Excavation, backfilling, and subgrade preparation are included in Section 31 23 16: EXCAVATION and Section 31 23 23: FILL.

B. Placement and compaction of aggregate base is included in Section 32 15 00: AGGREGATE SURFACING.

1.3 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Association of State Highway and Transportation Officials (AASHTO):

a. T-209, Standard Method of Test for Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA).
b. T-166, Bulk Specific Gravity of Compacted Hot-Mix Asphalt.

2. Colorado Department of Transportation (CDOT):

a. Standard Specifications for Road and Bridge Construction (CDOT Standard Specifications).

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

a. D 2026, Standard Specification for Cutback Asphalt (Slow-Curing Type).
b. D 2950, Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.

1.4 SUBMITTALS

A. Shop Drawings:

1. Asphalt Pavement Plan to include:

a. Proposed procedures, methods, equipment, and sequence for placing asphalt pavement in each area required.
b. Protection for completed pavement until ready for use.
c. Order of constructing the various components of the Work.
d. Narrative with figures to illustrate the plan.

2. Catalog and manufacturer’s data sheets for all equipment to be used to place and compact pavement.

B. Mix Design:

1. Proposed mix design developed in accordance with CDOT Standard Specifications, Part 401.02 by a materials laboratory and stamped by a licensed engineer in the State of Colorado and practicing in this field.
2. Laboratory test results of the materials used in the mix design including:

a. Source of aggregate and asphalt materials.
b. Gradation, specific gravity, source and description of individual aggregates and the final blend.
c. Physical properties of aggregates.
d. Source and grade of the performance graded binder (PG Binder).
e. Proposed job mix formula that defines the allowable gradation, percent of asphalt cement, and temperature at discharge point at the plant.
f. Compaction temperature.

1.5 CONTRACTOR QUALITY CONTROL

A. Certified quality control test results for all asphalt pavement materials. Provide submittal prior to importing materials. Provide tests as specified during production.

B. Perform in-place density, gradation, and other tests during pavement placement as needed to develop and manage operations and produce consistent and uniform pavement meeting the Specifications.

C. Notify ENGINEER when any one of the following occur:

1. Asphalt pavement is about to be placed on prepared aggregate base.
2. Soft or loose surface is encountered where pavement is to be placed.
3. Materials appear to be deviating from the Specifications.

1.6 THORNTON QUALITY ASSURANCE

A. THORNTON's independent materials testing firm will perform field quality assurance tests to measure in-place density, gradation and Atterberg limits, maximum theoretical density, and asphalt content to confirm that materials placed meet the requirements of these Specifications.

B. THORNTON's independent materials testing firm's tests will be performed on materials taken at the place of paving. CONTRACTOR shall provide assistance as necessary with sampling and testing.

C. CONTRACTOR shall pay for retesting due to failed tests. No additional placement shall occur until passing tests are achieved.

PART 2 PRODUCTS

2.1 MATERIALS

A. Asphalt Pavement.

1. Hot mix asphalt (HMA) shall be composed of a mixture of aggregate, filler, hydrated lime, and asphalt binder and shall meet the requirements of CDOT Standard Specifications Section 403.

B. Aggregates for Asphalt Pavement.

1. Aggregates for HMA shall be uniform quality, durable, hard particles of crushed stone or gravel free of organic or deleterious materials.

2. Mix design for asphalt pavement may consist of Grading SX and Grading S aggregates as approved by the ENGINEER.

a. Aggregates for asphalt Grading SX shall be in accordance with CDOT Standard Specifications Section 703.04 and as specified below. Minimum thickness of Grading SX shall be 1-1/2".

Sieve Size	Percent Passing by Weight
3/4-inch	100
1/2-inch	85 - 100
3/8-inch	Per mix design
No. 4	Per mix design
No. 8	28 - 58
No. 30	Per mix design
No. 200	2 - 10

b. Aggregates for Grading S asphalt shall be in accordance with CDOT Standard Specifications Section 703.04 as specified below. Minimum thickness of Grading S shall be 2-1/2".

Sieve Size	Percent Passing by Weight
1-inch	100
3/4-inch	90 - 100
1/2-inch	Per mix design
3/8"	Per mix design
No. 4	Per mix design
No. 8	23 - 49
No. 30	Per mix design
No. 200	2 - 8

C. Performance Graded (PG) Asphalt Binders

1. Certified asphalt binder PG-58-28 in accordance with CDOT Standards and Specifications Section 702.01.

D. Liquid Asphalt

1. Liquid asphalt for prime coat, tack coats, or treatment of aggregate base shall be Grade MC250 conforming to ASTM D2026 and CDOT Standard Specifications Section 702.02.

E. Pavement Markings

1. All pavement markings shall be thermoplastic meeting the requirements of the THORNTON Standards and Specifications for the Design and Construction of Public and Private improvements.

2.2 EQUIPMENT

A. Mixing Plant:

1. The mixing plant shall be capable of producing a uniform material, have adequate capacity, and be maintained in good mechanical condition. Defective parts shall

be replaced or repaired immediately if they adversely affect the proper functioning of the plant or plant units, or adversely affect the quality of the HMA.

B. Hauling Equipment:

1. Trucks used for hauling HMA material shall have tight, clean, smooth beds, or functional and maintained conveyor belt bottom that is thinly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent. Petroleum distillates such as kerosene or fuel oil will not be permitted. Each truck shall have a cover of canvas or other suitable material to protect the mixture from the weather and excessive temperature loss or cooled layers of mix in truck.

C. Pavers:

1. Self-propelled pavers shall be provided for full lane width paving capable of spreading and finishing the HMA, material in full lane widths applicable to the typical section and thicknesses shown on the Drawings and shall be equipped with:

   a. Anti-segregation devices.
   b. A vibratory screed assembly capable of being heated.

2. Pavers used for shoulders, patching, and similar construction, not requiring fine grade control shall be capable of spreading and finishing courses of HMA material without segregation.
3. The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and shall have an automatic distribution system that will place and spread the mixture uniformly in front of the screed.
4. The paver shall be capable of operating at forward speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver shall be avoided. The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, or gouging the mixture. Self-propelled pavers shall be equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, and maintaining the screed at the specified longitudinal grade and transverse slope. The sensors may be contact or non-contact type devises. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices when they are required for the situation:

   a. Grade control device at least 12 feet in length.
   b. Adequate length of control line and stakes, if no other type of geometric control is present.
   c. A straight edge at least 5 feet in length will be available to verify the crown on the screed.

5. The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent. Automatic mode should be used where possible. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.
6. 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.

D. Compaction Equipment

1. Provide dedicated compaction equipment of suitable type, capable of achieving the requirements of the specifications, and which provide a satisfactory uniform, dense pavement.

2. Hauling or placement equipment shall not be considered compaction equipment.
3. Provide hand-operated equipment for use in confined areas not accessible to regular compaction equipment or where regular compaction equipment might damage existing structures or facilities. Compaction equipment shall be subject to the approval of ENGINEER.
4. Equipment used for compaction of pavement shall consist of a self-propelled, steel drum and pneumatic type rollers capable of compacting and finishing material into a uniform embankment. Rollers shall be free to pivot about an axis parallel to the direction of travel.

PART 3 EXECUTION

3.1 GENERAL

A. Equipment used to mix, deliver, place, compact, and install asphalt pavement and pavement marking materials shall meet CDOT standards.

1. All pavement markings shall be thermoplastic meeting the requirements of THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements.

3.2 MIXING, DELIVERY, AND COMPACTION

A. Materials for hot bituminous asphalt pavement shall be mixed, delivered, placed and compacted in accordance with the requirements of CDOT as specified herein.

B. Deliver mixture at a minimum temperature of 235°F measured behind the paver screed. Produce hot-mix asphalt mixture at the lowest temperature within the specified temperature range that yields a workable mix, uniformly coats the aggregate, and allows required compaction.

3.3 TEMPERATURE AND WEATHER LIMITATIONS

A. When the air temperature falls below 50°F, extra precautions shall be taken in drying the aggregates, controlling the temperatures of the materials and placing and compacting the mixtures.

B. Place bituminous mix only on prepared compacted surfaces free from water, snow, or ice and when the temperature and weather conditions permit the asphalt to be properly placed and finished.

C. Mixtures shall not be placed on a wet or frozen surface nor when the air or the pavement temperature is below the temperatures listed in CDOT Table 401-3. Placement temperature limitations are discussed below.

Table 401-3, Placement Temperature Limitations in Degrees F

Compacted Layer Thickness in inches	Minimum Surface and Air Temperature[(a)]	
	Top Layer of Pavement	Layers Below Top Layer
< 1 1/2	60	50
1 1/2 to < 3	50	40
≥ 3	45	35

(a) Air temperature taken in the shade. Surface is the existing base on which the new pavement is placed.

3.4 TRAFFIC CONTROL

A. No vehicular traffic or load shall be permitted on the newly constructed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent

distortion or loss of fines. If the weather or other conditions warrant it, the period of time before opening to traffic may be extended at the discretion of the ENGINEER.

B. Provide barricades or other traffic control devices to exclude vehicles from travelling through areas to be paved.

3.5 HOT BITUMINOUS PAVEMENT INSTALLATION

A. Hot bituminous asphalt pavement in areas to be patched: Pavement for patching existing roads or parking areas.

1. Place hot bituminous asphalt pavement per CDOT-05 Section 401. Compact bituminous pavement by rolling using both steel wheel and pneumatic tire rollers. Furnish rollers of sufficient number, weight, and type to obtain the required density while the mixture is in a workable condition. Begin compacting bituminous pavement as soon as the mixture is placed. Continue compaction until the required density is obtained and before the mixture surface temperature falls below 185°F. Remove all roller marks with the finish rolling.
2. CONTRACTOR shall sweep and clean the street before final asphalt patching. The surface shall be cleaned for the full width and length to be treated immediately prior to application of the bituminous material. Dust and other material in depressions or other places not removed by mechanical sweepers shall be swept with hand brooms or removed by the use of flushers.
3. Pavement patch shall at least match thickness of existing pavement.
4. Saw cut and trim loose edge of existing pavement back at least 12 inches beyond the edge of the trench to solid pavement with no cracks.
5. Broom and tack coat edges and asphalt surfaces.
6. Place and compact to the total thickness. Finish smooth, dense, and flush with surface of existing connected pavement.
7. Tack coat:

    a. Apply a tack coat at the approximate rate of 0.05 to 0.10 gallons per square yard to all vertical surfaces of existing pavement; and construction joints against which asphalt pavement will be placed. Application shall comply with CDOT-05 Section 407. Dust or contamination of tack coats will require brooming and reapplication.

8. Prime coat:

    a. Where a prime coat is specified, prior to placing asphalt pavement apply the prime coat to the aggregate base at the approximate rate of 0.25 to 0.40 gallons per square yard. Application shall comply with CDOT-05 Section 407. Dust or contamination of prime coats will require brooming and reapplication.
    b. Prior to placement of subsequent material, blot any excess primer that fails to penetrate the surface with clean sand.

3.6 COMPACTION

A. The breakdown compaction should be completed as quickly as possible after placement occurs.

B. The HMA shall be compacted by rolling. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continued until the required density is obtained. Final compaction shall be obtained using steel wheel rollers.

C. Pavement operations shall be suspended when density requirements are not met and the surface temperature falls below 185° F, or there is obvious surface distress or breakage, the problem shall be resolved prior to continuing paving operations. The minimum compaction temperatures may be adjusted according to the asphalt binder supplier recommendations. Adjusted minimum compaction temperatures must be shown on the approved mix design or on other asphalt binder supplier documents, and be available on the job site.

D. All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted on bridge decks.

E. Establish a rolling pattern or procedure during the beginning of paving operations that will achieve the required compaction and surface tolerances. This procedure may be reevaluated by ENGINEER throughout the paving operations.

F. Compact all HMA paving to between 92.0 and 96.0 percent of maximum theoretical density as determined by ASTM D 2950. Determine Rice density in accordance with AASHTO T 209. Use Rice values to calculate relative compaction according to AASHTO T 166.

G. Determine the proper Rice value to use for the initial day's placement. Subsequent day's Rice value(s) will be based on the current day's production. Provide the producer's Rice value, which shall be used for production until the actual day's Rice value is determined and accepted by THORNTON.

H. All joints shall be compacted to between 94.0 and 96.0 percent of Rice. Test shall be obtained on each side of joint, every 200 linear feet. Rice values shall be used in calculating relative compaction according to AASHTO T 166. Cores if needed will be used to verify compaction results.

I. Core the pavement, as required by THORNTON, for field density tests in accordance with AASHTO T 230, Method B, or for field calibration of nuclear density equipment in accordance with the ASTM D 2950. At a minimum, cores for nuclear density equipment calibration shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation. Untested areas during placement will also require cores to be taken to verify compaction.

J. All places not accessible to the rollers shall be compacted to the required density.

K. Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture and compacted to conform to the surrounding area.

3.7 QUALITY CONTROL

A. CONTRACTOR shall perform quality control tests prior to and during placement of asphalt pavement as necessary to control the quality of the work and as necessary to resolve problems identified by quality assurance testing.

B. Cooperate with ENGINEER in performing sampling and testing, and in resolving any discrepancies between quality assurance and quality control test results.

3.8 QUALITY ASSURANCE

A. THORNTON will perform supplemental quality assurance testing to confirm that the materials paced conform to the specification requirements, for both acceptance and documentation purposes, and to confirm the accuracy of CONTRACTOR's quality control testing.

B. THORNTON's quality assurance testing will utilize the same test methods specified for CONTRACTOR's quality control testing.

C. Cooperate with THORNTON in performing sampling and testing, and in resolving any discrepancies between quality assurance and quality control test results.

END OF SECTION

SECTION 32 31 19
DECORATIVE METAL FENCES AND GATES

PART 1 GENERAL

1.1 WORK INCLUDES

A. Metal fence at Mechanically Stabilized Earth Wall (MSEW)-2.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society for Testing Materials (ASTM):

a. A239 - Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
b. A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
c. A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
d. A1011/A1011M - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
e. D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
f. D2244 - Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
g. F2814 - Guide for Design and Construction of Ornamental Steel Picket Fence Systems for Security Purposes.
h. F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets.

2. American Institute of Steel Construction (AISC):

a. “Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings,” eighth edition.

3. American Welding Society (AWS):

a. “Code for Arc and Gas Welding in Building Construction,” AWS D1.0.
b. “Structural Welding Code.”

4. State and local building codes, together with applicable state and local laws.

1.3 SUBMITTALS

A. Shop Drawings:

1. Submit list of salvaged items from existing fence.
2. Submit drawings of fabricated items. The following shall be included in the submittal:

a. Describe all fabricated items and show all dimensions, sizes, finishes, fasteners and welds, and relationship of work to adjoining construction.
b. Reference all construction materials by ASTM designations and grades. Catalog work sheets showing illustrated cuts of items to be furnished, including scale details, dimensions and materials, may be submitted for standard manufactured items.

3. Submit placement or erection drawings which indicate locations of fabricated items. Reproduction of Contract Documents will not be accepted for this purpose. Verify all dimensions to ensure proper fit of all fabricated items.

PART 2 PRODUCTS

2.1 POSTS AND RAILS

A. General:

1. Strength and Stiffness Requirements: ASTM F 2408, Ornamental Fences, except as modified in this Section.
2. Roll-Formed Steel Shapes: Roll-formed from ASTM A 653, Grade 45, steel.
3. Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 24.
4. Protective Coatings: ASTM F 2408.
5. All fence posts, pickets, rails, and fittings shall be powder coated black.
6. Manufacturer:

a. Merchant Metals, 12345 NW Grand Avenue, El Mirage, AZ 85335.

1) Guardsman Commercial decorative ornamental steel fence.

B. Line Posts:

1. Galvanized square steel tubular members.
2. Post size and height shall match those of salvaged existing members.

2.2 OTHER

A. Pickets:

1. Galvanized steel 3/4 inch square tubular members.
2. Strength and Stiffness Requirements: ASTM A 653.

B. Rails

1. 1-3/8 inch x 1-1/2 inch gauge galvanized steel U channel.
2. Strength and Stiffness Requirements: ASTM A 653.

C. Fence Fittings

1. General: In conformance with ASTM F 626, except as modified in this Section.
2. Standard Post Caps: Cast aluminum or malleable iron or formed steel flat tops manufactured to form a weather-tight closure.
3. Finial Tops for Pickets: Cast aluminum, attached to pickets by 1/4 inch rivet. All finials extend 6 inch above rail.

PART 3 EXECUTION

3.1 GENERAL

A. Salvage and re-use fence where possible. Salvaged materials shall be properly stored and covered during construction to prevent damage.

B. Install metal fence in accordance with ASTM F 2408, except as modified in this Section, and in accordance with fence manufacturer's recommendations, as approved by ENGINEER. Erect fencing in straight lines between angle points.

C. Provide all necessary hardware for a complete fence installation.

3.2 PREPARATION

A. Establish locations of fence lines, terminal posts, and concrete foundations.

3.3 POST SETTING

A. Driven posts are not acceptable.

B. Set posts in the ground with minimum embedment below finished grade of 24 inches and with top rail at proper height above finished grade. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

C. Backfill post holes in the ground with Class B concrete to 2 inches below finished grade.

D. Set fence post in concrete walls by either casting fence posts in place, casting blockouts in the top of the wall, or coring the concrete in the top of the wall.

1. Cast-in-place posts: Set posts plumb. Secure posts to prevent movement during concrete placement. Embed posts 24 inches deep in concrete.
2. Cast-in-place blockouts: Place blockouts 24 inches deep and 6 inches in diameter.
3. Coring: Core holes 6 inches in diameter and 24 inches deep.

E. Posts set in blockout holes or core holes shall be grouted in place with Type 1 grout in accordance with the requirements of Section 03 62 00: NON-SHRINK GROUT.

F. Post set in landscaped areas shall be covered with minimum 3 inches of mulch or topsoil.

3.4 BRACING

A. Brace gate and corner posts diagonally to adjacent line posts to ensure stability.

3.5 HORIZONTAL SUPPORTS AND PICKETS

A. Do not install horizontal supports and pickets until concrete has cured minimum 7 days.

END OF SECTION

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SECTION 32 33 00
SITE FURNISHINGS

PART 1 GENERAL

1.1 WORK INCLUDES

A. Flagpole sleeve and assembly

B. Planters

C. Bollards

D. Benches

1.2 SUBMITTALS

A. Shop Drawings

1. Product Data: For each type of product.

B. Samples

C. For each exposed product and for each color and texture specified.

1. Samples for Initial Selection: For units with factory-applied finishes.
2. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.
3. Include full-size Samples of all site furnishings. Approved samples may be incorporated into the Work.

D. Maintenance

1. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 PRODUCTS

2.1 PLANTERS

A. LLDPE Urban Vase 41, Circular, Large Reservoir Planter, Color: Brownstone as provided by EarthPlanter, Auburn, NY, 877-815-9276, or approved equal.

2.2 BOLLARDS

A. Annapolis Standard Metal Bollard, 6-inch Diameter, Embedded, Protective Sleeve, Color: Black, as provided by Landscape Forms, Kalamazoo, MI 800-430-6209, or approved equal.

2.3 FLAGPOLE SLEEVE

A. Steel Ground Sleeve Assembly with Steel Lightning Spike as provided by Concorde American Flagpole, Grapevine, TX, 800-527-3902, or approved equal.

2.4 BENCHES

A. Surface mounted, diamond pattern, steel bench of the color matching the existing benches or as approved by THORNTON.

B. Match existing bench or equivalent product approved by THORNTON.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed. Bollards and flagpoles to be coordinated with pavement placement and geomembrane work.

C. Install site furnishings level, plumb, true, and securely anchored and positioned at locations indicated on Drawings.

D. Install benches in generally the same location as the existing benches. Location of benches to be approved by THORNTON.

END OF SECTION

SECTION 32 92 00
TURF AND GRASSES

PART 1 GENERAL

1.1 WORK INCLUDES

A. Reclaiming specific areas within the limits of site disturbance as directed by the ENGINEER including:

1. Sod or seed preparation.
2. Soil amendment application.
3. Sodding or seeding.
4. Mulching.
5. Weed barrier.
6. Re-seeding as necessary during warranty period.

1.2 REFERENCES

A. THORNTON Standards and Specifications for the Design and Construction of Public and Private Improvements, Sections 806 and 807.

1.3 DEFINITIONS

A. Areas to be Seeded: Areas disturbed during construction except areas to be covered with roadbase, river rock, mulch, or concrete. Areas will be as directed by the ENGINEER.

B. Sodding Period: Perform under favorable weather and soil moisture conditions.

1. Spring: Spring thaw to June 1.
2. Fall: September 15 until consistent ground freeze.

1.4 SUBMITTALS

A. Shop Drawings:

1. Proposed methods and equipment for sodding or seeding.
2. Proposed source and materials for sod, seeds, and mulch.
3. Manufacturer’s product data and installation instructions for erosion blanket.

B. Quality Control:

1. Sod certifications.

1.5 DELIVERY, STORAGE, AND PROTECTION

A. Follow THORNTON Standards and Specifications 805, 806 and 807.

B. General: Deliver in original, unopened containers. Protect materials from animals and moisture. Wet, moldy, open, or broken packages will not be accepted. Nonflowing materials will be rejected.

1.6 SPECIAL GUARANTEE

A. Provide extended warranty, with THORNTON named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for re-sodding or re-seeding all areas not achieving a satisfactory stand, including mulching, during a period of 1 year after the date of substantial completion.

B. Reseeding shall take place during the first month of next seeding period.

1.7 MAINTENANCE

A. Operations: Perform after planting until Initial Acceptance, and during warranty period, to include:

1. Mulch: Replace wherever and whenever washed or blown away.
2. Re-sod or re-seed unsatisfactory areas or portions thereof during the next seeding period.

PART 2 PRODUCTS

2.1 SOD

A. Sod shall meet the requirements of THORNTON Standards and Specifications Section 806.2.B.

2.2 SOIL AMENDMENT

A. Soil amendments shall meet the requirement of THORNTON Standards and Specifications Section 804.3.

2.3 SEED

A. Seed shall be new crop delivered in original containers, unopened, bearing dealer's warranty analysis. Maximum crop and weed content shall be 0.10 percent each. Seed shall be free of all noxious weeds. Minimum germination shall be 85 percent and minimum purity shall be 95 percent. If seed on the market does not meet minimum purity and germination percentage, compensation is to be made for a lesser percentage of purity or germination by furnishing additional seed to equal specified mix. Product comparison shall be made on based of pure live seed (PLS) in pounds. Formula for determining quantity of PLS shall be:

Pounds of Seed x Purity x Germination = Pounds PLS

B. Thornton Buff/Blue Grama Mix

Common Name	Scientific Name	Lb/acre (PLS)
Buffalograss	Buchloe dactyloides	37
Blue Grama	Bouteloua gracilis	8
	Total	45

2.4 MULCH

A. Provide clean, fresh straw, free of weeds and weed seeds. Mulch material shall be seed-free or fumigated to prevent introduction of weeds. Mulch shall not contain more than 5 percent seed by weight and shall not be musty, moldy, decayed, or caked. Mulch shall be shredded redwood bark screened to 2 inch to 5 inch in length, 1/4 inch to 1/2 inch in width, and 1/8 inch to 1/4 inch in thickness.

B. Tackifier: Provide mulch tackifier that is 100 percent organic and biodegradable.

2.5 WEED BARRIER

A. Weed barrier shall be made from permeable polypropylene meeting the following minimum requirements:

1. Thickness: 23 millimeters.
2. Grab Tensile Strength: 70 pounds.
3. Trapezoidal Tear Strength: 27 pounds.
4. Water Permeability: 10 gallons per minute per square foot.

2.6 EROSION BLANKET

A. Permanent erosion blanket shall be 100 percent coconut fiber erosion blanket. Coconut fiber matrix shall be minimum 0.5 pound per square yard. Provide photodegradable mesh and thread top and bottom of blanket.

PART 3 EXECUTION

3.1 GENERAL

A. Sodding, seeding, mulching, and weed barrier shall be performed in accordance with THORNTON Standards and Specifications Sections 804, 805, 806, and 807. Weed barrier shall be anchored in fill per manufacture's recommendations.

3.2 EROSION CONTROL BLANKET

A. Place erosion control blanket on slopes steeper than 3H:1V or at locations directed by ENGINEER.

B. Place erosion control blanket in accordance with manufacturer's recommendations.

3.3 FINAL INSPECTION

A. Perform final inspection 1 year after date of substantial completion. Final inspection shall confirm that an acceptable stand has been achieved and is acceptable to THORNTON.

END OF SECTION

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SECTION 33 05 13
MANHOLES AND STRUCTURES

PART 1 GENERAL

1.1 WORK INCLUDES

A. Prefabricated concrete manholes.

B. Prefabricated concrete inlets.

C. Prefabricated metal end sections.

D. Prefabricated concrete handholes and vaults.

E. Frames, grates, and covers for manholes, inlets, handholes, and vaults.

1.2 REFERENCES

A. American Concrete Institute (ACI):

1. 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.

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

1. A 48 - Standard Specification for Gray Iron Castings.
2. C 150 - Standard Specification for Portland Cement.
3. C 478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
4. C 857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
5. C 858 - Standard Specification for Underground Precast Concrete Utility Structures.
6. C 923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
7. D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

C. American Association of State Highway and Transportation Officials (AASHTO).

1. M 36 - Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
2. M 243 - Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches.

1.3 SUBMITTALS

A. Shop Drawings:

1. For each precast concrete structure. Include unit dimensions, section details, finishes, reinforcement, connection details, lifting and erection inserts, other embedded items, the alignment of pipe blockouts, and layout diagrams identifying installation locations and identification marks. The method of anchoring proposed to secure multiple concrete sections. The method of connecting the trench liner and apron liner, to the pre-cast concrete structure.

1.4 QUALITY ASSURANCE

A. After installing, demonstrate to ENGINEER that the structures have been properly installed, level, and tight joints, at the correct elevations and orientations, and that backfill has been placed in accordance with the Specifications.

1.5 PRODUCT DELIVERY, HANDLING, AND STORAGE

A. Lift and support units only at designated lifting and supporting points.

B. Transport units in a manner that will not result in overstressing or damage during delivery, handling, and storage of units.

C. Do not place units directly on earth during storage.

D. Place stored units so that identifications marks are discernible.

PART 2 PRODUCTS

2.1 PRECAST

A. The concrete and reinforcing materials used to construct the structures shall conform to Section 03 30 50: BASIC CONCRETE MATERIALS, Section 03 20 00: CONCRETE REINFORCEMENT, and Section 03 30 00: CAST-IN-PLACE CONCRETE. Manholes shall be precast and shall conform to ASTM D C478. Repair mortar and an epoxy bonding agent shall be used if necessary, to repair minor surface damage to precast sections of cast-in-place manhole bases at the discretion of ENGINEER. Repair products shall be in accordance with Section 03 01 30: MAINTENANCE OF CONCRETE.

B. The lid, walls, and foundation shall be adequately designed to handle all applicable loads in accordance with ASTM D C587. The manholes, inlets, and other vaults will be subject to AASHTO HS-20 Loading.

C. The riser sections shall be manufactured as shown on the approved shop drawings.

D. Cast wall pipes and holes for pipe penetrations at the elevations and sizes indicated on the Drawings.

E. Joint Sealer for the precast sections shall be flexible materials such as CONSEAL, RAMNEK, KOR-N-SEAL, or engineer approved comparable product.

F. Damp-proofing material shall be in accordance with Section 07 10 00: DAMPPROOFING AND WATERPROOFING.

2.2 END SECTIONS

A. End sections shall be composed of galvanized steel meeting requirements of AASTHO M 36.

B. Metal end sections and coupling bands shall be fully coated in bituminous material conforming to the requirements of AASTHO M 190, Type A coating or materials conforming to the requirements of AASHTO M 243 except that the use of tar base material will not be permitted. Coating shall be shop applied. The minimum thickness of the coating shall be 1.3 mm.

2.3 FRAMES AND COVERS

A. Frames and covers for manhole openings shall be cast-iron, ASTM A 48, 2408A of East Jordan Iron Works, Inc or engineer approved comparable product. The manhole frame shall be flange mounted with bolts to the top of the precast concrete lid.

B. Frames and grates for inlets shall be gray-iron, ASTM A 48, Catch Basin set model V3418-1 or engineer approved comparable product.

C. Bolts for flange mounting the manhole and inlet frames shall be stainless steel bolts, Type 316.

D. Frames and covers for manholes shall be watertight. Cover and grates should be stamped with THORNTON's name.

E. Castings shall be smooth, clean, and free from blisters, blowholes, and shrinkage. Mating surfaces of the frame and cover shall be machined to prevent movement of the lid. Frames, covers, and grates shall be match marked in sets before shipping to the site.

F. Provide manhole and inlets with locking lid and McGard Intimidator man locks two per manhole, Model No. 11701.

2.4 LADDER

A. Manhole steps shall be 3/4-inch-diameter, Grade 60, steel-encased in polypropylene, 12 inches wide, or equivalent Occupational Safety and Health Administration (OSHA)-approved ladder.

2.5 GROUT

A. Grout used to grout drainpipes shall be Type I grout in accordance with Section 03 62 00: NON-SHRINK GROUT.

PART 3 EXECUTION

3.1 MANHOLE AND CONCRETE INLET BASE

A. The invert of precast and cast-in-place bases shall be hand worked to provide channels conforming in size to the inside diameter of the piping as indicated on the approved Drawings. The channels shall vary uniformly in size and shape from inlet to outlet. The concrete base shall be shaped with a wood float and shall receive a hard steel trowel finish before the concrete sets. A template shall be used to accurately form the level surface that will receive the first precast section.

B. During construction of cast-in-place bases, all piping shall be in place, including ring-type seals, before concrete placement. Pipe grade and alignment shall be verified immediately upon placement of concrete to assure that the pipelines are in proper position prior to the concrete taking an initial set. The invert elevation and flow line of piping shall be as shown on the approved Drawings. The manhole base shall extend 6 inches (250 millimeters (mm)) below the bottom of the lowest pipe and 4 inches (150 mm) above the top of the largest pipe. Inlet bases shall match the invert of the lowest upstream pipe and be sloped toward the invert of downstream pipe.

C. Cast-in-place bases shall set a minimum of 3 days before the manhole construction is continued. In certain critical situations, the setting time may be reduced upon approval of ENGINEER.

3.2 INSTALLING MANHOLE AND INLET SECTIONS

A. The concrete manhole base and successive precast sections will receive a mastic joint sealing compound prior to setting the precast sections in place as shown on the Drawings. The joints will be mortared and tooled to a smooth finish, free of voids.

B. Assemble the precast sections to the elevation required by the location of the manhole or inlet in accordance with the Drawings.

C. Secure the frame to the grade ring with mortar in accordance with the Drawings.

D. After the frame is securely set the cover shall be installed. All necessary cleaning of foreign materials from the frames and covers shall be accomplished to ensure a satisfactory fit.

E. Where manholes or inlets are to be given a protective coating, they shall be free of seepage and surface moisture.

F. Piping installation adjacent to the manhole or inlet and connection to the base or shaft sections shall be performed as shown on the Drawings. Piping installation into flexible pipe connectors shall be in accordance with the manufacturer's recommendations for assembly, lubricants, and limits of deflection.

3.3 INSTALLING END SECTIONS

A. Metal end sections shall be installed according to the manufacturer's recommendations for connection with plastic pipe.

B. If a band collar is used, the collar shall be manufactured of the same material as the end section.

3.4 DAMPPROOFING

A. At the discretion of ENGINEER, dampproofing material shall be applied to the exterior surfaces of concrete manholes and inlets in accordance with the manufacturer's recommendations and Section 07 10 00: DAMPPROOFING AND WATERPROOFING.

3.5 WORKMANSHIP

A. The precast concrete structures shall be installed in conformance with the manufacturer's written instruction, on a well-compacted foundation, as specified in Section 31 23 13: SUBGRADE PREPARATION. The structures shall be installed to the elevations and locations shown on the Drawings.

B. Covers and grates shall be set to the elevations indicated on the Drawings.

C. Grout pipes in place in accordance with Section 03 62 00: NON-SHRINK GROUT.

D. Tolerances shall be in accordance with ACI 117.

END OF SECTION

SECTION 33 11 07
STEEL PIPING

PART 1 GENERAL

1.1 WORK INCLUDES

A. Galvanized steel pipe, fittings, and accessories required and necessary to provide complete galvanized steel pipe installation for the void space drain extension.

1.2 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

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

a. A 36/A 36M - Specification for Carbon Structural Steel.
b. A 53/A 53M - Specification for Pipe, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
c. A 105/A 105M - Specification for Carbon Steel Forgings for Piping Applications.
d. A 139 - Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).
e. A 234/A 234M - Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
f. A 283/A 283M - Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
g. A 370 - Test Methods and Definitions for Mechanical Testing of Steel Products.
h. A. 516/A 516M - Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.
i. A 570/A 570M - Specification for Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality.
j. A 572/A 572M - Specification for High-Strength Low Alloy Columbium-Vanadium Structural Steel.
k. A 770/A 770M - Specification for Through-Thickness Tension Testing of Steel Plates for Special Applications.

2. American Society of Mechanical Engineers (ASME):

a. Boiler and Pressure Vessel Code.
b. Code for Pressure Piping.

3. American Welding Society (AWS):

a. D 1.1 – Structural Welding Code, Steel.

1.3 SUBMITTALS

A. Shop Drawings:

1. For Standard Manufactured Items: Manufacturer’s catalog work sheets showing illustrated cuts of items to be furnished and demonstrating compliance with Specification requirements. Include scale details, dimensions, fasteners, finishes, and materials of construction.
2. Reference all construction materials by ASTM designations and grades.

1.4 QUALITY ASSURANCE

A. Steel Pipe: Manufacturer's certified test report substantiating pressure rating and safety factor specified.

B. Manufacturer's Certification of Compliance: For manufactured items and materials to certify compliance with the Specifications.

PART 2 PRODUCTS

2.1 GENERAL

A. All piping components shall be pressure rated to minimum 50 pound per square inch (psi) operating pressure.

2.2 STEEL PIPE

A. Pipe:

1. Steel: Type E or S, Grade B, Schedule 40, Galvanized.
2. Provide grooved pipe connections; except where shown on Drawings.

B. Fittings and Specials:

1. Stainless Steel: ASTM A53, Schedule 40, Galvanized.

2.3 PIPE CLIPS

A. Two-Hole Pipe Strap:

1. Steel: ASTM A 53, Schedule 40, Galvanized.
2. Minimum Mounting Hole Diameter: 7/16 in.

B. Anchors:

1. Bolts: Stainless steel, ASTM F 593, Alloy Group 1 or 2.
2. Nuts: Stainless steel, ASTM F 594, Alloy Group 1 or 2.
3. Washers: 316 Stainless steel.

PART 3 EXECUTION

3.1 GENERAL

A. Store the steel pipe and components at the site in a suitable location protected from weather, corrosion, theft, vandalism, or other damage.

3.2 PREPARATION

A. Pipe and Fittings:

1. Inspect before exposed pipe or fitting is installed.
2. Clean ends of pipe thoroughly, remove foreign matter and dirt from inside of pipe, and keep clean during and after laying.

3.3 PIPING SYSTEM INSTALLATION

A. Pipe Fittings and Appurtenances: Install in accordance with the manufacturer's instructions and these Specifications.

B. Install to lines and grades shown on the Drawings, or as otherwise approved in writing by ENGINEER.

C. Follow approved installation sequence.

D. Install pipe, fittings, specials, couplings, expansion joints, appurtenances, and accessories in accordance with manufacturer's instructions.

E. Measure for grade at pipe invert, not at top of pipe.

F. Provide adequate support to prevent deflections in excess of specified tolerances.

G. Prevent debris and foreign material from entering pipe during and after installation.

H. Tolerances

1. Deflection from Horizontal Line: Maximum 1/2-inch.
2. Deflection from Vertical Line: Maximum 1/2-inch.
3. Circumferential Pipe Deflection: Maximum 5 percent of pipe diameter.

END OF SECTION

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SECTION 33 24 00
WELL ABANDONMENT

PART 1 GENERAL

1.1 WORK INCLUDES

A. Abandon existing monitoring wells in upper parking area.

1.2 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

1. American Society for Testing Materials (ASTM):

a. A239 - Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
b. A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
c. A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
d. A1011/A1011M - Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
e. D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
f. D2244 - Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
g. F2814 - Guide for Design and Construction of Ornamental Steel Picket Fence Systems for Security Purposes.
h. F2408 - Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets.

2. Occupational Safety and Health Administration (OSHA).
3. State of Colorado, Office of the Engineer (SEO):

a. 2 CCR 402-2, Rules and Regulations for Water Well Construction, Pump Installation, and Monitoring and Observation Hole/Well Construction.

4. State and local building codes, together with applicable state and local laws.

1.3 SUBMITTALS

A. Shop Drawings:

1. Well Abandonment Plan. The plan shall include, as a minimum, the following:

a. Proposed extend of demolition.
b. Proposed backfill materials, methods, and elevations.
c. Drawing and narrative that describes the work.
d. Schedule and sequence for completion of the Work, including report preparation.

2. Administrative:

a. Completed Well Abandonment Report for each well. Copies of the State forms are attached.

PART 2 PRODUCTS

2.1 CEMENT-BENTONITE GROUT

A. Type 4 in accordance with Section 03 62 00: NON-SHRINK GROUT.

B. The grout shall be mixed in a manner resulting in a smooth slurry.

C. The proportions of the various materials may be varied by ENGINEER in the field.

D. Grout shall be placed by tremie methods.

PART 3 EXECUTION

3.1 ABANDONMENT

A. Obtain written approval from ENGINEER before well abandonment.

B. Abandon wells in accordance with SEO Rules and Regulations for Water Well Construction, Pump Installation, Cistern Installation, and Monitoring and Observation Hole/Well Construction (2 CCR 402-2, 2018).

1. Abandon in accordance with paragraph 16-3 for Wells or Boreholes in Type II and Type III Aquifers.

C. Existing groundwater observation well abandonment shall be performed as follows:

1. Remove the surface casing and concrete surface seal from the boring if present.
2. Remove well pipe(s) to a depth of at least 3.0 feet below final grade or limit of excavation, whichever is lower.
3. Backfill the well pipe(s) and the excavation with Type 4 grout to within 2.0 feet of final grade and the remainder of the excavation with common fill.

D. If grout is used, monitor the top of grout for 48 hours and place additional grout, if needed, to maintain final top elevation of grout at the existing ground surface.

E. Dispose of debris from abandonment in accordance with Section 02 41 00: DEMOLITION.

END OF SECTION

SECTION 33 41 01
HDPE PIPE

PART 1 GENERAL

1.1 WORK INCLUDES

A. High-Density Polyethylene (HDPE) pipe for the following:

1. Storm sewer replacement at Memorial Plaza.

1.2 SUBMITTALS

A. Shop Drawings:

1. Product Data:

a. Manufacturer's and local representative name, location, and telephone number.
b. Submit manufacturer's material data and literature for product.
c. Manufacturer's certificates of compliance with reference standards, catalog work sheets showing illustrated cuts of items to be furnished, including scale details and dimensions.

2. Installation, Field Testing, and Demonstration Work Plan: Provide Work plan that includes:

a. Installation sequence, procedures, and equipment that will be used to install the pipe.
b. Equipment and procedures for hydrostatic testing of completed sections prior to installation.

3. Installer Qualifications:

a. Installed and welded at least 5,000 lineal feet of similar sized HDPE pipe and materials in the last 5 years.

B. Quality Control:

1. Hydrostatic test results within 7 days after tests are complete.

1.3 REFERENCES AND STANDARDS

A. The following is a list of standards that may be referenced in this Section:

1. American National Standards Institute (ANSI):

a. 304 Stainless Steel.
b. B16.1 – Pipe Flanges and Fittings.

2. American Iron and Steel Institute (AISI):

a. AISI 304 – Stainless Steel.

3. American Water Works Association (AWWA):

a. C219 – Bolted, Sleeve-Type Couplings for Plain-End Pipe.

b. C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 65 In. (100 mm Through 1,650 mm), for Waterworks.

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

a. A 193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
b. A 194 - Standard Specification for Carb on Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
c. A 283 - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
d. A 307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 pound per square inch (psi) Tensile Strength.
e. A 536 - Ductile Iron Casting Tensile Requirements.
f. A 563 - Standard Specification for Carbon Steel and Alloy Steel Nuts.
g. D 638 - Standard Test Method for Tensile Properties of Plastics.
h. D 746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
i. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
j. D 1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
k. D 1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
l. D 2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
m. D 3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
n. D 3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
o. F 714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
p. F 1473 - Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.
q. F 2164 - Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
r. F 2206 - Standard Specification for Fabricated Fittings of Butt-Fused Polyethylene (PE).

5. NSF International (NSF):

a. NSF 61: Drinking Water System Components.
b. NSF 372: Drinking Water System Components-Lead Content.

6. Plastics Pipe Institute (PPI):

a. PPI Handbook of Polyethylene Pipe.
b. TR-33: Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.
c. TN-38: Bolt Torque for Polyethylene Flanged Joints.

1.4 QUALITY ASSURANCE

A. During transporting, storing, and installation of the pipe and pipe fittings, the pipe and pipe fittings shall not be dropped or subjected to any unnecessary jar, impact, or other treatment that could damage the pipe.

B. Pipe shall not be stored under conditions that would cause injury to the pipe. Any length of pipe that, in the opinion of ENGINEER, is damaged beyond repair by CONTRACTOR in hauling, handling, unloading, storing, or otherwise shall be removed from the work site and replaced by and at the expense of CONTRACTOR.

1.5 SEQUENCING AND SCHEDULING

A. Notify ENGINEER in writing at least 5 days prior to start of:

1. Field Welding
2. Field hydrostatic testing.
3. Field Compression testing
4. Field lining demonstration

PART 2 **PRODUCTS**

2.1 HDPE PIPE, MANIFOLD, AND FITTINGS

A. HDPE pipe shall be polyethylene pipe and fittings fabricated using extra high molecular weight, high density ethylene/hexane copolymer PE4710 polyethylene resin meeting the nominal physical property and pipe performance requirements listed in the following table and specified in this Section.

HDPE PIPE PROPERTIES

Property	Unit	Test Procedure	Typical Value
Material Designation	--	PPI-TR4	PE 4710
Cell Classification	--	ASTM D3350	445574C
Density	g/cm^3	ASTM D1505	0.959
Melt Index	g/10 minutes	ASTM D1238	<0.15
Flexural Modulus	Psi	ASTM D790	>120,000
Tensile Strength	Psi	ASTM D638	>3,600
SCG (PENT)	Hours	ASTM F1473	>100
HDB@73.4°F (23°C)	psi	ASTM D2837	1600
HDB@140°F (60°C)	psi	ASTM D2837	1000
HDS (hydrostatic design stress) @73.4°F	psi	PPI-TR4	1000
HDS @140°F	psi	PPI-TR4	630
Color; UV Stabilize [C]	--	--	Black with minimum 2% carbon Black
Brittleness Temperature	°F	ASTM D746	<-180

B. HDPE pipe sections shall be fabricated in lengths not greater than 60 feet. Ends of the sections shall be prepared for field fusion.

C. The Standard Dimension Ratio (SDR) for HDPE pipe shall be:

1. Storm sewer pipe - DR 21.

D. The pipe shall be to the dimensions and tolerances specified in ASTM F 714.

E. HDPE pipe, manifold, and fittings shall be in accordance with AWWA C906.

F. The HDPE pipe shall be in compliance with the physical and performance requirements of this Specification and extruded from resin that satisfies ASTM D 1248 pipe grade resin Type III, Class C, Category 5, grade P34 polyethylene compound. The pipe shall provide long term endurance characteristics recognized by the compressed ring environmental stress crack resistance greater than 1,000 hours.

G. HDPE pipe fittings shall be standard commercial products manufactured by injection molding or by extrusion and machining, or shall be fabricated from HDPE pipe conforming to this Specification. The fittings shall be fully pressure rated by the manufacturer to provide a working pressure equal to the pipe for 50 years of service at 73.4°F with an included 2:1 safety factor. The fittings shall be manufactured from the same resin type, grade, and cell classifications as the pipe. The manufacture of the fittings shall be in accordance with good commercial practice to provide fittings homogeneous throughout and free from cracks, holes, foreign inclusions, voids, or other injurious defects. The fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The minimum “quick-burst” strength of the fittings shall not be less than that of the pipe with which the fittings are to be used.

H. Flex Restraint

1. Restraint collar electrofused to the HDPE pipe exterior to resist longitudinal movement of HDPE pipe.
2. Electofusion Flex Restraint; Integrity Fusion Products, Inc.; 270 Parkade Court Peachtree City, GA 30269 or ENGINEER-accepted comparable product.

2.2 FLANGES

A. Backup Rings:

1. Flanged ends, compatible with AWWA C207 Class D.
2. Minimum long-term pressure rating equal to the pipe.
3. Polypropylene with ductile iron insert.

B. Bolting Materials:

1. Bolting Materials:

a. Stainless steel Type 316 bolts shall conform to ASTM A 193, Grade B8M.
b. Stainless steel Type 316 nuts and washers shall conform to ASTM A 194, Grade 8M.
c. Low-carbon steel bolts shall conform to ASTM A 307, Grade B.
d. Low-carbon steel nuts shall conform to ASTM A 563 Heavy Hex.
e. Match flange type.

C. Blind Flange:

1. The blind flange shall conform to the requirements of an AWWA C207 Class D blind flange.
2. The blind flange shall be carbon steel or ENGINEER-accepted alternate material.

2.3 PIPE GRADING MATERIALS

A. Burlap concrete bags

1. Burlap bags filled with sand and Portland cement placed on the upstream slope to smooth grade transitions and temporarily anchor HDPE pipes.

2. SlingBag 60 lb Revetment Burlap Bags; One Securities Centre, 5 Concourse Parkway, Suite 1900, Atlanta, GA 30328.

PART 3 **EXECUTION**

3.1 GENERAL INSTALLATION

A. Install to lines and grades shown on the Drawings, or as otherwise approved in writing by ENGINEER.

B. Follow approved installation sequence.

C. Install pipe, fittings, appurtenances, and accessories in accordance with manufacturer's instructions and AWWA requirements.

D. Measure for grade at pipe invert, not at top of pipe.

3.2 STORAGE AND HANDLING OF MATERIALS

A. Inspect the pipe and fittings at the time of delivery. Any pipe or fittings which are found to be defective shall be rejected and removed immediately from the site.

B. Pipe shall be unloaded, stored, and handled so as to avoid damage to the pipe, lining, coating, and gaskets.

C. Any damage to the pipe incurred as a result of unloading, storage, or handling shall be repaired by CONTRACTOR to the satisfaction of ENGINEER.

D. Any pipe that is damaged during unloading, storage, handling, or installation, which cannot be repaired to the satisfaction of ENGINEER shall be immediately removed from the site by CONTRACTOR.

3.3 HDPE PIPE FABRICATION, ASSEMBLY, AND INSTALLATION

A. Pipe shall be stored on clean, level ground to prevent undue scratching or gouging of the pipe. If the pipe must be stacked for storage, such stacking shall be done in accordance with the pipe manufacturer's recommendations. The handling of the pipe shall be done in such a manner that it is not damaged by dragging over sharp objects or cut by chokers or lifting equipment.

B. Sections of pipe having been discovered with cuts or gouges in excess of 10 percent of the wall thickness of the pipe shall be cut out and removed. The undamaged portions of the pipe shall be rejoined using the butt fusion joining method.

C. Fused segments of pipe shall be handled so as to avoid damage to the pipe. When lifting fused sections of pipe, chains or cable-type chokers shall be avoided. Nylon slings are preferred. Spreader bars are recommended when lifting long fused sections. Care shall be exercised to avoid cutting or gouging the pipe.

D. Sections of HDPE pipe shall be joined into continuous lengths on the job site above ground. The joining method shall be the butt fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The butt fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the pipe manufacturer.

E. Butt fusion joining shall be 100 percent efficient, offering a joint weld strength equal to or greater than the tensile strength of the pipe. Socket fusion shall not be used. Extrusion welding or hot gas welding of HDPE pipe shall not be used.

F. Fabrication of all pipe, fittings, flanges, and accessories shall conform to applicable AWWA, ASTM, AISC, and AWS requirements. The amount of field fabrication necessary for completion of the work shall be limited to the extent practicable.

G. Pipe shall be compressed and installed using equipment and methods that will allow safe installation without potential for damage to the pipe. Slings, grapples, and other handling equipment shall meet the recommendations of the pipe manufacturer.

H. Each pipe section or fitting shall be thoroughly cleaned of all foreign material and carefully examined for cracks and defects before installing in the existing outlet pipes. The interior of all installed pipe shall be kept free of debris at all times.

I. All pipe cuts shall be straight and true, leaving a smooth end without damage to the pipe. Pipe cutting equipment and procedures shall conform to the recommendations of the pipe manufacturer.

J. All burrs shall be removed from the ends of cut pipe.

K. Fittings and other appurtenant structures shall be constructed at the locations shown on the drawings.

L. Pipe and appurtenant structures shall not be installed when the bottom of the excavation is frozen, or when there is a possibility that ice or frost will penetrate the bottom of the excavation. No pipe or appurtenant structures shall be installed unless backfilling can be completed before the formation of ice or frost.

M. Pipe shall be adequately supported to prevent deflections in excess of those recommended by the pipe manufacturer and to maintain required spacing to existing conduit.

N. Pipe shall be laid on as firm and uniform surface as possible to provide a uniform bearing along the entire pipe barrel in accordance with Section 31 23 23: FILL.

3.4 FIELD QUALITY CONTROL

A. Hydrostatic Testing:

1. Test installed piping systems prior to placement of concrete encasement or backfill unless accepted by ENGINEER in writing.
2. Include testing procedures and equipment in required submittals. Testing equipment and procedures shall be capable of accurately measuring leakage volumes within the range of required acceptance criteria.
3. Perform hydrostatic test in accordance with ASTM F 2164 and the specifications herein:

    a. Use water as test medium.
    b. Maximum filling velocity shall not exceed 0.25 feet per second, calculated based on full area of pipe.
    c. Expel air from piping system during filling. Expel through relief valves installed at high points in system or other strategic locations.
    d. Test Pressure: As provided in these specifications, measured at the lowest point in the pipe or system.
    e. Apply and maintain test pressure of 30 psi with a hydraulic force pump. Valve off piping system when test pressure is reached.
    f. Maintain test pressure continuously for a minimum of 4 hours, adding make-up water only as necessary to maintain pressure.
    g. Reduce pressure to 15 psi and monitor the pressure for a 1-hour test phase. Do not increase pressure or add make-up water during the test phase.

h. Perform testing during daylight hours. If excessive thermal deformation is anticipated, test may be performed at night if accepted by ENGINEER in writing.

4. Acceptance Criteria:

a. The installed pipe is acceptable if no visual leakage is observed, and pressure during the test phase remains steady (±2 psi).

5. If leakage is observed or if the pressure drops more than 2 psi during the test phase, repair defective pipe section and repeat test.

END OF SECTION

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SECTION 33 46 16
SUBDRAINAGE PIPE

PART 1 GENERAL

1.1 WORK INCLUDES

A. Subdrainage piping for the collection trench drain pipe including the solid piping conveying the subdrainage to the nearest structure.

B. Subdrainage piping for the retaining wall drainage system at Mechanically Stabilized Earth Wall (MSEW)-2.

C. Cleanout vaults.

1.2 REFERENCES

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

1. D 1784 - Specification for Rigid (Poly Vinyl Chloride) (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
2. D 1785 - Specification for PVC Pipe Schedules 40, 80, and 120.
3. D 2241 - Specification for (PVC) Pressure-Rated Pipe (SDR Series).
4. D 3139 - Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
5. D 3034 - Specification for Type PSM PVC Sewer Pipe and Fittings.

B. American Water Works Association (AWWA).

1.3 SUBMITTALS

A. Shop Drawings:

1. Submit details for pipe slot pattern and all fabricated fittings, couplings, and fasteners to be use as part of all subdrain piping systems.
2. Subdrainage System Work Plan. The plan shall include installation and backfilling procedures, include description of all procedures that will be used, material descriptions, and other work incidental to installation of the drain systems. Coordinate with Section 31 23 23: FILL.

B. Quality Control:

1. Certificates of compliance for pipe and fittings.
2. As-built survey of installed piping on DVD.

PART 2 PRODUCTS

2.1 PIPE

A. Drain pipe and fittings for the collection trench, MSEW-2 drain system, and connecting drains shall be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D 1784.

B. Drain pipe shall consist of SDR 35 pipe and fabricated fittings of the size specified on the drawings.

C. Piping at cleanout locations shall consist of PVC Schedule 40 pipe and fabricated fitting of the size on the drawings.

D. Drain pipe couplings shall be watertight bell and spigot connections with elastomeric gaskets and shall be free of imperfections that might cause leakage at joints.

E. Slotted drain pipe shall have four rows of slots. The rows shall be in the longitudinal direction of the pipe and the slots shall be cut in the circumferential direction of the pipe. The rows shall be centered on the quarter points (90° apart) of the circumference. Slots shall be spaced uniformly along the pipe. The minimum opening will be measured on the inner surface of the pipe. Slots shall conform to the following:

Number of Slots Per Lineal Foot of Pipe	Width of Slot (inches)	Opening per Lineal Foot (square inches)
64	0.25	37.5

1. Manufacturers and Products:

   a. Titan Industries or approved equivalent.

F. Gaskets and lubricants shall be compatible with the pipe, couplings, and with each other when used together. One gasket shall be furnished with each bell end of every pipe, fitting, and coupling.

G. End caps.

H. Cover and protect all subdrainage piping including pipe, fittings, and gaskets at all times including on-site storage.

2.2 CLEANOUT BOXES

A. Fiber precast concrete reinforced plastic.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions, accepted submittal, AWWA M23, AWWA M41, these specifications, and the following:

1. As next section of pipe is being readied for laying, clean end of previously laid pipe of foreign material and apply thin film of specified lubricant to entire surface of bell ring.
2. At the same time, lubricate gasket and install in spigot groove.
3. Ensure gasket tension is uniform around groove before placing pipe.
4. Position pipe section until approximately in line with previously laid pipe section and spigot is centered in bell.
5. Force pipe "home" as defined in manufacture's installation instructions and secure to proper alignment and grade with specified backfill. Excavators or loaders cannot be used to force pipe "home."

B. Inspect before pipe or fitting is installed or buried.

C. Clean ends of pipe thoroughly, remove foreign matter and dirt from inside of pipe, and keep clean during and after laying.

D. Damaged pipe shall be removed and replaced.

E. Do not bend straight pipe segments or angle joints to accommodate changes in direction.

F. PVC pipe sleeves shall meet the material requirements of unslotted subdrainage piping, except that the dimensions shall be as shown in the Drawings.

3.2 CLEANING

A. Examine pipe and fittings prior to installation and remove all soil, sand, gravel, and other foreign objects prior to installation.

B. Examine and remove any gravel or other debris from installed pipe prior to installing subsequent pipe or fittings.

C. Remove all soil, sand, gravel, debris, and foreign matter observed in video inspection. All pipe shall be clean from all foreign material before final video inspection is accepted.

3.3 DEFECTS

A. In addition to any deficiencies covered by AWWA M23, pipe which has any of the following visual defects will not be accepted:

1. Pipe that is sufficiently out-of-round to prohibit proper joining or ability to pass a mandrel test.
2. Improperly formed bell and spigot ends.
3. Fractured, cracked, chipped, dented, abrased, damaged by exposure to the environment, or otherwise damaged pipe.

3.4 PREPARATION

A. Pipe Cutting

1. Cut pipe smooth, straight, and at right angles to the pipe axis with saws or pipe cutters designed specifically for the material.
2. Do not damage the pipe.
3. Remove burrs and wipe off all dust from the jointing surfaces.

3.5 INSTALLING CLEANOUT VAULTS

A. Excavation for cleanout boxes shall conform to Section 31 23 16: EXCAVATION.

B. Backfill around cleanout boxes shall conform to Section 31 23 23: FILL.

3.6 INSPECTION

A. Perform video inspection (camera survey) of interior of all subdrainage pipe. Inspection shall be performed in accordance with the following schedule.

1. When any subdrainage pipe has been backfilled with between 4 and 6 feet of fill.
2. Final acceptance when the drain pipe is in place, backfill placement is complete, and the drain pipe has been cleaned.

END OF SECTION

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