Final

Urban Drainage and Flood Control District

Standard Specifications Division 2 through Division 33

CSI *MasterFormat*® 2004

Prepared for

Urban Drainage and Flood Control District

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CH2MHILL®

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URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

Contents

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SELECTIVE SITE DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK consists of the removal and disposal of trees, slope and ditch protection, abandoned utility services, curbs, gutters, pipes, sidewalks, appurtenances, traffic control devices, guardrail, fences, foundations, pavements, pavement markings, and any other obstructions that are not designated or permitted to remain. It shall also include salvaging, stockpiling and loading salvable materials, sandblasting, plugging structures, cleaning culverts, and sawing and cutting to facilitate controlled breaking and removal of concrete and asphalt to a neat line. Except in areas to be excavated, the resulting trenches, holes, and pits shall be backfilled.

B. Materials removed and not designated to be salvaged or incorporated into the WORK shall become the property of CONTRACTOR.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.

2. Section 31 23 00, Excavation and Fill.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 GENERAL

A. CONTRACTOR shall raze, remove, and dispose of all structures and obstructions which are identified on the PROJECT, except utilities, structures and obstructions removed under other contractual agreements or as otherwise provided for in the CONTRACT DOCUMENTS, and salvable material designed to remain the property of OWNER.

B. Salvable Material:

1. All salvable material designated in the CONTRACT or by ENGINEER to remain the property of OWNER shall be removed without damage, in sections or pieces which may be readily transported, and shall be stockpiled by CONTRACTOR at specified locations within the PROJECT limits.

2. CONTRACTOR shall safeguard salvable materials and shall be responsible for the expense of repairing or replacing damaged or missing material until it is incorporated into the work, or is loaded onto OWNER’s equipment by CONTRACTOR.

C. Signs and Traffic Signals:

1. Removal of signs shall include removal of posts, footings, pedestals, sign panels, and brackets. Concrete adhering to salvable signposts shall be removed.

2. Removal of sign panels shall include removal of the panel and its attachment hardware from the existing installation and adjusting the spacing of the remaining panels.

3. The removal of traffic signal items shall include poles, mast arms, signal heads, span wires, footings, all attachment hardware, and other incidental materials. Removal of signal poles or pedestal poles shall include pole, span wire, cable, signal heads, overhead sign support wire, footings, and pedestrian push buttons. Removal of traffic signal controller and cabinet shall include removal of the footing and all auxiliary equipment contained within the cabinet.

D. Pavements, Sidewalks, and Curbs:

1. All concrete pavements, sidewalks, structures, curbs, gutters, etc., designated for removal, shall be disposed of offsite by CONTRACTOR at CONTRACTOR's expense.

2. Sawing of concrete and asphalt shall be done to a true line, with a vertical face, unless otherwise specified.

3. The minimum depth of a saw cut shall be two (2) inches.

4. For reinforced concrete, the minimum depth shall be two (2) inches, or to the depth of the reinforcing steel, whichever occurs first.

E. Abandonment of Existing Sewer Facilities:

1. All existing sewer facilities to be plugged and abandoned in place are specifically shown on the DRAWINGS.

2. Unless otherwise specified on the DRAWINGS, the procedures and methods for the abandonment of said facilities shall conform to the requirements set forth in the CONTRACT DOCUMENTS for that specific item.

3. Abandonment of existing sewer facilities shall be included in this item of work unless otherwise provided for under other WORK items in the CONTRACT DOCUMENTS.

END OF SECTION

SECTION 03 11 00

CONCRETE FORMING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall supply all labor, tools, equipment and materials to set forms for the proper placement of concrete for structures. It is CONTRACTOR's responsibility to design and build adequate forms and to leave them in place until the forms can be safely removed. CONTRACTOR is responsible for damage and injury caused by removing forms carelessly or before the concrete has gained sufficient strength. Means and methods of repair shall be reviewed by ENGINEER prior to performing the WORK.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 15 00, Construction Joints.
2. Section 03 31 00, Structural Concrete.
3. Section 03 35 00, Concrete Finishing.
4. Section 03 60 00, Grouting.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
    a. Manual of Concrete Practice.
    b. 117, Specifications for Tolerances for Concrete Construction and Materials.
    c. 318, Building Code Requirements for Structural Concrete.
    d. SP-4, Formwork for Concrete.
2. American Plywood Association (APA):
    a. J20, Grades and Specifications.
    b. PS-1-07, US Product Standard for Structural Plywood.
    c. V345, Concrete Forming.

1.04 SUBMITTALS

A. General:

1. Design, placement and maintenance of formwork and form systems is the responsibility of CONTRACTOR. Submittals other than those listed are not required nor will they be reviewed.

2. Alternate form system configurations require preparation by a licensed Professional Engineer and submittal to ENGINEER for review and approval.

B. Product Technical Data:

1. Manufacturer and type of form materials.

2. Manufacturer and type of form ties.

3. Manufacturer and type of void form including compressive strength.

4. Manufacturer of form release agent.

C. CONTRACTOR shall submit information about the type of wedge anchor or nail, and the means of patching the surface for review and acceptance by ENGINEER.

1.05 QUALITY ASSURANCE

A. Formwork, and if required shoring and reshoring, shall be designed by a Professional Engineer licensed to practice in the state where the PROJECT is located.

PART 2 PRODUCTS

2.01 GENERAL

A. For the purposes of this SPECIFICATION, exposure shall be defined as a surface, interior or exterior, of a structure that will be exposed to view during its use. For example, the interior wall of a buried culvert is a surface exposed to view.

2.02 FORMS FOR SURFACES EXPOSED TO VIEW

A. Walls:

1. APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.

2. Symons hand set steel-ply forms, or equal.

B. Beams:

1. APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.

2. Symons hand set steel-ply forms, or equal.

C. Sides of Column Footings:

1. APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.

2. Steel of sufficient thickness that the form remains true to shape after numerous repetitive uses.

3. Symons hand set steel-ply forms, or equal.

D. Sides of Curved or Straight Continuous Wall Footings:

1. APA high-density overlay Plyform Class I exterior.

2. APA PS 1-07, B-B Plyform Class I, exterior.

3. For curved surfaces, plywood of sufficient thickness, free from knots and other imperfections, which can be cut and bent and held in place accurately to the required curvature without splintering or splitting, shall be used.

E. Floor and Roof Slabs: APA PS 1-07, B-B Plyform Class I, exterior. The plywood shall be mill oiled and edge sealed.

F. Columns: Regardless of materials of construction, the forms shall be such to permit bracing in two directions at half height and full height at a minimum. Two braces at ninety degrees (90°) are required at half and full height.

1. Steel of sufficient thickness that the form remains true to shape after numerous repetitive uses.

2. Fiberglass of sufficient thickness that the form remains true to shape.

G. Column Capitals: Steel, sixteen (16) gage or thicker, so that the form remains true to shape after numerous repetitive uses.

2.03 FORMS FOR SURFACES NOT EXPOSED TO VIEW

A. Wood or steel sufficiently tight to prevent mortar leakage.

2.04 ANCHORAGE IN SLABS FOR BRACES FOR WALL AND COLUMN FORMS

A. Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column alignment under all load conditions including wind.

B. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of wall or column braces in water retaining structures. Wedge anchors or nails may be used in other structures when in the opinion of ENGINEER the resulting concrete finish patch will be acceptable.

2.05 ANCHORAGE IN SLABS FOR UPTURNED COLUMN FOOTING FORMS

A. Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column configuration and diameter. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of column footing forms.

2.06 FORM TIES

A. Water Retaining Structures and Below Grade Structures: Symons, S-Panel Ties, or equal, with water seal and one (1) inch break back cones on both tie ends, shall be used on all wall forms.

B. Other Structures: Symons, S-Panel Ties, or equal, with one (1) inch break back cones on both tie ends, unless otherwise called out or shown in the DRAWINGS or approved by ENGINEER, shall be used on all wall forms.

C. Twisted Wire Ties: Twisted wire ties with loops to hold forms in position are not permitted.

2.07 CHAMFER STRIP

A. Chamfer strips, three-quarters (3/4) inch or as shown on the DRAWINGS, shall be placed in the corners of forms and at the tops of walls or up-turned footings, to produce beveled edges on permanently exposed concrete surfaces. Interior angles of intersecting concrete surfaces and edges of construction joints shall not be beveled unless otherwise indicated in the DRAWINGS. The chamfer strip may be made of wood or polyvinyl chloride (PVC).

2.08 STIFF-BACKS

A. Stiff-backs for wall forms shall be constructed of lumber or Glulams, uniform in width and thickness, free from knots and other surface defects. Only one (1) joint is permitted in the board of a stiff-back and joints shall be offset so as to not occur at the same point. Stiff-backs shall extend to a point not less than six (6) inches above the top of forms.

2.09 GANG WHALER PLATES FOR THE TOP OF CURVED WALLS

A. Gang whaler plates shall be constructed of plywood as described below cut to the radius of the wall curve. The gang whaler plate shall be of sufficient depth to permit notching for stiff-backs.

1. APA high-density overlay Plyform Class I, exterior.

2. APA PS1, B-B Plyform Class I, exterior.

2.10 WEDGE INSERTS

A. When permitted by ENGINEER at the tops of walls or columns, wedge inserts may be used to support future formwork or catwalks. The inserts shall be Richmond Screw Anchor, or equal.

2.11 FORM RELEASE AGENT

A. Magic Kote by Symons Corp. or equal.

PART 3 EXECUTION

3.01 GENERAL

A. Forms shall be used, wherever necessary, to confine the concrete and shape it to the specified lines and grades as shown on the DRAWINGS. CONTRACTOR shall set and maintain concrete forms so as to ensure completed WORK is within all applicable tolerance limits. If a type of form does not, in the opinion of ENGINEER, consistently perform in an acceptable manner, the type of form shall be changed and the method of erection shall be modified by CONTRACTOR, subject to the review of ENGINEER.

B. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete, and shall be maintained rigidly in position. The design of formwork and placing rate of concrete with medium and high-range water reducing agents shall be adjusted to compensate for the greater hydraulic pressures exerted on the forms by concrete of high fluidity.

C. Forms shall be clean and free from mortar and other foreign material from previous use prior to being placed.

D. CONTRACTOR shall demonstrate that forms are vertical, with proper alignment, grade or radius when requested by ENGINEER.

3.02 FORM SURFACE TREATMENT

A. Prior to placing reinforcing steel, coat the forms with a non-staining release agent that will effectively prevent the absorption of moisture and prevent bond of the concrete to the form. Contact with hardened concrete against which fresh concrete is to be placed is prohibited. All bond breaking materials or processes shall be used only after acceptance by ENGINEER. Care shall be taken in applying form oil to avoid contact with reinforcement steel. Embedded material which becomes coated with form oil shall be thoroughly cleaned or replaced at the expense of CONTRACTOR.

3.03 TOLERANCES

A. Tolerances are defined as allowable variations from specified alignments, grades, and dimensions. Allowable variations from specified alignments, grades, and dimensions are prescribed in the following sub-section. Descriptions of these criteria can be found in Part 2 of the ACI Manual of Concrete Practice, and ACI 117.

B. Footings and Foundations:

1. Drilled Piers:

a. Vertical Alignment: Less than or equal to two percent (≤2%) of the shaft length.

b. Lateral Alignment: Less than or equal to one-twenty-fourth (≤1/24) of shaft diameter, three (3) inches maximum.

c. Level Alignment to Cut-off Elevation: More than one (1) inch, less than three (3) inches.

2. Continuous Wall Footings (Circular and Non-circular):

a. Lateral Alignment: Less than or equal to two percent (≤2%) of the footing width, two (2) inches maximum.

b. Relative Alignment: Variation less than or equal to one (≤1) inch in ten (10) feet (variation between specified plane and as built surface).

c. Cross-sectional Dimension:

1) Horizontal Dimension: Variation more than two (2) inches, less than one-half (1/2) inch.
2) Vertical Dimension (thickness): Variation plus or minus one-half (±1/2) inch.

d. Circular Wall Footing Only:

1) Variation in Radius in Any Twenty (20) Feet of Wall Length: Less than or equal to one-half (≤1/2) inch.
2) Variation in Radius in Entire Wall Length: Less than or equal to one (≤1) inch.

3. Column Footings:

a. Lateral Alignment: Variation less than or equal to two (≤2) inches.

b. Level Alignment: Variation from specified elevation more than one-half (1/2) inch, less than two (2) inches.

c. Relative Alignment: Variation less than or equal to one (≤1) inch in ten (10) feet (variation between specified plane and as built surface).

d. Cross-sectional Dimension:

1) Horizontal Dimension: Variation more than two (2) inches, less than one-half (1/2) inch.
2) Vertical Dimension (Thickness): Variation plus or minus one-half (±1/2) inch.

C. Cast-in-Place Concrete for Buildings and other Structures:

1. Member (such as a beam, column, wall, slab, or pier):

a. Vertical Alignment: Variation from specified plump less than or equal to three-eighths (≤3/8) inch (full height) one-quarter (1/4) inch (one form section).

b. Lateral Alignment:

1) Maximum in Any Bay: Variation less than or equal to one-half (≤1/2) inch.
2) Maximum in Any Twenty (20) Feet of Length: Variation less than or equal to one-half (≤1/2) inch.
3) Maximum for Entire Wall Length: Variation less than or equal to one (≤1) inch.
4) Floor and Wall Opening Locations: Variation less than or equal to one-half (≤1/2) inch.
5) Saw cuts and Joints: Variation less than or equal to three-quarters (≤3/4) inch.

c. Level Alignment:

1) Top Elevation of Slabs: Variation less than or equal to three-quarters (≤3/4) inch.
2) Lintels, Other Lines Exposed to View: Variation less than or equal to three-quarters (≤3/4) inch.

d. Cross-sectional Dimensions:

1) Walls and Slabs (Thickness): Variation plus or minus one-quarter (±1/4) inch.
2) Columns and Beams: Variation more than one-half (1/2) inch, less than one-quarter (1/4) inch.
3) Size of Wall and Floor Openings: Variation plus or minus one-quarter (±1/4) inch.

e. Relative Alignment (Offset between Adjacent Formwork): Variation plus or minus one-quarter inch (±1/4) inch.

f. Variation in Specified Grade:

1) For Any Distance Less than Ten (<10) Feet: Variation less than or equal to one-quarter (≤1/4) inch.
2) For Entire Structure: Variation plus or minus one-half (±1/2) inch.
3) For Manholes and Outlet Structures: Variation less than or equal to one (≤1) inch.

2. Stairways:

a. Relative Alignment:

1) Difference in Height between Adjacent Risers: One-eighth (1/8) inch.
2) Difference in Width between Adjacent Treads: One-quarter (1/4) inch.

3.04 PLUMB AND STRING LINES

A. Plumb and string lines shall be installed on wall and column forms before, and maintained during, concrete placement. There shall be sufficient number of plumb or string lines in walls, for example at every other stiff-back, properly installed to permit

continuous monitoring. During concrete placement, CONTRACTOR shall continually monitor plumb and string line positions and immediately correct deficiencies. The plumb and string lines shall extend to a point at least six (6) inches above the top of wall or column.

3.05 FORMWORK CAMBER

A. In order to maintain specified tolerances of joists, beams or slabs subject to dead load deflection, CONTRACTOR shall camber formwork to compensate for dead load deflection prior to hardening of the concrete.

3.06 GANG WHALER PLATES FOR CIRCULAR WALLS

A. CONTRACTOR shall place a gang whaler plate cut to the curvature of the wall, such as a circular wall, at the top of the wall forms. The gang whaler plate shall be attached to the forms with a gang whaler rod at appropriately designed intervals. The gang whaler plate may be notched to permit the stiff-back to extend above the top of the wall forms. The gang whaler plate shall be sufficiently stiff to maintain the required curvature.

3.07 HAND SET MODULAR FORMS

A. Hand set modular forms, such as Symons hand set steel-ply forms, shall be placed with no more than two intersecting joints occurring at one level in the formwork above the bottom modular form level. Figure 1 illustrates the required form pattern.

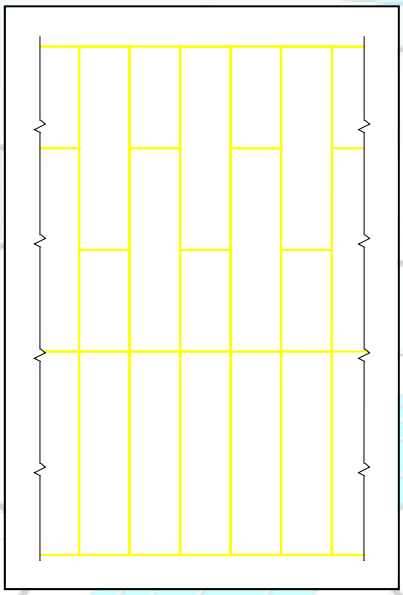

Figure 1

B. The above form configuration is one way recommended by Simons Corp. to eliminate vertical, in plane, bending of the forming system. CONTRACTOR may develop alternate means of maintaining vertical alignment.

3.08 FORMWORK CLOSURE

A. Forms that prohibit visual review of items such as reinforcing steel, waterstops and bearing pads by ENGINEER, shall not be placed until ENGINEER has performed a final review of the reinforcing steel.

B. CONTRACTOR shall use compressed air from an air compressor to blow out construction debris and dirt at the bottom of sections or members to be placed such as walls, slabs, beams and columns, prior to placing forms or concrete.

C. CONTRACTOR shall demonstrate to ENGINEER that all debris, such as loose concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

3.09 HOT OR COLD WEATHER PLACEMENT AND STEEL FORMS

A. Prior to placing concrete when steel forms are used, the forms shall be heated when the surface temperature of the form is below forty degrees Fahrenheit (40°F) or cooled when the surface temperature of the form is above ninety degrees Fahrenheit (90°F). If water is used to cool forms where ponding of water may occur (for example, at the bottom of a column), the water shall be permitted to drain prior to placing concrete.

3.10 REMOVAL OF FORMS

A. The forms for any portion of a structure shall not be removed until the concrete has reach sufficient strength with a factor of safety of 2.0, to withstand applied loads such as self weight and wind loads or withstand damage when the forms are removed.

B. For post-tensioned concrete slabs and beams, formwork shall not be removed until the entire slab or member has been stressed and stressing records accepted.

3.11 RESHORES

A. When a reshore plan is to be performed, it shall comply with Article Quality Assurance.

END OF SECTION

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SECTION 03 15 00

CONSTRUCTION JOINTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall supply all labor, tools, equipment and material for the preparation of construction joints in concrete in accordance with these SPECIFICATIONS and as shown in the DRAWINGS.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 11 00, Concrete Forming.
2. Section 03 15 13, Waterstops.
3. Section 03 21 00, Reinforcing Steel.
4. Section 03 31 00, Structural Concrete.
5. Section 03 60 00, Grouting.
6. Section 32 16 00, Sidewalks, Curbs, and Gutters.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specifications for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 302, Guide for Concrete Floor and Slab Construction.
   d. 318, Building Code Requirements for Structural Concrete.
2. ASTM International (ASTM): C1059, Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.

1.04 SUBMITTALS

A. Provide Product Data for the Following: Bonding Agent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Epoxy Bonding Agent:

1. Master Builders; Concresive Liquid (LPL).

2. Master Builders; Concresive Standard Liquid.

B. Concrete and Closure Grout Placement: In accordance with Section 03 60 00, Grouting.

PART 3 EXECUTION

3.01 EXAMINATION

A. ENGINEER shall review the preparation of all construction joints prior to concrete and grout closure placements. It is the responsibility of CONTRACTOR to notify ENGINEER of these activities. If joint placement is performed without ENGINEER's presence or approval, the WORK may be deemed unacceptable and non-conforming to these SPECIFICATIONS. If ENGINEER determines that construction review of a particular activity is unnecessary, ENGINEER will provide direction to CONTRACTOR to proceed with that particular activity without construction review.

3.02 SURFACE PREPARATION

A. The surface of concrete construction joints shall be clean of all materials that inhibit bond. Materials such as curing compounds, laitance, saw dust, wood, dirt, polyethylene, pipe tape coating, and paper shall be removed. Concrete shall be roughened to produce a surface texture of plus or minus one-sixteenth (±1/16) inch. Concrete surfaces shall be wetted with clean potable water and standing water removed immediately before new concrete or closure grout is placed. Unless otherwise called out in the DRAWINGS, a bonding agent shall be used prior to placing the concrete or grout.

3.03 PIPE GROUT CLOSURE SECTIONS

A. Pipe Surface Preparation: Unless otherwise detailed in DRAWINGS, all pipes penetrating concrete sections such as wall and floor slabs shall have all coatings and other materials that can inhibit bond completely removed from the portion of the pipe to be in contact with the concrete or slab closure grout.

B. Ground Surface Preparation: The ground surface at joints such as pipe/slab closures shall be smooth and properly graded and compacted. All debris such as Styrofoam, paper, polyethylene and wood shall be removed. The ground surface shall be dampened and prepared to prevent the inclusion of dirt, pieces of aggregate or balls of soil in the concrete or grout.

3.04 CONCRETE AND CLOSURE GROUT PLACEMENT

A. Mixing, surface preparation in addition to that prescribed above, placement, and curing of grout at pipe closure joints shall be performed in strict accordance with Section 03 60 00, Grouting, and when a proprietary grout is specified, with the grout manufacturer's directions. Special care shall be taken to ensure that the grout is thoroughly and properly consolidated at waterstops, pipe weep rings, and existing concrete surfaces. An appropriate capacity vibrator shall be used when necessary or required by the manufacturer to properly consolidate the grout.

END OF SECTION

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SECTION 03 15 13

WATERSTOPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish and securely install expanding rubber waterstops where shown or specified in the DRAWINGS. The WORK includes cleaning of concrete surfaces and installation of expanding rubber waterstop.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 15 00, Construction Joints.

2. Section 03 31 00, Structural Concrete.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. D412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension.

b. D2240, Standard Test Method for Rubber Property—Durometer Hardness.

1.04 SUBMITTALS

A. Provide product data for the following:

1. Waterstop Product.

2. Adhesive.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver the waterstop materials to the PROJECT site in the manufacturer's unpacked containers with all labels intact and legible at time of use. Materials shall be stored in a secure, indoor, dry area. Maintain the waterstops in a dry condition during delivery, storage, handling, installation, and concealment.

PART 2 PRODUCTS

2.01 MATERIALS

A. Hydrophilic Rubber Waterstop:

1. The waterstop shall have the minimum performance standard of:

Property	ASTM Standard	Results
Tensile Strength (MPa)	D412	0.98
Elongation	D412	550
Hardness (Hs)	D2240	30 Durometer Type A
The time period to maximum volume expansion is 35 days.		

2. Materials approved for use are:

   a. Adeka Corporation; MC-2010M.

   b. Adeka Corporation; KM-3030M.

   c. Adeka Corporation; P201 (except in contact with potable water).

   d. Adeka Corporation; KC Series.

B. Adhesive:

1. The adhesive shall be 3M-2141 as manufactured by the 3M Company, or Adeka Corporation H-1000 Ultra Bond.

PART 3 EXECUTION

3.01 GENERAL

A. Coordinate as required with other trades and SPECIFICATIONS to ensure proper execution of the waterstop installation.

B. The components and installation procedures shall be in accordance with the manufacturer's printed specifications and recommendations. Installation shall be performed by skilled workers who are trained in procedures and methods required for proper performance of the waterstop.

3.02 EXAMINATION

A. Examine the concrete surface and correct any surface imperfections which may prevent proper installation and performance of the waterstop. The finished concrete surface, prior to surface preparation, shall be equal to a steel trowel finish.

3.03 SURFACE PREPARATION

A. Concrete surfaces shall be clean and free of dirt, saw dust, laitance, grease, form oils, form release agent, or other contamination to ensure proper adhesion of the waterstop to the concrete surface. Use a wire brush to lightly roughen the surface. Remove all concrete dust with a soft brush.

3.04 WATERSTOP PLACEMENT

A. Measure and cut an exact length of waterstop. Splices are not permitted in the waterstop in vertical wall joints of structures. Splices in horizontal joints are

acceptable, however, only one (1) splice is permitted in twenty five (25) feet. Splice of waterstops in horizontal joints shall be made by butting and gluing the ends of the waterstop with an approved adhesive.

B. Refer to the manufacturer's recommendations for minimum clearance to a concrete face. Unless a greater clearance is recommended by the manufacturer, the minimum clearance shall be two (2) inches. Use the greater clearance if the recommended clearance is more than two (2) inches.

C. Using a brush, apply a uniform coat of adhesive to the concrete surface along the line of placement. Apply a uniform coat of adhesive to the waterstop. Gaps in the glue application shall not be permitted.

D. After the adhesive has dried to a tacky condition (about fifteen [15] minutes in the summer and thirty [30] minutes in the winter), firmly press the waterstop to the concrete surface. When installing the waterstop on curved surfaces such as pipes, temporary bands (for example, wire or rope) may be used to assist in securing the waterstop to the surface. Any temporary means of securing the waterstop shall be removed prior to placing concrete or grout.

E. Concrete placement within twelve (12) hours is required. The waterstop shall be protected from water and from displacement prior to concrete placement. During concrete placement, CONTRACTOR shall visually observe the waterstop to ensure proper placement and alignment.

END OF SECTION

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SECTION 03 21 00

REINFORCING STEEL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of furnishing and placing reinforcing steel in accordance with these SPECIFICATIONS and in conformity with the DRAWINGS.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 31 00, Structural Concrete.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

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

a. M31M/M31, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

b. AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges.

2. American Concrete Institute (ACI):

a. ACI Detailing Manual.

b. 117, Specifications for Tolerance for Concrete Construction and Materials.

c. 318, Building Code Requirements for Structural Concrete.

3. American Welding Society (AWS):

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

b. D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.

c. D2.0, Welded Highway and Railway Bridges.

4. ASTM International (ASTM):

a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.

b. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.

c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

d. A996/A996M, Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

e. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

f. A767/A767M, Standard Specification for Zinc-coated (Galvanized) Steel Bars for Concrete Reinforcement.

g. A775/A775M, Standard Specification for Epoxy-coated Steel Reinforcing.

5. Concrete Reinforcing Steel Institute (CRSI):

a. Manual of Standard Practice.

b. Placing Reinforcing Bars.

1.04 SUBMITTALS

A. Two copies of a list of all reinforcing steel and bending diagrams shall be furnished to the ENGINEER at the site of the work at least one week before the placing of reinforcing steel is begun. Such lists will not be reviewed for accuracy. The CONTRACTOR shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the plans.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Reinforcing steel shall be stored off of the ground and protected from oil or other materials detrimental to the steel or bonding capability of the reinforcing bar. Epoxy-coated reinforcing bars shall be stored on protective cribbing.

PART 2 PRODUCTS

2.01 REINFORCING STEEL

A. Deformed Bars: All bar steel reinforcement shall be of the deformed type, ASTM A615, AASHTO M31M/M31, and Grade (40 or 60) as specified on the DRAWINGS.

B. Spirals:

1. Spirals, hot-rolled plain or deformed bars per ASTM A615, Grade 60 or cold drawn wire per ASTM A82/A82M as specified on the DRAWINGS.

2. Spirals for columns shall have two (2) “spacers” with a section modulus >0.030in^3 in order to maintain the proper pitch and spacing.

C. Epoxy-Coated Reinforcing Bars: Epoxy-coated reinforcing bars shall conform to ASTM A775/A775M. When required, damaged epoxy coating shall be repaired with

patching material conforming to ASTM A775/A775M in accordance with the material manufacturer's recommendations.

D. Zinc-coated (Galvanized Reinforcing Bars): Zinc-coated reinforcing bars shall conform to ASTM A767/A767M. When required, damaged zinc coating shall be repaired with a zinc-rich formulation conforming to ASTM A767/A767M.

E. Welded Wire Fabric: All welded wire fabric reinforcement shall conform to ASTM A497/A497M.

F. Identification:

1. Bundles of reinforcing bars and wire spirals shall be tagged, with a metal tag, showing specification, grade, size, quantity, and suitable identification to permit checking, sorting, and placing. When bar marks are used to identify reinforcing bars on the DRAWINGS, the bar mark shall be shown on the tag. Tags shall be removed prior to concrete placement.

2. Bundles of flat sheets and rolls of welded wire fabric shall be tagged similar to reinforcing bars.

2.02 TIE WIRE

A. 16 gauge wire ties, manufactured by American Wire Tie, Inc., or equal. When epoxy-coated reinforcing steel is shown on the DRAWINGS, PVC coated wire ties shall be used. The minimum PVC coating shall be 0.7 mils.

2.03 BAR SUPPORTS

A. General: Bar supports and spacing shall be in accordance with the CRSI Manual of Standard Practice, Chapter 3, a maximum of four (4) feet, or as required by the DRAWINGS.

B. Floor Slabs: Uncoated steel or non-metallic composite chairs shall be used unless otherwise shown on the DRAWINGS. If required by ENGINEER, the chair shall be stapled on a bearing pad to prevent chair displacement. The bearing pad shall be made of exterior grade plywood and be approximately five (5) inches square.

C. Columns: Plastic "space wheels" manufactured by Aztec (Model DO 12/40), or equal, are required.

D. Epoxy-Coated and Zinc-Coated Bar Supports: Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports made of dielectric or other acceptable materials. Wire supports shall be fully coated with dielectric material, compatible with concrete. Reinforcing bars used as support bars shall be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars shall be epoxy-coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing shall be made of corrosion-resistant material or coated with dielectric material.

2.04 FABRICATION

A. Fabrication tolerances for straight and bent bars shall be in accordance with the requirements of Subsection 4.3, Tolerance, of ACI 315 and the CRSI Manual of Standard Practice.

PART 3 EXECUTION

3.01 GENERAL

A. Rust, seams, surface irregularities, or mill scale shall not be cause for rejection provided that the weight and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM Specification.

3.02 BAR LIST

A. CONTRACTOR shall be responsible for the accuracy of the lists and for furnishing and placing all reinforcing steel in accordance with the details shown on the DRAWINGS.

B. Bar lists and bending diagrams for structures, which are included on the DRAWINGS, do not have to be furnished by CONTRACTOR. When bar lists and bending diagrams are included on the DRAWINGS, they are intended for estimating approximate quantities. CONTRACTOR shall verify the quantity, size, and shape of the bar reinforcement against those shown on the DRAWINGS and make any necessary corrections before ordering.

3.03 BENDING

A. All reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent, except as shown on the DRAWINGS or permitted. Bars shall not be bent or straightened in a manner that may injure the material.

3.04 SPIRALS

A. One and one-half (1-1/2) finishing bends are required at the top and bottom of the spiral. Spacers shall be provided in accordance with Chapter 5, Section 9 of the CRSI Manual of Standard Practice. Welding as an aid to fabrication and/or installation is not permitted.

3.05 PLACING AND FASTENING

A. When placed in the WORK, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust, or other foreign substance.

B. The placing, fastening, splicing, and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the DRAWINGS and the latest edition of “CRSI Placing Reinforcing Bars.” In case of discrepancy between the DRAWINGS and the CRSI publication stated above, the DRAWINGS shall govern. Reinforcement shall be placed within the tolerances provided in ACI 117.

C. Steel reinforcement shall be accurately placed in the positions shown on the DRAWINGS and firmly held during the placing and setting of concrete by means of

spacer strips, stays, metal chairs or other approved devices or supports. Precast concrete bricks or other types of bricks are not permitted for support of reinforcement in footings, slabs, or any other part of the work. Chair and bolster supports for slabs and walls shall be spaced at a maximum of four- (4-) foot centers unless otherwise shown on the DRAWINGS. Staples used to attach bar supports to wall and roof forms shall have the staple "tails" clipped after form removal. For columns, three (3) wheels, spaced one hundred twenty degrees (120°) apart, shall be placed every four (4) feet of column height. CONTRACTOR may increase the column spiral pitch if a conflict occurs with the wheel. Pre-tied column reinforcing steel lowered into column forms shall be lowered vertically to prevent damage to the space wheels.

D. Bars shall be securely tied at fifty percent (50%) of all intersections except where spacing is less than one (1) foot in each direction, when alternate intersections shall be tied unless otherwise called out on the DRAWINGS or in applicable SPECIFICATIONS. Tying of steel by spot welding shall not be permitted unless specifically authorized by ENGINEER. The placing and securing of the reinforcement in any unit or section shall be accepted by ENGINEER before any concrete is placed in any such unit or section.

E. Bundle bars shall be tied together at not more than six- (6-) foot centers.

3.06 SPLICING

A. Bar steel reinforcement shall be furnished in the full lengths indicated on the DRAWINGS. Splicing of bars, except where shown on the DRAWINGS, shall not be permitted without the written acceptance of ENGINEER. Splices shall be staggered. In cases where permission is granted to splice bars, other than those shown on the DRAWINGS, the additional material required for the lap shall be furnished by CONTRACTOR at CONTRACTOR's own expense. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar. All splices shall be full contact splices.

B. Splices shall not be permitted at points where the section is not sufficient to provide a minimum distance of two (2) inches between the splice and the nearest adjacent bar or the surface of the concrete.

C. Welding of reinforcement shall be done only if detailed on the DRAWINGS or if authorized by ENGINEER in writing. Welding shall be done by a certified welder. The welding shall conform to AWS D1.4/D1.4M with the modifications and additions specified hereinafter. Where AWS D2.0 Specifications for Welded Highway and Railway Bridges is referenced, the reference shall be construed to be for AWS D1.1. Where the term AWS D1.1/D1.1M is used it shall mean the American Welding Society Structural Welding Code, D1.5/D1.5M as modified and amended by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. After completion of welding, coating damage to coated reinforcing steel bars shall be repaired.

D. When required or permitted, a mechanical connection may be used to splice reinforcing steel bars or as substitution for dowel bars. The mechanical connection shall be capable of developing a minimum of one hundred twenty five percent (125%) of the yield strength of the reinforcing bar in both tension and compression. All parts of mechanical connections used on coated bars, including steel splice

sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

3.07 CUTTING

A. When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage.

END OF SECTION

SECTION 03 31 00

STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, and equipment for the construction of reinforced cast-in-place concrete.

B. This section includes basic finishing and curing methods, accessory control, and expansion and contraction joint devices.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 11 00, Concrete Forming.
2. Section 03 15 00, Construction Joints.
3. Section 03 15 13, Waterstops.
4. Section 03 21 00, Reinforcing Steel.
5. Section 03 35 00, Concrete Finishing.
6. Section 03 39 00, Concrete Curing.
7. Section 07 92 00, Sealants.
8. Section 32 16 00, Sidewalks, Curbs, and Gutters.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
    a. C33, Standard Specification for Concrete Aggregates.
    b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
    c. C150, Standard Specification for Portland cement.
    d. C260, Standard Specification for Air-entraining Admixtures for Concrete.
    e. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.

f. C618, Standard Specification for Coal and Raw or Calcined Natural Pozzolan for Use in Concrete.

g. C979, Standard Specification for Pigments for Integrally Colored Concrete.

h. C1059, Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.

i. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

2. American Concrete Institute (ACI):

a. 211, Standard Practice for Selecting Proportions for Concrete.

b. 301, Specifications for Structural Concrete.

c. 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.

d. 305.1, Specification for Hot Weather Concreting.

e. 306.1, Specification for Cold Weather Concreting.

f. 309, Standard Practice for Consolidating Concrete.

g. 318, Building Code Requirements for Structural Concrete.

h. 504, Guide to Joint Sealants.

1.04 SUBMITTALS

A. Provide product data on the following:

1. Ready-mixed concrete mix designs.

2. Fly ash.

3. Admixtures (such as air-entraining and water-reducing admixtures).

4. Form release agents.

5. Bonding agents.

6. Grout.

1.05 QUALITY ASSURANCE

A. Qualifications: The ready-mixed concrete supplier to CONTRACTOR shall have the capability to produce and deliver concrete, meeting the requirements of the DRAWINGS and SPECIFICATIONS. The supplier shall have a contingency plan for a back-up plant in the event of a mechanical malfunction of one of the primary plant(s).

1.06 DELIVERY, STORAGE, AND HANDLING

A. The ready-mixed concrete truck driver shall provide the batch ticket to ENGINEER at the time of concrete delivery. The ticket shall summarize the following information legibly in an easily discernible table:

1. Weight in pounds of all materials, excepting the water reducing and air-entraining agents which shall be in ounces.

2. Cubic yards batched.

3. The ratio of water to cementitious (W/C) materials ratio.

4. Temperature of the concrete at the time it was batched.

5. Time of batching.

6. Free moisture in the fine and coarse aggregates in percent of weight of aggregate.

7. Gallons of water that may be added at the site without exceeding the permissible W/C ratio.

8. Concrete Mix Design Number.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Acquire cement and aggregate from the same source for all work.

B. Cement: Cement shall be Portland cement Type II, unless otherwise indicated on the DRAWINGS.

C. Aggregate:

1. Fine Aggregate: Fine aggregate shall consist of hard, strong, durable particles complying with the provisions of ASTM C33.

2. Coarse Aggregate: Coarse aggregate shall conform to the provisions of ASTM C33. Aggregate shall be crushed aggregate or angular screened natural aggregate. Hydraulic - cement aggregate is unacceptable.

D. Water: Water shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel. Mixing water for prestressed, pretensioned and prestressed post-tensioned concrete or for concrete which will contain aluminum embedments shall not contain deleterious amounts of chloride ion.

E. Admixtures: Admixtures to be used in concrete shall be subject to prior acceptance by ENGINEER. The admixture shall maintain the same composition and performance throughout the WORK as the product used in the concrete proportions established in accordance with ACI 211. Admixtures containing chloride ions shall not be used.

1. Air Entrainment:

a. An air-entraining agent shall be used in all concrete. The agent used shall conform to ASTM C260.

b. Unless otherwise shown on the DRAWINGS, the amount of air-entraining agent used in each concrete mix shall be such as will affect the entrainment of the percentage of air shown in the following tabulation in the concrete as discharged from the mixer or pumper discharge hose if applicable. Table 1 is applicable for concrete strengths less than five thousand (5,000) psi.

Table 1

Nominal Max. Aggregate Size (Inch)	Average Air Content (Percent)	
	Severe Exposure	Moderate Exposure
3/8	7-1/2 ± 1-1/2	6 ± 1-1/2
3/4	6 ± 1-1/2	5 ± 1-1/2
1-1/2	5-1/2 ± 1-1/2	4-1/2 ± 1-1/2

c. The level of exposure shall be determined by ENGINEER.

d. When a batch of concrete delivered to the PROJECT does not conform to the minimum specified air content, an air-entraining admixture may be added, one (1) time only for the batch, at CONTRACTOR's option prior to consideration for rejection. After the admixture is added, the concrete shall be remixed for a minimum of twenty (20) revolutions of the mixer drum at mixing speed. The concrete shall then be retested and if found acceptable, may be placed in accordance with the SPECIFICATIONS.

2. Water Reducing, Set-Controlling Admixture: CONTRACTOR shall use a "mid-range" water reducing, set controlling admixture, Polyheed 997, or equal. The water-reducing admixture shall be used in all concrete and shall conform to ASTM C494/C494M, specifically Types A, B, C, D, and E.

3. Finely Divided Mineral Admixtures (Fly Ash): Mineral admixtures shall be limited to fly ash conforming to ASTM C618, Class C or Class F. Class C fly ash is not permitted where sulfate resistant cement is required.

F. Evaporative Retardant: In accordance with Section 03 29 00, Concrete Curing.

G. Bituminous Coating: Bituminous Coating for aluminum pipes will be in accordance with AASHTO M-190 Type A.

H. Grout: In accordance with Section 03 60 00, Grouting.

I. Epoxy Bonding Agent:

1. Master Builders; Concresive Liquid (LPL).

2. Master Builders; Concresive Standard Liquid.

2.02 COMPRESSIVE STRENGTH

A. Concrete compressive strength requirements consist of a minimum strength that must be obtained before various loads of stresses are applied to the concrete and, for concrete designated by strength, a minimum strength at the age of twenty eight (28) days. Unless otherwise shown on the DRAWINGS, the twenty eight (28) day compressive strength of structural concrete shall be a minimum of four thousand five hundred (4,500) psi.

B. The mix shall be designed for required strengths in accordance with ACI 301. The ratio of water to the sum of concrete plus pozzolan shall not exceed 0.45 by weight for durable, watertight, concrete. The amount of fly ash in the mix shall be between fifteen and twenty percent (15 and 20%) by weight of the total cementitious materials.

C. Unless otherwise permitted or specified in the DRAWINGS, the concrete shall be proportioned and produced to have a slump not to exceed four (4) inches or less than two and one-half (2-1/2) inches. Concrete not consolidated by internal vibration shall be proportioned to have a slump not to exceed five and one-half (5-1/2) inches or less than four (4) inches.

2.03 SOURCE QUALITY CONTROL

A. Batching:

1. Measuring and batching of materials shall be done at a batching plant.

2. Portland Cement:

a. Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed. Bulk cement shall be weighed on scales separate and distinct from the aggregate hopper or hoppers. Batching shall be such that the accuracy of batching shall be plus or minus one percent of the required weight.

3. Water:

    a. Unless water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. In lieu of the volume method, CONTRACTOR shall be permitted to use a water-metering device.

4. Aggregates:

    a. Aggregates shall be handled from stockpiles or other sources to the batching plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. Batching shall be so conducted as to result in the weights of material required for each type aggregate within a tolerance of two percent (2%).

    b. Free water contents of the coarse and fine aggregates shall be continuously tested and concrete mixture adjusted for moisture conditions of the aggregate in order to meet the designated water/cement ratio.

5. Fine Aggregate:

    a. The proportion of fine aggregate shall be between thirty six and forty four percent (36 and 44%) by volume of the total aggregates in the concrete.

B. Mixing:

1. Ready-mixed concrete shall be either “central mixed” or “shrink mixed” concrete as defined in ASTM C94/C94M. “Truck mixed” concrete as defined in ASTM C94/C94M shall not be permitted. Mixing time shall be measured from the time water is added to the mix, or cement contacts the aggregate. All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement. Mixers and agitators, which have an accumulation of hard concrete or mortar, shall not be used. Ready-mixed concrete shall be mixed and transported in accordance with ASTM C94/C94M.

2. The temperature of mixed concrete, immediately before placing shall not be less than fifty degrees Fahrenheit (50°F) or more than ninety degrees Fahrenheit (90°F). Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits. Neither aggregates nor mixing water shall be heated to exceed one hundred fifty degrees Fahrenheit (150°F).

3. The time elapsing from the time water is added to the mix (or the cement comes in contact with aggregate) until the concrete is deposited in place at the site of the WORK shall not exceed sixty (60) minutes when the concrete is hauled in non-agitating trucks, nor more than ninety (90) minutes when hauled in truck mixers or truck agitators.

4. The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first one-quarter (1/4) of the specified mixing time.

5. Cement shall be charged into the mixer by means that will not result in loss of cement because of the effect of wind, or in accumulation of cement on surfaces of hoppers or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

C. Transporting Mixed Concrete; Mixed Concrete or Truck Mixers:

1. Transporting of mixed concrete shall conform to ASTM C94/C94M.

2. Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

3. No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless approved by ENGINEER. If additional water is to be incorporated into the concrete at the site, the drum shall be revolved not less than thirty (30) revolutions at mixing speed after the water is added and before discharge is commenced. One (1) addition of water at the site to adjust mix workability is permitted but the maximum water cement ratio shall not be exceeded.

4. CONTRACTOR shall furnish a water-measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix on the site. All water tanks on transit mix trucks shall be filled prior to being batched and arrive at the construction site one hundred percent (100%) full.

5. Each load of ready mixed concrete delivered at the job shall be accompanied by the ticket in accordance with Article Delivery, Storage, and Handling.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to placing concrete, CONTRACTOR shall remove all debris and thoroughly dampen the surfaces that may be in contact with the concrete to be placed.

B. CONTRACTOR shall use compressed air from an air compressor to blow out construction debris and dirt at the bottom of members to be placed such as walls, beams, and columns, prior to final placement of forms that may obscure any joint. CONTRACTOR shall demonstrate to ENGINEER that all debris, such as concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

C. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.

D. No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms, and preparation of surfaces involved in the placing have been reviewed by ENGINEER.

E. Immediately before placing concrete, all surfaces upon or against which the concrete is to be placed shall be free from standing water, mud, debris, or loose materials.

F. No concrete shall be placed when form surfaces that may be in contact with the concrete, reinforcement, embedded items or sub-base is less than thirty two degrees Fahrenheit (32°F). When the mean daily outdoor temperature is less than forty degrees Fahrenheit (40°F), the temperature of the concrete shall be maintained between fifty degrees Fahrenheit (50°F) and seventy degrees Fahrenheit (70°F) for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury as a result of concentration of heat. Combustion heaters shall not be used during the first twenty four (24) hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

G. Concrete shall not be placed against forms exposed to heating unless the temperature of the forms is first cooled to less than or equal to ninety degrees Fahrenheit (≤90°F).

3.02 PLACEMENT

A. Placement shall conform to ACI 301, Chapter 8, ACI 304, ACI 306.1, ACI 305.1, and ACI 309. No concrete shall be placed in water except with the written permission of ENGINEER. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. The concrete shall be placed by equipment that will prevent segregation or loss of ingredients. The stream of concrete shall not be allowed to separate by permitting it to fall freely over rods, spacers or other embedded materials.

B. Unless otherwise called out in these SPECIFICATIONS or shown on the DRAWINGS, the placement lift depth of concrete in walls shall be limited to two (2) feet or less to minimize surface defects such as air voids that can form on concrete surfaces. Lift depths shall be limited to one (1) foot if, in the opinion of ENGINEER, the quality of the finish is unacceptable at the two- (2-) foot lift depth.

C. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.

D. Concrete shall not be dropped more than five (5) feet unless confined by closed chutes or pipes. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the ends of projecting reinforcement.

E. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement.

F. Concrete shall not be pumped through aluminum alloy pipe.

G. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete.

3.03 CONSOLIDATION

A. Concrete vibrators for consolidating concrete shall be two and one-half inch (2-1/2") diameter “high cycle” vibrators with a frequency under load of eight thousand (8,000) to ten thousand four hundred (10,400) vibrations per minute (vpm). Concrete vibrators of lesser capacity are unacceptable for use in any part of the construction. CONTRACTOR shall have at least one standby concrete vibrator ready for use for every two (2) concrete vibrators in use during a concrete placement.

B. All concrete shall be thoroughly consolidated with internal vibrators as recommended in ACI 309 immediately after deposition. The concrete shall be thoroughly worked around the reinforcing steel, around embedded items and into corners of forms. Vibration shall be supplemented by spading, rodding, or forking to eliminate all honeycomb and voids around embedded items.

C. The vibrator shall be inserted vertically, allowing it to penetrate rapidly to the bottom of the lift and at least six (6) inches into the previous lift. The vibrator shall be held at the bottom of lift for five to fifteen (5 - 15) seconds. The vibrator shall be pulled up at a rate of about three (3) inches per second.

D. The vibrator shall be inserted so that the fields of action overlap. The field of action is approximately eight (8) times the vibrator’s head diameter. Thus for a two and one-half (2-1/2) inch diameter vibrator, the spacing of each insertion shall be approximately twenty (20) inches.

E. Vibration shall be stopped when the concrete surface takes a sheen and large air bubbles no longer escape.

F. Do not use a vibrator to move concrete horizontally.

3.04 OPENINGS AND INSERTS

A. Pipe sleeves, inserts for pipe connections, anchors, and forms for pipe holes shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. In the event that openings are inadvertently omitted or improperly placed, ENGINEER may require the concrete to be cored at the proper location. Filling of improperly placed openings shall be done with expansive grout or dry pack or mortar applied with an accepted epoxy adhesive. The surfaces of the opening shall be roughened prior to filling.

3.05 EMBEDDED ITEMS

A. At the time of concrete placement, embedded items shall be clean and free from mud, oil, and other coatings that may adversely affect bonding capacity. Aluminum embedments shall be coated with a bituminous material to prevent electrolytic action between the embedded item and reinforcing steel that results in concrete deterioration. Embedment items shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. Contact between embedded items and reinforcing steel or tendon ducts is unacceptable and is not permitted.

3.06 CONSTRUCTION JOINTS

A. The location of all construction joints shall be subject to the acceptance of ENGINEER. The surface of all construction joints shall be thoroughly cleaned and all laitance and standing water removed. Clean aggregate shall be exposed by abrasive blast cleaning. Wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning. Construction joints shall be keyed at right angle to the direction of shear. Except where otherwise shown on the DRAWINGS, keyways shall be at least one and one-half (1-1/2) inch in depth over at least twenty five percent (25%) of the area of the section.

3.07 EVAPORATIVE RETARDANT

A. The use of an evaporative retardant is required to assist in proper placement of concrete in accordance with Section 03 29 00, Concrete Curing. Apply two (2) times; after screeding and after the first floating operation. The retardant should be applied at a rate of one (1) gallon of sprayable solution per two hundred to four hundred (200 - 400) square feet by spraying with an industrial type sprayer. If the nozzle of the sprayer becomes plugged, CONTRACTOR shall clean, or replace, the nozzle. Under no circumstances shall the retardant be used except by spraying a mist with a nozzle. The retardant shall be applied in strict conformance with the manufacturer's recommendations and precautions. In no case shall the retardant be used as a finishing agent. The use of an evaporative retardant requires review and approval by ENGINEER.

3.08 FIELD QUALITY CONTROL

A. CONTRACTOR shall assist OWNER or the concrete testing consultant as requested during the performance of quality control testing. When concrete is placed using a concrete pumper, concrete for testing will be taken from the pumper discharge hose.

END OF SECTION

SECTION 03 31 01

SCULPTED CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, and equipment for the construction of reinforced cast-in-place sculpted concrete (concrete and Shotcrete). Where "sculpted concrete" is called out on the DRAWINGS, it shall be up to the CONTRACTOR whether to use concrete and Shotcrete or just Shotcrete as necessary to conform to the lines, grades, thicknesses, and typical cross sections shown on the DRAWINGS. Sculpted concrete is to be finished to look like natural rock where exposed above ground.

B. Work includes preparation of substrate surface, placing reinforcing steel, and placement and shaping of the top concrete or Shotcrete surface to look like natural sedimentary rock, and related items as shown or specified.

C. This section includes basic finishing and curing methods, accessory control, and expansion and contraction joint devices.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 31 00, Structural Concrete.
2. Section 03 11 00, Concrete Forming.
3. Section 03 15 00, Construction Joints.
4. Section 03 15 13, Waterstops.
5. Section 03 21 00, Reinforcing Steel.
6. Section 03 35 00, Concrete Finishing.
7. Section 03 39 00, Concrete Curing.
8. Section 07 92 00, Sealants.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.

c. C150, Standard Specification for Portland Cement.

d. C260, Standard Specification for Air-entraining Admixtures for Concrete.

e. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.

f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

g. C979, Standard Specification for Pigments for Integrally Colored Concrete.

h. C1059, Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete.

i. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

2. American Concrete Institute (ACI):

a. 211, Standard Practice for Selecting Proportions for Concrete.

b. 301, Specifications for Structural Concrete.

c. 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.

d. 305.1, Specification for Hot Weather Concreting.

e. 306.1, Specification for Cold Weather Concreting.

f. 309, Standard Practice for Consolidating Concrete.

g. 318, Building Code Requirements for Structural Concrete.

h. 504, Guide to Joint Sealants.

i. 506, Recommended Practice for Shotcreteing

1.04 SUBMITTALS

A. Provide product data on the following:

1. Ready-mixed concrete or Shotcrete mix designs.

2. Fly ash.

3. Admixtures (such as air-entraining and water-reducing admixtures).

4. Form release agents.

5. Bonding agents.

6. Grout.

7. Concrete coloring pigment.

8. Data for proprietary materials and items including patching compounds, curing compounds, and other requested by the ENGINEER.

9. Contractor statement detailing previous sculpted concrete experience.

10. A sculpted concrete construction plan is to be submitted in writing to the ENGINEER for review 7 days prior to construction. The plan shall describe methods and equipment proposed for hauling, placing, curing, and protecting sculpted concrete as well as placement schedules indicating anticipated daily progress.

11. Shop drawings for sculpted concrete feature indicating sizes, spacing, locations, and quantities of reinforcing steel, bending and cutting schedules, splicing, supporting and spacing devices, and other accessories.

12. The CONTRACTOR shall construct a sample sculpted concrete panel measuring not less than 50 square feet. The sample panel shall represent the finished surface texturing, coloring, and etching of the sculpted concrete feature. The ENGINEER or other representatives of the OWNER shall observe and approve the sample panel prior to the construction of any sculpted concrete features.

13. Contractor shall submit to the ENGINEER for review and approval, all proposed texture mats to be utilized by the CONTRACTOR to achieve the most natural rock appearance and texture possible. If other methods of texturing will be performed, the contractor shall submit detailed descriptions of such methods for review.

1.05 QUALITY ASSURANCE

A. Structural Concrete as specified in Section 03 31 00, Structural Concrete, shall be used in the construction of the sculpted concrete feature unless Shotcrete is previously approved.

B. Prior to placement of structural concrete for the sculpted concrete feature, the ENGINEER or other representatives of the OWNER must observe all reinforcing bar, forms, and surfaces receiving concrete. Prior to placing concrete CONTRACTOR must repair all discrepancies identified by ENGINEER or other representatives of the OWNER.

C. OWNER's Direction:

1. It is intended that the finished sculpted concrete feature simulate natural rock as shown on the DRAWINGS. OWNER’s direction and aesthetic intentions are specified herein.

2. To achieve the natural rock simulation, the CONTRACTOR shall coordinate fully with ENGINEER or other representatives of the OWNER. The ENGINEER or OWNER explicitly reserves the right to continuously monitor the WORK for aesthetic quality until the desired effects are achieved.

3. All WORK in this section shall be observed by the ENGINEER or other representatives of the OWNER. CONTRACTOR shall ensure a representative of the OWNER is onsite prior to placement of concrete.

4. For sculpted concrete work, visits to other project sites (to view examples) may be required. Adequate notification of the intent to begin WORK on this item (minimum 24 hours) is required to ensure inspection and oversight by the ENGINEER and/or OWNER.

D. The fabrication of artificial rockwork and placement, installation, and/or adjustment of finish details and sculptures shall be accomplished in such a manner as to appear as realistic as possible and "read right" to the trained eye. This element is artistic in nature and may require field adjustments to completed work to obtain the desired effect. The ENGINEER will decide questions of aesthetic effect. Minor changes or adjustments to in-place work shall be made at the CONTRACTOR's expense.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Structural concrete delivery, storage, and handling shall be performed in accordance with Section 03 31 00, Structural Concrete.

B. Ready-mixed Shotcrete shall comply with ASTM C94 except that it may be delivered to the Shotcrete equipment in the dry state if that equipment is capable of adding the water and mixing satisfactorily with the dry ingredients, or with ASTM C685, in which case the ingredients are delivered dry and proportioned and mixed at the site.

C. Structural reinforcing steel delivery, storage, and handling shall be performed in accordance with Section 03 21 00, Reinforcing Steel.

PART 2 PRODUCTS

2.01 MATERIALS

A. Definition: Where "sculpted concrete" is called out on the plans, concrete or Shotcrete shall be used as necessary to meet the thickness, lines, and grades indicated on the plans.

B. Concrete class:

1. Concrete

a. Concrete shall meet the requirements of Class B concrete in accordance with section 601 of the Colorado Department of Transportation "Standard Specifications for Road and Bridge Construction".

b. The concrete mix shall be made with AASHTO M 43 size No. 8 coarse aggregate.

Sieve size U.S. Standard Square Mesh Sieves	ASHTO M 43 size No. 8 coarse aggregate Percent by Weight Passing
¾”	-
½”	100
⅜”	85-100
No. 4	10-30
No. 8	0-10
No.16	0-5

2. Shotcrete

a. Shotcrete shall be placed as a wet mixture of aggregate and Portland cement.

b. The minimum 28-day compressive strength shall be 4500 psi.

c. Coarse aggregates

1) AASHTO M 43 Size No. 8

Sieve size U.S. Standard Square Mesh Sieves	ASHTO M 43 size No. 8 coarse aggregate Percent by Weight Passing
¾”	-
½”	100
⅜”	85-100
No. 4	10-30
No. 8	0-10
No.16	0-5

d. Fine aggregates

1) AASHTO M6
2) ASTM C33

Sieve size U.S. Standard Square Mesh Sieves	ASTM C33 Fine Aggregate Percent by Weight Passing
¾”	-
½”	-
⅜”	100
No. 4	95-100
No. 8	80-100
No.30	50-85
No. 50	25-60
No. 100	2-10

C. Use cement conforming to one of the following:

1. Portland Cement conforming to ASTM C-150. Use only one brand of cement throughout the project.

2. Blended hydraulic cement conforming to ASTM C-595 type IS, IS-A, IP, or IP-.

D. Water shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances. For finished Shotcrete, use curing water that is free from elements that could cause staining.

E. Submit for acceptance proportioning and test data from prior experience. If data from prior experience are not available or accepted, make and have tested specimens from three or more different mix proportions. Submit mix design containing recommended mix proportions and test results for acceptance of ready-mixed Shotcrete. Air entrainment shall be 5-8% prior to pumping.

F. General: Structural concrete shall conform to Section 03 31 00, Structural Concrete. Structural reinforcing steel shall conform to Section 03 21 00, Reinforcing Steel.

G. Concrete Pigment: Concrete coloring shall conform to ASTM C979.

H. Fibermesh: Fibermesh shall not be allowed in sculpted concrete features unless written approval is provided by ENGINEER.

I. Reinforcing Steel: reinforcing steel shall meet the requirements of section 03 21 00 Reinforcing Steel.

2.02 COMPRESSIVE STRENGTH

A. Concrete compressive strength shall conform to Section 03 31 00, Structural Concrete.

2.03 SOURCE QUALITY CONTROL

A. Batching, Mixing, Transporting Mixed Concrete; Mixed Concrete or Truck Mixers: Shall comply with Section 03 31 00, Structural Concrete.

2.04 ADMIXTURES

A. Use of admixtures shall be permitted upon approval by the ENGINEER.

2.05 STAINING

A. See section 09 91 00 of these specifications for information related to staining sculpted concrete.

PART 3 EXECUTION

3.01 EQUIPMENT

A. All Shotcrete shall be applied to the substrate surface via pneumatic-feed or positive displacement guns. All guns, air compressors, delivery hoses, and nozzles shall work

together to provide the appropriate Shotcrete product as determined acceptable by the ENGINEER. Failure to meet the desired product and strengths may result in rejection of equipment and/or methods employed by the CONTRACTOR at the discretion of the ENGINEER.

3.02 GENERAL

A. "Sculpted concrete" shall be constructed with a single layer of concrete or Shotcrete. The CONTRACTOR is responsible for reviewing the DRAWINGS and deciding which application method will maintain the intended shape and grades. Any other application approach must be reviewed and approved by the ENGINEER.

B. The "Test Section" shall be constructed first. This section will be inspected by the ENGINEER and OWNER. Once deemed acceptable and any necessary modifications to future work are discussed and agreed upon, the CONTRACTOR shall commence construction on other sculpted concrete. There is no specified sequence for the other areas.

3.03 PREPARATION

A. Excavation to subgrade shall be carefully considered by the CONTRACTOR. Subgrade may be sloped uniformly, or stepped in accordance with the grading shown on the DRAWINGS as a means of reducing the concrete/Shotcrete quantity required. No adjustment in quantity shall be made for concrete/Shotcrete placed at thicknesses greater than the uniform layer shown on the DRAWINGS. The building of earthen steps on top of a sloping subgrade plane that has been compacted and approved is strictly prohibited. All concrete/Shotcrete necessary to achieve the layout shown on the DRAWINGS shall be included in the unit cost of the sculpted concrete.

B. Prior to placing concrete, CONTRACTOR shall remove all debris and thoroughly dampen the surfaces that may be in contact with the concrete to be placed.

C. CONTACTOR shall examine the subgrade, and the conditions under which concrete reinforcement is to be placed, and correct conditions that would prevent the proper and timely completion of the work. The subgrade shall be free of water, unfrozen, mud, debris, or loose materials and have met compaction requirements as specific in section 31 23 00. CONTRACTOR shall not proceed with the work until unsatisfactory conditions have been corrected.

A Shotcrete flash coat may be applied over the top of the completed subgrade. The flash coat shall consist of a 1-inch layer of Shotcrete that will cap and protect the subgrade material during placement of reinforcing steel and prior to placement of sculpted concrete. The flash coat thickness can be counted towards the total required thickness of sculpted concrete if the following conditions are met: This requirement may be waived by OWNER or ENGINEER if CONTRACTOR can demonstrate it is not required and will not compromise the quality of the structure.

1. The thickness of the flash coat does not exceed 1.5 inches

2. The flash coat is power washed clean after steel placement is complete.

3. The flash coat Shotcrete does not excessively crack, break apart, and/or separate from the subgrade prior to placement of sculpted concrete. Determination of acceptance shall be performed by the ENGINEER.

D. CONTRACTOR shall use compressed air from an air compressor to blow out construction debris and dirt at the bottom of members to be placed such as walls, beams, and columns, prior to final placement of forms that may obscure any joint. CONTRACTOR shall demonstrate to ENGINEER that all debris, such as concrete particles, saw dust, loose tie wire, bar tags, tape, trash, and dirt, have been thoroughly removed.

E. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed.

F. No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms, and preparation of surfaces involved in the placing have been reviewed by ENGINEER.

G. Concrete shall be placed when form surfaces that may be in contact with the concrete, reinforcement, embedded items or sub-base are greater than thirty-two degrees Fahrenheit (32°F). When the mean daily outdoor temperature is less than forty degrees Fahrenheit (40°F), the temperature of the concrete shall be maintained between fifty degrees Fahrenheit (50°F) and seventy degrees Fahrenheit (70°F) for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury as a result of concentration of heat. Combustion heaters shall not be used during the first twenty four (24) hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

H. Concrete shall not be placed against forms exposed to heating unless the temperature of the forms is first cooled to less than or equal to ninety degrees Fahrenheit (≤90°F).

3.04 CONCRETE PLACEMENT

A. Concrete shall be placed directly on approved subgrade in accordance with the requirements set for in Section 03 31 00.

B. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.

C. Concrete shall not be dropped more than five (5) feet unless confined by closed chutes or pipes. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and worked around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and strain shall not be placed on the ends of projecting reinforcement.

D. Where steep slopes are required, the chutes shall be equipped with baffle boards or be in short lengths that reverse the direction of movement.

E. Concrete shall not be pumped through aluminum alloy pipe.

F. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete.

3.05 SHOTCRETE PLACEMENT

A. Place Shotcrete using suitable delivery equipment and procedures that will meet the requirements of this specification. Refer to ACI Standard 506-66, Recommended Practice for Shotcreteing.

B. Do not place Shotcrete if drying or stiffening of the mix takes place at any time prior to delivery to the nozzle. Do not use rebound or previously expended material in the Shotcrete mix.

C. Remove over-spray or rebound prior to final set and before placement of Shotcrete material on such adjacent surfaces.

D. Placement Techniques:

1. Control thickness, method of support, air pressure, and/or water content of Shotcrete to preclude sagging or sloughing off. Discontinue Shotcreteing or provide suitable means to screen the nozzle stream if wind or air currents cause separation of the nozzle stream during placement.

2. Dampen absorptive substrate surfaces prior to placement of Shotcrete to facilitate bond and to reduce the possibility of shrinkage cracking developing from premature loss of the mixing water.

3. Broom or scarify the surface of freshly placed Shotcrete to which, after hardening, additional layers of Shotcrete are to be bonded. Dampen surface just prior to application of succeeding layers.

4. Provide a supply of clean dry air adequate for maintaining sufficient nozzle velocity for all parts of the Work, and if required, for simultaneous operation of a suitable blow pipe for clearing away rebound.

E. Placement Around Reinforcement:

1. Hold the nozzle at such a distance and angle to place material behind reinforcement before any material is allowed to accumulate on its face. In the dry-mix process additional waste may be added to the mix when encasing reinforcement to facilitate a smooth flow of material behind the bars.

2. Do not place Shotcrete through more than one layer of reinforcing steel rods or mesh in one application unless demonstrated by pre-construction tests that steel is properly encased. Test to ascertain if any voids or sand pockets have developed around or behind reinforcement by probing with an awl or other pointed tool; by removal of randomly selected bars; or by coring or other suitable means.

3.06 COVER OF REINFORCEMENT

A. Place concrete and/or Shotcrete to provide the 1 ½" (minimum) cover over all reinforcement.

3.07 LINE AND THICKNESS CONTROL

A. Use adequate ground wires or other accepted means to establish the thickness, surface planes, and finish lines of the concrete/Shotcrete.

B. No additional payment will be made for concrete volume or steel reinforcement placed in excess of amounts shown on the DRAWINGS, unless the ENGINEER agrees that conditions warrant such a change that go beyond the requirements set forth in Section 3.03(A) of this SPECIFICATION. If the CONTRACTOR prepares the subgrade in such a manner requiring additional concrete to meet design lines and grades without ENGINEER approval, the ENGINEER may require additional reinforcement steel at no additional charge to the OWNER.

3.08 CONSOLIDATION

A. Concrete vibrators for consolidating concrete shall be two and one-half inch (2-1/2") diameter "high cycle" vibrators with a frequency under load of eight thousand (8,000) to ten thousand four hundred (10,400) vibrations per minute (vpm). Concrete vibrators of lesser capacity are unacceptable for use in any part of the construction. CONTRACTOR shall have at least one standby concrete vibrator ready for use for every two (2) concrete vibrators in use during a concrete placement.

B. All concrete shall be thoroughly consolidated with internal vibrators as recommended in ACI 309 immediately after deposition. The concrete shall be thoroughly worked around the reinforcing steel, around embedded items, and into corners of forms. Vibration shall be supplemented by spading, rodding, or forking to eliminate all honeycomb and voids around embedded items.

C. The vibrator shall be inserted vertically, allowing it to penetrate rapidly to the bottom of the lift and at least six (6) inches into the previous lift. The vibrator shall be held at the bottom of lift for five to fifteen (5 - 15) seconds. The vibrator shall be pulled up at a rate of about three (3) inches per second.

D. The vibrator shall be inserted so that the fields of action overlap. The field of action is approximately eight (8) times the vibrator's head diameter. Thus for a two and one-half (2-1/2) inch diameter vibrator, the spacing of each insertion shall be approximately twenty (20) inches.

E. Vibration shall be stopped when the concrete surface takes a sheen and large air bubbles no longer escape.

F. Do not use a vibrator to move concrete horizontally.

3.09 OPENINGS AND INSERTS

A. Pipe sleeves, inserts for pipe connections, anchors, and forms for pipe holes shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. In the event that

openings are inadvertently omitted or improperly placed, ENGINEER may require the concrete to be cored at the proper location. Filling of improperly placed openings shall be done with expansive grout or dry pack or mortar applied with an accepted epoxy adhesive. The surfaces of the opening shall be roughened prior to filling.

3.10 EMBEDDED ITEMS

A. At the time of concrete placement, embedded items shall be clean and free from mud, oil, and other coatings that may adversely affect bonding capacity. Aluminum embedments shall be coated with a bituminous material to prevent electrolytic action between the embedded item and reinforcing steel that results in concrete deterioration. Embedment items shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete shall not alter their alignment or location. Contact between embedded items and reinforcing steel or tendon ducts is unacceptable and is not permitted.

3.11 CONSTRUCTION JOINTS

A. The location of all construction joints shall be subject to the acceptance of ENGINEER. The surface of all construction joints shall be thoroughly cleaned and all laitance and standing water removed. Clean aggregate shall be exposed by abrasive blast cleaning. Wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning. Construction joints shall be keyed at right angle to the direction of shear. Except where otherwise shown on the DRAWINGS, keyways shall be at least one and one-half (1-1/2) inch in depth over at least twenty five percent (25%) of the area of the section.

B. Construction joints shall not be allowed within a location where water is expected to flow over in the final constructed condition.

C. Taper construction joints to a shallow edge form, about 1 inch thick, except where the joint will be subjected to compressive stress. In this case, use non-tapered joints and take special care to avoid or remove trapped rebound at the joint.

D. The entire joint shall be thoroughly cleaned and wetted prior to the application of additional concrete/Shotcrete.

E. Make joints perpendicular to the main reinforcement. Continue reinforcement across joints.

F. Position construction and control joints to conform to the locations of natural occurring cracks and joints in the simulated rock and earth forms.

3.12 FINISHES

A. CONTRACTOR will provide an expert(s) to perform texturing and shaping of the concrete/Shotcrete that is left exposed above ground.

B. Finished product shall simulate natural rock as described in the SPECIFICATIONS and DRAWINGS. The CONTRACTOR shall achieve the desired appearance by 1) troweling the concrete/Shotcrete smooth, 2) cutting rock formation scars into the surface, and 3) texturing the entire surface using both texture mats and power

washing to achieve a natural rock finish. Alternative methods must be approved by ENGINEER.

C. Extend texture layer a minimum of 3 feet below finished grade.

D. If a trail section is included in the sculpted concrete a broom finish shall be applied to the trail surfaces shown on the DRAWINGS. Broom marks shall be perpendicular to the traveled direction. The broomed surface shall be smooth and void of sculpted concrete carvings.

3.13 CURING AND PROTECTION

A. Concrete:

1. Curing requirements specified in 03 39 00 Concrete Curing, shall be followed at all times.

2. The use of an evaporative retardant is required to assist in proper placement of concrete in accordance with Section 03 29 00, Concrete Curing. Apply two (2) times; after screeding and after the first floating operation. The retardant should be applied at a rate of one (1) gallon of sprayable solution per two hundred to four hundred (200 - 400) square feet by spraying with an industrial type sprayer. If the nozzle of the sprayer becomes plugged, CONTRACTOR shall clean or replace the nozzle. Under no circumstances shall the retardant be used except by spraying a mist with a nozzle. The retardant shall be applied in strict conformance with the manufacturer's recommendations and precautions. In no case shall the retardant be used as a finishing agent. The use of an evaporative retardant requires review and approval by ENGINEER.

B. Shotcrete:

1. Initial Curing

a. Following curing procedures of ACI Standard 308. Immediately after finishing, keep Shotcrete continuously moist for at least 24 hours. The methods and materials used for curing shall be approved by ENGINEER prior to placing Shotcrete.

2. Final Curing

a. Provide additional curing immediately following the initial curing and before the Shotcrete has dried. Use one of the following materials or methods:

1) Continue the method used in initial curing.
2) Materials conforming to "Specifications for Sheet Materials for Curing Concrete," (ASTM C171).
3) Other moisture retaining coverings accepted upon approval by ENGINEER.

C. Duration and Temperature of Curing

1. Continue curing for the first 7 days after installation or for the first 3 days if high early strength is obtained. During the curing period, maintain Shotcrete or concrete above 40^{o}F and in a moist condition as specified above. Prevent rapid drying at the end of the curing period

3.14 REPAIR OF SURFACE DEFECTS

A. Remove and replace concrete or Shotcrete, which lacks uniformity, exhibits segregation, honeycombing, or lamination, or which, contains any dry patches, slugs, voids or sand pockets. Remove and replace damaged in-place concrete or Shotcrete.

B. Replace any concrete or Shotcrete which subsides after placement.

3.15 FIELD QUALITY CONTROL

A. CONTRACTOR shall assist OWNER or the concrete testing consultant as requested during the performance of quality control testing. Testing will be taken from the concrete truck.

B. Test panels shall be shot for the Shotcrete. The panels should be 18” by 18” by 3” and shot at the same orientation as the majority of the structure. Panels shall be shot for every day of placement and every 25 CY of Shotcrete placed. All panels should be cured at the project site. Cores should be taken from the panel in accordance with ASTM C 42. Cores will be used to verify compressive strength. CONTRACTOR is to provide the panels for use in Shotcrete testing and have them available in the field prior to the start of Shotcrete. CONTRACTOR is to notify the ENGINEER 48 hours in advance of the start of Shotcrete operations.

END OF SECTION

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SECTION 03 35 00

CONCRETE FINISHING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall supply all labor, tools, equipment, and materials to finish properly placed concrete for structures.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 11 00, Concrete Forming.
2. Section 03 31 00, Structural Concrete.
3. Section 03 60 00, Grouting.
4. Section 32 16 00, Sidewalks, Curbs, and Gutters.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 116, Cement and Concrete Terminology.
   b. 121, Quality Assurance Systems for Concrete Construction.
   c. SP-15, ACI 301 Field Reference Manual.
   d. 309, Identification and Control of Consolidation-Related Surface Defects in Formed Concrete.
   e. 311, Guide for Inspection of Concrete.
2. ASTM International (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C150, Standard Specification for Portland Cement.
3. U.S. Department of Interior—Bureau of Reclamation (USBR):
   a. M-47, Standard Specifications for Repair of Concrete.

1.04 SUBMITTALS

A. Provide product data on the following:

1. Grout.

2. Bonding agent.

3. Method of repairing defects, unless otherwise called out herein.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver the materials to the PROJECT site in the manufacturer's containers with all labels intact and legible at the time of use. Materials shall be stored in a secure, indoor, dry area. Maintain grouts and aggregates in a dry condition during delivery, storage, and handling.

PART 2 PRODUCTS

2.01 MATERIALS

A. Premixed Pre-Packaged Grout:

1. Master Builders; EMACO R320.

2. Master Builders; EMACO S66-CR.

B. Epoxy Bonding Agent:

1. Master Builders; Concresive Liquid (LPL).

2. Master Builders; Concresive Standard Liquid.

C. Cement:

1. ASTM C150, Type to match original concrete surface.

D. Aggregate:

1. ASTM C33, one hundred percent (100%) passing the No. 30 mesh sieve.

E. Bond Coat Mortar:

1. Mortar used to bond patching mortar shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of one (1) part cement to not more than one (1) part sand by damp loose volume.

F. Patching Mortar:

1. Patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of one (1) part cement to not more than two and one-half (2-1/2) parts sand by damp loose volume. White Portland cement shall be substituted for a part of the gray Portland cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be

mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that shall permit placing.

G. Water:

1. Only clean potable water shall be used. A calibrated measuring device is required for measuring the proper amount of water to be added to pre-packaged grouts and mortars.

PART 3 EXECUTION

3.01 PREPARATION

A. The means and methods of repair of improperly placed or finished concrete shall be reviewed by ENGINEER prior to performing the WORK. Regardless of prior approval of the means and methods of concrete finish repair, no concrete finish shall be repaired until ENGINEER has reviewed the existing finish. This includes defects caused by ineffective and improper vibration such as honeycomb, excessive air voids on formed surfaces, placement “pour” lines (cold joints), and sand streaking. It also includes defects caused by excessive form deflections, form damage, or form failure.

B. Repair of Surface Defects:

1. Surface defects, unless otherwise specified by the CONTRACT DOCUMENTS, shall be repaired immediately after form removal, but not before review by ENGINEER. The surface temperature of the concrete shall be fifty degrees Fahrenheit (50°F) and rising. CONTRACTOR shall measure surface temperatures when requested by ENGINEER. If necessary, CONTRACTOR shall enclose and heat the area to be repaired to bring the surface temperature of the concrete and air temperature to acceptable levels, and to permit proper curing.

2. All honeycombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. Feathered edges shall not be permitted. The area to be patched and an area at least six (6) inches wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared, mixed to the consistency of thick cream, and after surface water has evaporated from the area to be patched, well brushed into the surface.

3. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one (1) hour before being finally finished. The patched area shall be kept damp for seven (7) days. Metal tools shall not be used in finishing a patch in a formed wall that shall be exposed.

C. Alternative Surface Defect Repairs:

1. Certain types of defects may require the use proprietary compounds for adhesion or as patching ingredients. ENGINEER shall review these defects and request means and methods for these repairs from CONTRACTOR.

2. In lieu of, or in addition to, the foregoing patching procedures using bond coat and patching mortars, epoxy bonding agents and premixed pre-packaged grouts may be used for repair of defective areas. Such compounds shall be used in accordance with the manufacturer's written recommendations and directions. ENGINEER shall review and provide written acceptance of these procedures.

3.02 APPLICATION

A. Tie Holes:

1. Unless otherwise called out in the DRAWINGS tie holes shall be finished as specified herein.

2. Water Retaining Structures and Below grade Vaults with Breakback Cone Ties: Fill tie holes solid as specified in Section 03 60 00, Grouting.

3. Other Structures: After being cleaned and thoroughly dampened, fill tie holes solid as specified in Section 03 60 00, Grouting.

B. Finishing of Formed Surfaces:

1. Finishes shall be performed as called out on the DRAWINGS and in referenced SPECIFICATIONS.

2. Smooth Form Finish: The form facing material shall produce a smooth, hard, uniform texture on the concrete. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. Surface textures that result from forms with raised grain, torn surfaces, worn edges, patches, dents, or other defects shall be ground smooth or otherwise repaired.

a. Air Voids on Formed Surfaces: Air voids on formed surfaces deeper than one-quarter (¼) inch shall be filled with patching mortar. The frequency and size of air voids shall be equal to or better than shown in Figure 1. The total void area is one percent (1%) of the surface area, or thirty-six hundredths (0.36) square inches. This six-inch (6") by six-inch (6") figure shall be the visual standard for acceptance of the finish that does not require filling of air voids.

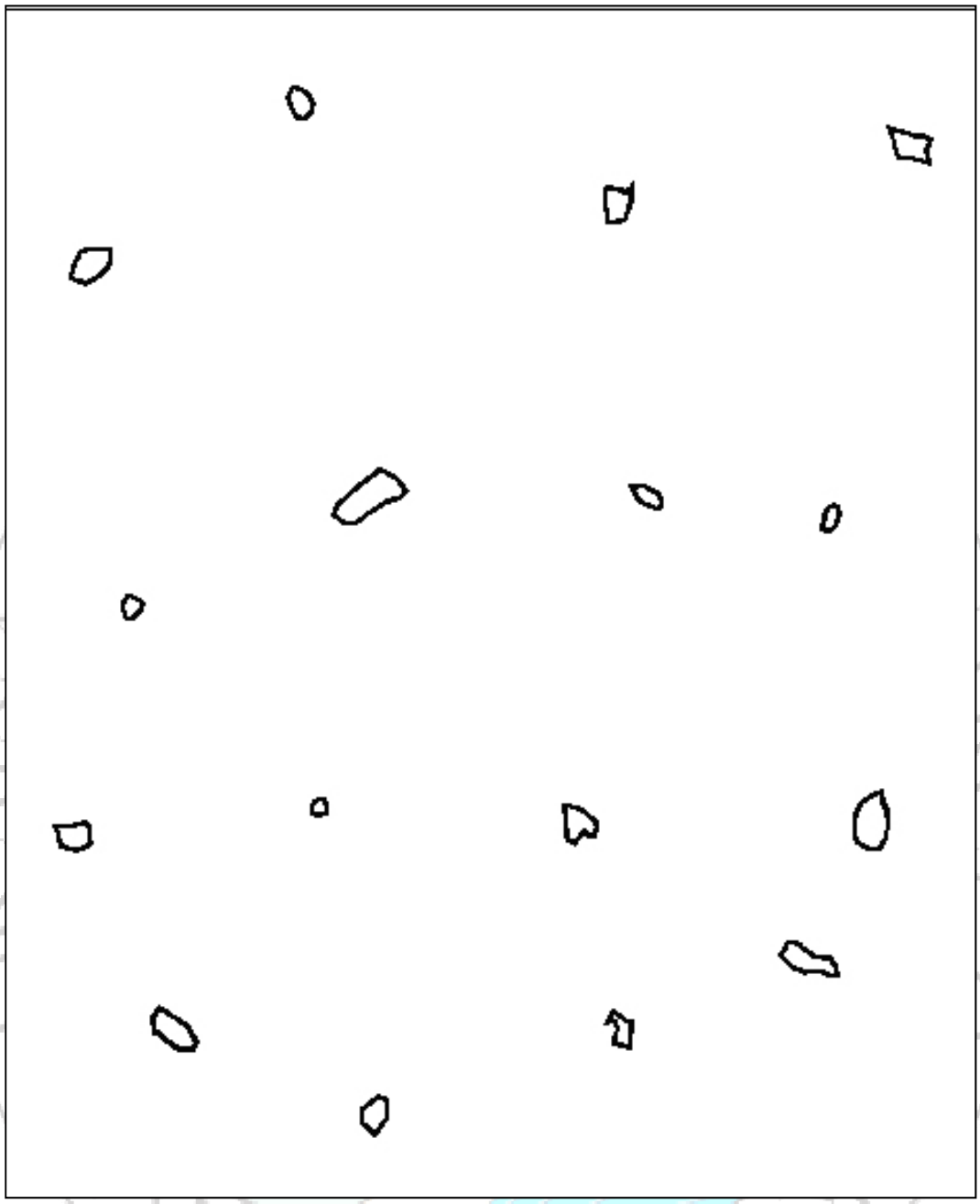

FIGURE 1

b. Tie Holes: Tie holes shall be filled as specified in Section 03 60 00, Grouting.

c. Form Fins: Chip or rub off form fins exceeding one-sixteenth (1/16) inch in height.

d. Rock Pockets: Poorly consolidated concrete shall be removed to sound concrete and the defect repaired. ENGINEER shall outline the area to be repaired.

3. As-Cast Finish: For as-cast concrete finish form materials shall produced a sound surface.

a. Air Voids: Fill air voids deeper than one-quarter (1/4) inch and larger than one-half (1/2) square inch. The total area of acceptable air voids is seventy-two hundredths (0.72) square inch in a six-inch (6”) by six-inch (6”) square.

b. Tie Holes: Tie holes shall be filled as specified in Section 03 60 00, Grouting.

c. Form Fins: Chip or rub off form fins exceeding one-eighth (1/8) inch in height.

4. Rubbed Finish: Immediately after removing the forms, form ties shall be broken back a minimum of three-quarters (¾) inch from the surface, honeycomb, voids, and other surface defects grouted. The surfaces shall then be thoroughly dampened and rubbed with a No. 16 carborundum stone or equal abrasive to create a uniform surface paste. The rubbing shall be continued to remove all form marks and surface irregularities producing a smooth, dense surface. After setting, the surface shall then be rubbed with a No. 30 carborundum stone until the surface is smooth in texture and uniform in color. Unless otherwise shown in the DRAWINGS only exposed surfaces shall have a rubbed finish.

5. Grout Finish: Prepare surface as described in “Rubbed Finishes” above. Mix one (1) part Portland cement and one-half (½) part fine sand with sufficient water to produce a grout with the consistency of thick paint. Wet surface of concrete to prevent absorption of water from grout, and apply grout uniformly with brushes. Immediately after applying grout mix, scrub the surface with a cork float or stone to coat surface and fill remaining air voids and other remaining surface defects. Remove excess grout by working the surface with rubber float. After the surface whitens from drying, rub with clean burlap. Cure surface for a period of seventy two (72) hours.

C. Finishing of Unformed Surfaces: Unless otherwise shown on the DRAWINGS unformed surfaces shall be finished as follows:

1. Slabs: Screed with straightedge to remove low and high spots bringing the surface to the required finish elevation of slope and float with a steel float at least three (3) feet in width. When the concrete has reached its initial set, finish with a steel trowel. Use a steel power trowel for large areas. Leave finish essentially free of trowel marks, uniform in texture and appearance and plane to the correct tolerance. Dusting the surface with dry cement, sand, or sprinkling with water is prohibited.

2. No wetting of concrete surfaces during slab finishing operations shall be permitted. Further, no concrete finishing operation shall be permitted while there is water on the surface of slabs and other flatwork.

3. Finishes that are exposed and subject to foot traffic shall receive a broom finish with a texture of plus or minus one-sixteenth (±1/16) inch or as designated on the DRAWINGS.

4. Tops of Walls with Bearings: Strike smooth tops of walls and similar unformed surfaces that shall have bearings or bearing pads, and finish with a steel trowel.

5. Stairways and Sidewalks: Strike smooth tops of stairs and sidewalks and finish with a light broom providing a texture of plus or minus one-sixteenth (±1/16) inch.

6. Slabs with Waterproofing Membranes: Strike smooth and float finish.

7. Construction Joint Surfaces: Surface shall be broom or raked finished. Surface shall be water or grit blasted prior to placing additional concrete, such as columns on column footings and column footings on reservoir slabs.

END OF SECTION

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SECTION 03 39 00

CONCRETE CURING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, and equipment for curing plain, reinforced, and post-tensioned, and cast-in-place concrete.

1.02 RELATED WORK

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 15 00, Construction Joints.

2. Section 03 31 00, Structural Concrete.

3. Section 03 35 00, Concrete Finishing.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):

a. 305.1, Specification for Hot Weather Concreting.

b. 306.1, Specification for Cold Weather Concreting.

c. 308.1, Standard Practice for Curing Concrete.

2. ASTM International (ASTM):

a. C171, Standard Specification for Sheet Materials for Curing Concrete.

b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

c. D2103, Standard Specification for Polyethylene Film and Sheeting.

1.04 SUBMITTALS

A. Provide data on curing compounds, sheet materials, and methods of securing sheet materials in place.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver curing materials in manufacturer’s original packaging including applicable instructions and manufacturer’s safety data sheets (MSDS).

PART 2 PRODUCTS

2.01 MATERIALS

A. Sheet Materials for Curing Concrete: White burlap-polyethylene sheeting weighing not less than ten (10) ounces per linear yard, forty (40) inches wide, impregnated on one side with white opaque polyethylene 0.004 inch thick as specified in ASTM C171 shall be used when called out in the DRAWINGS or in other applicable SPECIFICATIONS. The polyethylene shall be securely bonded to the burlap so that there will be no separation.

B. Liquid Membrane-Forming Compounds for Curing Concrete: Liquid membrane-forming compounds for curing concrete shall and conform to ASTM C309, Type 1-D with a red or white fugitive dye. Use a white dye unless otherwise directed by ENGINEER.

C. Polyethylene Film: Polyethylene film shall conform to ASTM D2103. The film shall have a thickness of six (6) mils and be a white opaque color.

D. Evaporative Retardant: Confilm manufactured by Master Builders, Inc. or approved equal.

E. Water: Only water from sources approved by ENGINEER shall be used.

F. Penetrating Sealer and Chloride Ion Screen: Masterseal SL40 by Master Builders, Inc. or approved equal.

G. Organic Corrosion Inhibiting Admixture: Rheocrete 222+ by Master Builders or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Perform the WORK in accordance with this SPECIFICATION and in accordance with applicable ACI standards. When a conflict occurs between this SPECIFICATION and ACI, the ACI standard shall control. All materials shall be used in accordance with the manufacturer’s printed instructions, a copy of which shall be on site.

B. Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete in accordance with ACI 308.1. The materials and method of curing shall be subject to review and acceptance by ENGINEER. Specific curing requirements may be called out on the DRAWINGS.

C. Curing shall be continued for at least seven (7) days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached seventy percent (70%) of the specified concrete strength.

3.02 CURING METHODS

A. Perform curing of concrete by curing compound, by moist curing, by moisture-retaining cover curing, or combinations thereof, as herein specified.

B. Provide moisture curing by one of the following methods:

1. Keep concrete surface continuously wet by covering with water.

2. Use continuous water-fog spray.

3. Cover concrete surface with moisture retaining cover specified in Paragraph 2.01.A. Place cover to provide coverage of concrete surfaces and edges with four- (4-) inch lap over adjacent moisture retaining covers, and seal using waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

C. Provide liquid membrane curing compound specified in Article Materials to concrete surfaces as follows:

1. Apply specified curing compound to concrete slabs within one (1) hour of final finishing operations or within one (1) hour of form removal. Apply uniformly in continuous operation by spray or roller in accordance with manufacturer's directions and these SPECIFICATIONS. Recoat areas subjected to heavy rainfall within three (3) hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Liquid Membrane Forming Compound and Evaporative Retardant Applicators/Sprayers: Membrane curing and evaporative retardant compounds shall be applied with a sprayer capable of maintaining a constant pressure. Spraying membrane curing compounds or evaporative retardants by other methods, such as rolling, shall be approved by ENGINEER.

b. When a spray-applied membrane-curing compound is used, it shall be applied in two (2) coats with the second coat applied at right angles to the first coat.

2. If finish materials are to be applied to the surface of concrete, follow manufacturer's recommendations to remove membrane curing compound.

3.03 APPLICATION

A. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces for seven (7) days by moist curing with forms in place. If forms are removed prior to completion of specified seven (7) day period, continue curing by methods specified in Article Curing.

B. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of specified curing methods in Article Curing.

C. Other Surfaces: Unless otherwise shown on the DRAWINGS all other surfaces shall be cured using two (2) applications of a membrane-curing compound conforming to

ASTM C309. The second application shall be applied at ninety degrees Fahrenheit (90°F) to the first application.

D. Rate of Temperature Change: Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed five degrees Fahrenheit (5°F) in any one (1) hour or fifty degrees Fahrenheit (50°F) in any twenty four (24) hour period.

E. Cold Weather: Curing during cold weather conditions shall include the above methods except for water cure unless measures are taken to prevent freezing of the water as specified in ACI 306.1.

F. Hot Weather: If the rate of evaporation approaches 0.2 $lb/ft^2/hr$, as estimated by ACI 305.1, precautions against plastic shrinkage cracking are required. CONTRACTOR shall have a recording thermometer, hygrometer, and wind gage on site seven (7) days prior to first concrete placement. When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow. Precautions against plastic shrinkage cracks may be required in conditions other than what is normally considered hot weather conditions.

3.04 PENETRATING SEALER AND CHLORIDE ION SCREEN

A. Concrete that may be subjected to deicing salts, brackish water, or spray from brackish water shall be protected with a penetrating sealer and chloride ion screen that is readily absorbed into the surface of the concrete to provide a breathable, water repellant finish that does not affect the surface color or texture of the concrete. A penetrating sealer and chloride ion screen is not required if the concrete contains an organic corrosion inhibiting admixture which slows the ingress of chlorides and moisture and forms a durable, protective film at the level of reinforcing steel. Concrete to be protected includes but is not limited to exterior concrete in walkways, stairs, slabs on grade, elevated parking areas, etc. Concrete surface and air temperature adjacent to the concrete shall be at least forty degrees Fahrenheit (40°F) during application and curing of sealer. Application rate shall be as recommended by manufacturer.

3.05 PROTECTION

A. During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

END OF SECTION

SECTION 03 60 00

GROUTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, and equipment for the placement of grout in tie holes and other locations as shown on the DRAWINGS and specified herein.

B. This section includes basic mixing, application, and curing methods for grout.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 11 00, Concrete Forming.

2. Section 03 15 00, Construction Joints.

3. Section 03 31 00, Structural Concrete.

4. Section 03 35 00, Concrete Finishing.

5. Section 03 39 00, Concrete Curing.

6. Section 32 16 00, Sidewalks, Curbs, and Gutters.

1.03 QUALITY STANDARDS

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. C78, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).

b. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

c. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.

d. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems used with Concrete by Slant Shear.

f. C1012, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to Sulfate Solution.

g. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.

1.04 SUBMITTALS

A. Provide product data on the following:

1. Grout.

2. Bonding agent.

3. Curing compound.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Cement based mortar shall be delivered and stored in manufacturer's packaging until it is ready to be mixed and placed. Mortar bags shall be stored off the ground and protected from water and all other substances that may penetrate packaging.

PART 2 PRODUCTS

2.01 MATERIALS

A. Mortar for Tie Holes: EMACO R320.

B. Bonding Adhesives: Concresive Liquid LPL or Concresive Standard Liquid.

C. Water: Only clean potable water shall be used.

D. Curing Compound: MB 429, Masterkure 100W, Masterkure 200W.

E. (Exposed) Reinforcing Steel Coating: EMACO P22.

F. Evaporation Reducer: Confilm Evaporation Reducer.

PART 3 EXECUTION

3.01 GENERAL

A. CONTRACTOR shall have a printed set of manufacturer's recommendations for product use onsite for review during preparation, mixing, and application of grout.

B. These grouts contain admixtures that increase grout strength and workability. The strength and performance of the grout is dependent on proper surface preparation, grout mixing and curing. CONTRACTOR shall be required to use a calibrated measuring device to add clean potable water to the grout mix. Water added to a grout mix without a calibrated device is cause for grout rejection, removal and re-placement.

C. Curing is critical to prevent shrinkage cracks that can develop with grouts containing some admixtures. Curing shall begin immediately after placement.

D. All mixing, surface preparation, handling, placing, consolidation, and other means of execution for pre-packaged mortars shall be done according to the instructions and

recommendations of the manufacturer and this SPECIFICATION. In the event that a conflict occurs between this SPECIFICATION and manufacturer's instructions, the manufacturer's instructions shall prevail in all cases.

3.02 INSTALLATION

A. Preparation:

1. Thoroughly clean the roughened surface and any exposed reinforcement of rust, dirt, loose chips, and dust. Maintain substrate in a saturated, surface-dry condition.

2. Where applicable, coat exposed reinforcing steel with EMACO P22 reinforcing steel bar protection coating prior to patching.

B. Mixing: Comply with mortar manufacturer's recommendations for water quantity. Mechanically mix with a slow speed drill (four hundred to six hundred [400 to 600] rpm) and Jiffler-type paddle. Pour approximately ninety percent (90%) of the mix water into the mixing container; then add the bagged material while continuing to mix. Add remaining water as needed. Mix time shall not exceed five (5) minutes.

C. Application:

1. Apply bonding adhesive such as Concresive Liquid LPL or Concresive Standard Liquid.

2. Place and finish with trowel or screed. In hot, windy, or dry conditions, where rapid surface evaporation may occur, apply evaporation reducer.

D. Curing: Apply Masterkure 200 W curing compound in accordance with label instructions.

3.03 FIELD QUALITY CONTROL

A. Field Tests:

1. When OWNER is to perform grout testing, CONTRACTOR shall assist OWNER or the concrete testing consultant as requested during the performance of quality control testing.

2. When prescribed in the DRAWINGS or by these SPECIFICATIONS, length change test specimens will be taken during construction from the first placement of each type of mortar, and at intervals thereafter as selected by ENGINEER to ensure continued compliance with these SPECIFICATIONS. Unless otherwise specified on the DRAWINGS or SPECIFICATIONS the testing will be performed by OWNER or testing representative.

3. When required, length change tests and fabrication of specimens for cement-based mortar shall be performed as specified in ASTM C1012 at intervals during construction as selected by ENGINEER. A set of three (3) specimens will be made for testing at seven (7) and twenty eight (28) days.

4. All mortar, already placed, that fails to meet the requirements of this SPECIFICATION, shall be subject to removal and replacement at the cost of CONTRACTOR.

5. Unless otherwise specified in the DRAWINGS or SPECIFICATIONS, the cost of all laboratory tests on grout shall be borne by OWNER, but CONTRACTOR shall assist ENGINEER in obtaining specimens for testing. However, CONTRACTOR shall be charged for the cost of any additional tests and investigation of WORK performed which does not meet the SPECIFICATIONS.

END OF SECTION

SECTION 05 52 00

METAL RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The WORK of this section shall consist of furnishing and erecting steel hand railings on headwalls, wingwalls, or at other locations as shown on the DRAWINGS, in accordance with the designs, dimensions instructions by ENGINEER, and these SPECIFICATIONS.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction, Inc. (AISC).

2. American Welding Society (AWS):

a. AWS D1.1/D1.1M, Structural Welding Code – Steel.

3. ASTM International (ASTM):

a. ASTM A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

b. ASTM A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

1.03 SUBMITTALS

A. CONTRACTOR shall submit detailed shop drawings based on field measurements to OWNER for review prior to fabrication.

B. Color Schedule: CONTRACTOR shall provide six (6) copies of the color schedule (if applicable) according to the DRAWINGS and SPECIFICATIONS. Color shall be shown on the DRAWINGS or shall be selected by ENGINEER from color systems of recognized paint companies. If materials of other manufacturers are used, colors shall match those selected.

C. Paint and Stain Samples: If requested by ENGINEER, prepare and submit paint samples. Remake samples until accepted.

D. Material List: As part of the submittal, include a letter listing the brand and quality of each different material for use on the PROJECT. Materials listed shall be accepted by ENGINEER before ordering materials.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel Railings and Steel Sleeves:

1. Pipe shall be standard weight pipe conforming to ASTM A53/A53M. Steel tubing shall conform to ASTM A501 or as designated on the DRAWINGS.

2. Galvanized pipe and tubing shall be required when designated on the DRAWINGS.

3. Sleeves shall be galvanized on all surfaces.

4. Weathering steel shall be required when designated on the DRAWINGS.

B. Fasteners:

1. Acceptable expansion bolts are as follows:

a. Hilti Corp; Kwik Bolt.

b. Wej-it Corp; Standard Wej-its.

c. USE; Taper-Bolt.

d. Olin Corp; Trubolt.

e. Phillips; Red Head Wedge Anchors.

2. Other brands of expansion bolts will be considered upon submission to ENGINEER of data sheets describing capacities and installation procedures of bolts.

3. The bolts, nuts, and washers shall be galvanized.

C. Miscellaneous: CONTRACTOR shall fabricate plates or structural shapes as indicated on the DRAWINGS. Include welded anchors where detailed and furnish all items to be embedded in concrete or masonry.

2.02 FABRICATION

A. General: Field measure the headwall, wingwall, or location where the railing is to be installed, compare to the DRAWINGS, and review with ENGINEER prior to fabrication.

B. Workmanship: Construct all items of sizes, shape, and materials as CONTRACTOR shall indicate and specify. Fabricate structural steel in accordance with AISC Specifications and additional requirements specified hereafter; perform fabrication and assembly in the shop to the greatest extent possible; form materials well, with sharp angles or lines, free from bends, twists, or open joints; shear and punch clean, true lines and surfaces; thickness of metal and details of assembly and supports shall provide ample strength and rigidity.

C. Welding: CONTRACTOR shall perform welding in the shop with welders qualified under the AWS D1.1/D1.1M welding code for class of work employed; protect adjacent construction and materials against damage; neatly and symmetrically make all welds; fill or grind to a uniform, smooth shape; where required to present uniform appearance, fill space between welds and weld irregularities with suitable metal putty or compound made for this purpose.

D. Fastenings: CONTRACTOR shall provide concealed fastenings wherever possible; do not use screws or bolts where they can be avoided; where used, heads shall be countersunk, screwed up tight and threads nicked to prevent loosening; and make threaded connections tight so that threads shall be entirely concealed by fittings.

E. Paint: All products not specified by name shall be “best grade” or “first line” products available by the manufacturer. Railings which are not designated to be painted shall be galvanized or weathering steel according to the DRAWINGS. Shop clean primer on hollow metal WORK immediately before painting to remove grease and dirt film from surfaces.

PART 3 EXECUTION

3.01 GENERAL

A. CONTRACTOR shall erect structural steel in accordance with the AISC Specifications with modifications and additional requirements specified hereafter.

B. Erect all WORK true to lines and planes, with vertical lines plumb and horizontal lines level.

C. Weld or bolt all permanent connections.

3.02 MISCELLANEOUS ANGLES, LINTELS, PLATES, AND EMBEDDED ITEMS

A. All welding procedures shall conform to AWS D1.1/D1.1M. All welds shall develop capacity of members being joined, unless specific length or extent is noted on the DRAWINGS.

B. Finish all cut ends neatly without irregular torch marks or sharp fins. Grind all cut surfaces to a smooth surface. Clean of all loose mill scale, rust, and foreign matter.

C. Any shop paint on surfaces adjacent to joints to be field welded shall be wire brushed to reduce the paint film to a minimum. Grind down burrs and sharp ridges at all exposed corners and surfaces of welds prior to field painting. After field welding, welded joints to be field primed.

D. The expansion bolts shall be installed per manufacturer’s recommendations.

3.03 PAINTING

A. Inspection: Examine surfaces scheduled to receive paint and finishes for conditions that may adversely affect execution, permanence, or quality of WORK and which cannot be put into an acceptable condition through preparatory WORK as included under Paragraph Preparation.

B. Preparation:

1. Sanding: Sand metal surfaces between coats to ensure smoothness and adhesion of subsequent coats. Use extra fine sandpaper to avoid cutting the edges when sanding. Apply putty or spackling compound after surfaces are primed and primer is dry. Bring material flush with adjoining surfaces.

2. Surface Filling: Surfaces shall be perfectly dry, clean, and smooth before starting WORK. Fill cracks, holes, or scratches full and make smooth before finish is applied to surfaces.

3. Ferrous Metal: Remove foreign material from unprimed metal with wire brush and dust clean.

4. Shop Primed Metals: Touch up shop-primed metals with a primer similar to the existing.

5. Zinc-Coated Metal (Galvanized Surfaces): Wash with mineral spirits and prime as specified.

6. Protection: Furnish and lay drop cloths or mask off areas where finishing is being done to protect floors and other work from damage during the execution of WORK. Where it becomes necessary to remove temporary coverings placed by others, replace same in proper manner.

7. Damage to Work of Others: Be responsible for any damage done to the work of other trades, repairing same to the satisfaction of ENGINEER. Replace any materials damaged to such an extent that they cannot be restored to their original condition.

C. Workmanship:

1. Existing Surfaces: If the surfaces are not in proper shape for painting, repair, rebuild, or refinish before proceeding with the WORK. CONTRACTOR is responsible for any poor WORK caused by improper surfaces. The application of the first coat does not relieve CONTRACTOR of the responsibility for failure of the base coat. Do not apply any coats on either damp or wet surfaces and in no case until the preceding coat is dry and hard.

2. General: Apply materials evenly without runs or sagging of materials and according to the manufacturer’s requirements. Sand WORK between coats.

3.04 TOUCH-UP PAINTING

A. CONTRACTOR shall, after erection of steel, apply touch-up paint to field bolt heads and nuts, field welds, and abrasions. When zinc coating has been scratched or removed from surfaces, three (3) coats of zinc rich paint shall be applied over the areas where the coating has been disturbed. Where excessive removal or damage to the zinc coating has occurred, replacement of zinc coating by hot dipping in a zinc bath may be necessary at the direction of ENGINEER.

END OF SECTION

SECTION 07 19 00

CONCRETE WATER REPELLENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of furnishing and applying two (2) coats of a semi-opaque, pure acrylic, water repellent, and colored coating to all designated concrete surfaces in accordance with the DRAWINGS and SPECIFICATIONS.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 35 00, Concrete Finishing.

1.03 SUBMITTALS

A. Submit color mixture to be used in a color block for approval by OWNER.

1.04 QUALITY ASSURANCE

A. Mock-ups:

1. Three (3) two-foot by two-foot (2' x 2') samples showing the designated colors and texture shall be prepared for initial approval.

2. The coating shall be applied by the same method to be used in the final field application to a surface similar in pattern and texture to the surfaces to be coated on the PROJECT.

3. A final sample for the chosen color and texture measuring at least four feet by four feet (4' x 4') shall be prepared as specified above and shall be set at the PROJECT site for a period of three (3) days for review by ENGINEER.

4. The final samples shall receive ENGINEER’s written approval before the coating can be incorporated into the WORK.

PART 2 PRODUCTS

2.01 MATERIALS

A. The coating shall be self-priming, semi-opaque colored toner containing only methyl methacrylate ethyl acrylate copolymer resins.

B. The toning pigments shall be suspended in solution at all times by a chemical suspension agent and solvent, shall be laminar silicates, titanium dioxide, and inorganic oxides.

C. There shall be no settling or color variation.

D. Use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of the coating formulation shall not be permitted.

Physical Properties	
Weight by Gallon	8.3 lbs, min.
Solids by Weight	30% min.
Sand (Silicone)	3.2 to 3.8 lbs/gallon (exclude at retaining walls with form liner finish

PART 3 EXECUTION

3.01 PREPARATION

A. All concrete finishing shall be completed in accordance with the SPECIFICATIONS. The concrete shall be at least fourteen (14) days old before the bonding agent and coating may be applied.

B. Prior to application of the coating material, all voids and irregularities shall be pointed and trued with a mortar consisting of cement and fine sand aggregate. Only minor voids which can be completely filled with the coating material may remain.

C. Within twenty-four (24) hours before the coating is applied, the concrete surfaces to be coated shall be hot-water blasted at a minimum of three thousand (3,000) psi followed by a cold-water rinse to remove dirt, curing agents, form release agents, or other foreign substances that would be detrimental to the coating penetration or color.

D. All surfaces to be coated shall be clean, dry, and free of frost or other foreign substances at the time of application.

3.02 APPLICATION

A. The coatings shall be applied to all exposed concrete elements above the ground line and shall extend a minimum of one (1) foot below the ground line or as shown on the DRAWINGS.

B. The coating shall be applied only when the ambient temperature is between forty degrees Fahrenheit (40°F) and ninety degrees Fahrenheit (90°F).

C. The coating shall be mixed by a mechanical mixer and shall be applied by spraying. A roller shall be used immediately after the spray application to obtain texture and fill minor voids as approved by ENGINEER. A brush may be used to apply coating to form liner finishes as approved by ENGINEER.

D. The process shall be applied uniformly in the following sequences:

1. Application of the first coat applied at a rate of forty five (45) square feet per gallon, and eighty (80) square feet per gallon for the second coat.

2. The second coat shall not be applied until at least twelve (12) hours after application of the first coat, but not to exceed ninety six (96) hours, or as recommended by the manufacturer.

3. Workmanship shall be such that the final coated surface is colored uniformly and presents a pleasing appearance.

END OF SECTION

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SECTION 07 91 00

MANHOLE PREFORMED JOINT SEALS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, equipment, and install joint sealer for precast concrete manholes, where shown on the DRAWINGS and as specified herein.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 33 05 13, Manholes.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. AASHTO M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.04 SUBMITTALS

A. CONTRACTOR shall submit product SPECIFICATIONS for all items pertaining to the WORK covered in this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. K. T. Snyder; Ram-Nek.

2. Hamilton-Kent; Kent-Seal No. 2.

3. Sheller-Globe; Tac-Tite.

4. Conseal CS-102

2.02 MATERIALS

A. General: Joint sealer shall be preformed, plastic gasket with hydrocarbon resins and inert mineral filler, in accordance with AASHTO M198, Type B.

B. Primers: Primers shall be used when recommended by the joint sealer manufacturer.

PART 3 EXECUTION

3.01 PREPARATION

A. CONTRACTOR shall clean the concrete surfaces in accordance with the manufacturer's recommendations. Mask edges, if required, to protect adjoining surfaces and produce a straight finish line. If required by the manufacturer, prime concrete surfaces with the recommended primer. Install bond breaker tape as required by the manufacturer to ensure sealant shall perform properly.

3.02 APPLICATION

A. CONTRACTOR shall apply the sealant in continuous beads without open joints, voids, or air pockets. Remove excess sealer promptly as WORK progresses and clean adjacent surfaces. Apply the sealer in accordance with the manufacturer's printed instructions and SPECIFICATIONS.

END OF SECTION

SECTION 07 92 00

SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, materials, tools, equipment, and perform all WORK and services for all sealant WORK, both exterior and interior where the words caulk, caulking, or sealant is shown on DRAWINGS or specified, in accordance with provisions of the CONTRACT DOCUMENTS, and completely coordinated with WORK of all other trades.

B. Although such WORK is not specifically indicated, CONTRACTOR shall furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to, or necessary for, a sound, secure, and complete installation.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 31 00, Structural Concrete.

2. Section 32 16 00, Sidewalks, Curbs, and Gutters.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. ASTM C509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.

b. ASTM C920, Standard Specification for Elastomeric Joint Sealants.

c. ASTM D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.

2. Sealant, Waterproofing and Restoration Institute (SWRI):

a. SWRI 2, Sealants the Professionals' Guide.

b. SWRI 7, Sealant Specifications.

3. Federal Specification (FED):

a. H-08-1 SEC 07920, Sealants and Caulking.

1.04 SUBMITTALS

A. CONTRACTOR shall submit product SPECIFICATIONS for all items pertaining to the WORK covered in this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Potable Water Containment Structures (Polyurethane Sealant): Sika; Sikaflex 1-a or Sikaflex 1-c.

2. Fire Resistant Sealant for Buildings: General Electric; 3-6548 silicone RTV foam.

3. Portland cement Concrete Pavements:

a. Dow Corning; 888 or 890.

b. Sika; Sikaflex, 15 LM.

4. Portland Cement Concrete Curb, Gutter, and Sidewalk: Sika; Sikaflex 1-a or Sikaflex 1cSL.

2.02 MATERIALS

A. Sealant:

1. Type: Provide non-sagging sealant for vertical joints. Sealants for horizontal joints may be self-leveling.

2. Filler Compatibility: Before use of any sealant, investigate its compatibility with joint surfaces, fillers, and other materials in joint system. Provide only materials compatible with installation conditions.

3. Color: Provide colors matching materials being sealed. Where compound is not exposed to view in finished WORK, provide manufacturer’s color which has best performance.

B. Joint Cleaner: Provide as recommended by sealant manufacturer.

C. Joint Primer-Sealer: Provide as recommended by sealant manufacturer.

D. Bond Breaker: Bond breaker material shall be furnished as recommended by sealant manufacturer.

E. Sealant Backer Rod: Rod stock of polyethylene, polyethylene jacketed polyurethane foam, or other flexible, non-absorbent, non-bituminous material recommended by sealant manufacturer. The backer rod shall:

1. Control joint depth.

2. Break bond of sealant at bottom of joint.

3. Provide proper shape of sealant bead to minimize possibility of sealant extrusion.

F. Compressible Sealant:

1. Size compressible sealant so that width of material is twice joint width.

2. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing.

3. Foamed polyurethane strip saturated with polymerized polybutylene waterproofing coated on front face with non-reactive release agent that will act as bond breaker for applied sealant.

4. Apply adhesive as recommended by sealant manufacturer.

PART 3 EXECUTION

3.01 GENERAL

A. Perform WORK in accordance with SWRI requirements for materials and installation or in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Maintain one (1) copy of each SWRI document on site.

C. Areas to be Sealed: Seal any joints or areas which may permit penetration of moisture, unless sealing WORK is specifically required under other sections and/or as shown on the DRAWINGS. Make all joints watertight.

D. Priming: Where required, prime joint surfaces. Limit application to surfaces to receive caulking. Mask off adjacent surfaces.

3.02 PREPARATION

A. Surface Preparation: Clean all joint surfaces. Joint walls shall be sound, clean, dry, and free from oil, grease, and frost. Curing compound residues and any other foreign matter shall be thoroughly removed. Where required to completely clean the joint, the joint shall be mechanically cleaned by water or sand blasting.

3.03 APPLICATION

A. Bond Breaker or Backer Rod Installation: Install bond breaker or backer rod as specified to regulate depth of sealant.

B. Compressible Joint Sealant: Install compressible sealant in joint to depth recommended by manufacturer. Take care to avoid contamination of sides of joint. Protect sidewalls of joint (to depth of sealant) as recommended by manufacturer. Install with adhesive on two (2) faces in contact with sides of joints.

C. Sealant:

1. Location:

    a. One or two component polyurethane (exterior and interior use).

    b. One or two component silicone (exterior use and interior wet area use).

    c. Compressible Sealant (where indicated).

    d. Epoxy Sealants (where indicated).

2. The joint shall be cleaned as recommended by sealant manufacturer.

3. The joint shall be primer-sealed as recommended by sealant manufacturer.

4. Use sufficient pressure to fill all voids and joints solid. Apply sealant when joint slot is at the mid-point of its designed expansion and construction. Install sealant with hand or power-operated caulking gun horizontally in one (1) direction and vertically from top to bottom. Avoid overlapping of sealant to eliminate entrapment of air.

5. To facilitate tooling, wet concave pointing tool with a diluted soap solution. Apply sealants when the surface and ambient temperature is forty degrees Fahrenheit (40°F) or higher and in accordance with the temperature limitations of the manufacturer.

3.04 MANUFACTURER'S FIELD SERVICES

A. Field Services: Obtain sealing compounds only from manufacturers who shall, when required, provide services of manufacturer's field service representatives at PROJECT site for purposes of advising and instructing installers in proper procedures and precautions for use of materials. Provide such services, when required, without expense to OWNER.

3.05 CLEANING

A. Dispose of all spillage and refuse sealant material in accordance with applicable regulations.

END OF SECTION

SECTION 09 91 00

STRUCTURAL CONCRETE COATING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of furnishing and applying two (2) coats of a semi-opaque pure acrylic water repellent and colored coating to all designated concrete surfaces in accordance with the DRAWINGS and SPECIFICATIONS.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 03 35 00, Concrete Finishing.

1.03 SUBMITTALS

A. Submit color mixture to be used in a color block for approval by OWNER.

1.04 QUALITY ASSURANCE

A. Mock-ups:

1. Three (3) two-foot by two-foot (2' x 2') samples showing the designated colors and texture shall be prepared for initial approval. The coating shall be applied by the same method to be used in the final field application to a surface similar in pattern and texture to the surfaces to be coated on the PROJECT.

2. A final sample for the chosen color and texture measuring at least four feet by four feet (4' x 4') shall be prepared as specified above and shall be set at the PROJECT site for a period of three (3) days for review by ENGINEER. The final samples shall receive ENGINEER’s written approval before the coating can be incorporated into the WORK.

PART 2 PRODUCTS

2.01 MATERIALS

A. The coating shall be self-priming, semi-opaque colored toner containing only methyl methacrylate ethyl acrylate copolymer resins. The toning pigments shall be suspended in solution at all times by a chemical suspension agent and solvent. The toning pigments shall be laminar silicates, titanium dioxide, and inorganic oxides. There shall be no settling or color variation. Use of vegetable or marine oils, paraffin materials, stearates, or organic pigments in any part of the coating formulation shall not be permitted.

Physical Properties	
Weight by Gallon	8.3 lbs, min.
Solids by Weight	30% min.
Sand (Silicone)	3.2 to 3.8 lbs/gallon (exclude at retaining walls with form liner finish)

PART 3 EXECUTION

3.01 PREPARATION

A. All concrete finishing shall be completed in accordance with the SPECIFICATIONS. The concrete shall be at least fourteen (14) days old before the bonding agent and coating may be applied.

B. Prior to application of the coating material, all voids and irregularities shall be pointed and trued with a mortar consisting of cement and fine sand aggregate. Only minor voids, which can be completely filled with the coating material, may remain.

C. Within twenty-four (24) hours before the coating is applied, the concrete surfaces to be coated shall be hot water blasted at a minimum of three thousand (3,000) psi followed by a cold-water rinse to remove dirt, curing agents, form release agents, or other foreign substances that would be detrimental to the coating penetration or color.

D. All surfaces to be coated shall be clean, dry, and free of frost or other foreign substances at the time of application.

3.02 APPLICATION

A. The coatings shall be applied to all exposed concrete elements above the ground line and shall extend a minimum of one (1) foot below the ground line or as shown on the DRAWINGS.

B. The coating shall be applied only when the ambient temperature is between forty degrees Fahrenheit (40°F) and ninety degrees Fahrenheit (90°F).

C. The coating shall be mixed by a mechanical mixer and shall be applied by spraying. A roller shall be used immediately after the spray application to obtain texture and fill minor voids as approved by ENGINEER. A brush may be used to apply coating to form liner finishes as approved by ENGINEER.

D. The process shall be applied uniformly in the following sequences:

1. Application of the first coat applied at a rate of forty-five (45) square feet per gallon, and eighty (80) square feet per gallon for the second coat.

2. The second coat shall not be applied until at least twelve (12) hours after application of the first coat, but not to exceed ninety six (96) hours, or as recommended by the manufacturer.

3. Workmanship shall be such that the final coated surface is colored uniformly and presents a pleasing appearance.

END OF SECTION

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK consists of clearing, grubbing, removing, and disposing of vegetation and debris within the limits of the PROJECT site as shown on the DRAWINGS and as required by the WORK. Vegetation and objects designated to remain shall be preserved free from injury or defacement.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.01 GENERAL

A. OWNER will designate all trees, shrubs, plants, and other objects to remain. Any object that is designated to remain and is damaged shall be repaired or replaced as directed by OWNER, at CONTRACTOR's expense.

B. No material or debris shall be disposed of within the PROJECT limits.

3.02 CONSTRUCTION

A. Clearing and grubbing shall extend to the toe of fill or the top of cut slopes or as designated on the DRAWINGS.

B. All surface objects, trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and grubbed, including mowing, as required.

C. Undisturbed stumps, roots, and nonperishable solid objects located two (2) feet or more below subgrade or embankment slope may remain in place.

D. In areas to be rounded at the tops of backslopes, stumps shall be removed to at least two (2) feet below the surface of the final slope line.

E. CONTRACTOR shall scalp the areas within the excavation or embankment grading limits. Scalping shall include the removal from the ground surface of sawdust, and other vegetation matter.

F. Except in areas to be excavated, all holes resulting from the removal of obstructions shall be backfilled with suitable material and compacted in accordance with Section 31 23 00, Excavation and Fill.

G. All cleared timber shall be removed from the PROJECT and shall become the property of CONTRACTOR.

H. Branches on trees or shrubs shall be removed as directed. All trimming shall be done in accordance with good tree surgery practices.

END OF SECTION

SECTION 31 14 13

TOPSOIL STRIPPING AND STOCKPILING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK consists of salvaging and stockpiling topsoil and wetland topsoil and excavating suitable topsoil or wetland topsoil from stockpiles, CONTRACTOR sources, available sources, or from the approved natural ground cover to place on designated areas.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.

2. Section 31 23 00, Excavation and Fill.

3. Section 31 25 00 Erosion and Sedimentation Control

4. Section 32 91 13, Topsoil

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil shall meet the requirements of Section 32 19 13 Topsoil. Topsoil shall consist of natural onsite ground cover or hauled material from offsite sources.

B. Erosion and Sedimentation Control for Stockpiles shall meet the requirements of Section 31 25 00, Erosion and Sedimentation Control.

C. Wetland topsoil material shall consist of moist organic soil, including any existing wetland vegetation and seeds. Material shall be excavated from areas as shown on the DRAWINGS, hauled material from offsite sources, or as directed by ENGINEER. All wetland topsoil materials shall meet the requirements of Section 32 19 13, Topsoil.

PART 3 EXECUTION

3.01 TOPSOIL

A. Topsoil within the limits of the PROJECT shall be salvaged prior to beginning excavating, fill or hauling, operations by excavating topsoil and stockpiling the material at designated locations on DRAWINGS or as designated by OWNER in a manner that will facilitate measurement, minimize sediment damage, and not obstruct natural drainage.

B. Imported topsoil shall be hauled to the site and stockpiled in locations designated by OWNER.

C. Salvaged topsoil exceeding the quantity required under the CONTRACT shall be disposed of at CONTRACTOR's expense.

3.02 STOCKPILE

A. No soil stockpile shall exceed ten (10) feet in height.

B. All topsoil stockpiles shall be protected from sediment transport by surface roughening, watering, and perimeter silt fencing.

C. Any topsoil stockpile remaining longer than 30 days shall be seeded with a sterile temporary cover (such as REGREEN or approved equivalent) or the approved specified final seed mixture.

D. Upon completion of PROJECT or as approved by OWNER or OWNERS REPRESENTATIVE, remove surplus subsoil and topsoil from site. Grade stockpile area as necessary for planting or seeding.

3.03 WETLAND TOPSOIL

A. Wetland topsoil material shall be excavated from areas designated on the DRAWINGS or as approved by ENGINEER to a minimum depth of eighteen (18) inches, or as otherwise designated, and placed within twenty four (24) hours in the wetland relocation site.

B. CONTRACTOR shall prepare the wetland relocation site to elevations specified in the DRAWINGS or as approved by ENGINEER prior to excavating the wetlands topsoil. If ENGINEER determines that this is not possible, then CONTRACTOR shall stockpile wetlands topsoil material in an approved area, to remain undisturbed until the relocation site has been prepared.

C. All wetland topsoil stockpiles shall be protected from sediment transport by surface roughening, watering, and perimeter silt fencing.

D. Storage time within the stockpile shall be as short as possible.

E. If deemed necessary by ENGINEER, the stockpile shall be protected in such a manner to preserve the wetland seed bank.

F. Wetland topsoil material shall be placed over the prepared relocation areas to a depth of eighteen (18) inches, or as otherwise designated.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of excavation, embankment fill, disposal of excess material, shaping, and compaction of all material encountered within the limits of WORK, including excavation and fill for structures. The excavation shall include, but is not limited to, the native soils which shall be excavated for the PROJECT WORK. All WORK shall be completed in accordance with these SPECIFICATIONS, the lines and grades, and typical cross-sections shown on the DRAWINGS.

B. All excavation shall be classified, “unclassified excavation,” or “muck excavation” or “rock excavation,” as hereafter described. All embankment shall be classified “embankment material” as hereafter described.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 23 19, Dewatering.
3. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

1.04 DEFINITIONS

A. Embankment Material shall consist of approved material acquired from excavation or from outside sources, hauled and placed in embankments.

B. Muck Excavation shall consist of the removal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.

C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of one-half (1/2) cubic yard or more, as determined by

physical or visual measurement. It shall also include replacement with approved material as required.

D. Unclassified Excavation shall consist of the excavation of all materials of whatever character required of the WORK, obtained within the PROJECT limits.

1.05 QUALITY ASSURANCE

A. Final topography and/or cross-sections shall be surveyed of areas that are to finished grade and compared to the design section for accuracy.

B. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

PART 2 PRODUCTS

2.01 MATERIALS

A. Embankment Material may consist of approved material acquired from excavations or material hauled from outside the PROJECT limits.

B. Suitable material identified onsite shall be used first for embankments and backfill.

C. Excess excavated native soils which are not used as embankment or backfill shall become the property of CONTRACTOR and shall be disposed of offsite by CONTRACTOR, in a location acceptable to ENGINEER.

D. Muck Excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, onsite or imported soils, or other material, whichever is most suitable for the specific situation encountered.

E. ENGINEER will determine which type of aggregate or other material which shall be used after observing the specific site conditions.

F. Structural Backfill:

1. When specified on the DRAWINGS or as required by ENGINEER, Class I structural backfill shall meet the following gradation requirements:

Sieve Size	**% By Weight Passing Square Mesh Sieves**
2-inch	100
No. 4	30 - 100
No. 50	10 – 60
No. 200	5 – 20

2. In addition, this material shall have a liquid limit not exceeding thirty five (35) and a plasticity index of not over six (6).

3. Impervious structural backfill, where shown or specified, shall consist of material having one hundred percent (100%) finer than two (2) inches in

diameter and a minimum of thirty-five percent (35%) passing a No. 200 U.S. Standard Sieve.

PART 3 EXECUTION

3.01 GENERAL EXCAVATION/EMBANKMENT

A. General:

1. The excavation and embankment shall be finished to reasonably smooth and uniform surfaces.

2. Variation from the subgrade plane shall not be more than eight-tenths (0.08) foot in soil or more than eight-tenths (0.08) foot above or one-half (0.50) foot below in rock.

3. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than four-tenths (0.04) foot.

4. Materials shall not be wasted without permission of ENGINEER.

5. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed.

6. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with Section 31 11 00, Clearing and Grubbing, of these SPECIFICATIONS.

7. CONTRACTOR shall notify ENGINEER in sufficient time before beginning excavation or embankment such that the necessary topography and/or cross-sections may be taken. CONTRACTOR shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to surveying the site.

8. When CONTRACTOR's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued.

   a. ENGINEER will contact archaeological authorities to determine the disposition thereof.

   b. When directed, CONTRACTOR shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities.

   c. Such excavation will be considered and paid for as extra WORK.

B. Excavation:

1. Unclassified:

a. All excess suitable material excavated from the PROJECT site and not used for embankment shall be removed from the PROJECT site and become the property of CONTRACTOR.

b. Where material encountered within the limits of the WORK is considered unsuitable for embankment (fills) on any portion of this PROJECT WORK, such material shall be excavated as directed by ENGINEER and replaced with suitable fill material.

c. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than six (6) inches in diameter, and boulders shall be hauled from the PROJECT site and disposed of by CONTRACTOR at CONTRACTOR's expense.

d. Debris is defined as "anything that is not earth which exists at the job site."

2. Muck:

a. Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, ENGINEER may require CONTRACTOR to remove the unsuitable materials and backfill to the finished graded section with approved material.

b. Disposal of the unsuitable material and replacement with suitable material shall be at CONTRACTOR's expense.

3. Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

4. Rock:

a. Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 foot below subgrade within the limits of the channel area, and the excavation shall be backfilled with material shown on the DRAWINGS or as designated by ENGINEER.

b. Disposal of material and replacement with suitable approved material shall be at CONTRACTOR's expense.

C. Embankment Construction:

1. Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, the placing and compacting of approved material within areas where unsuitable materials have been removed, and the placing and compacting of Embankment Material in holes, pits and other depressions within the PROJECT area.

2. Only approved materials shall be used in the construction of embankments and backfills.

3. Approved materials shall consist of clean onsite cohesive soils or approved imported soils.

4. Onsite cohesive soils or imported soils shall be placed and compacted in horizontal lifts, using equipment and procedures that produce recommended moisture contents and densities throughout the lift and embankment height. Onsite or imported cohesive soils shall be compacted within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content and compacted to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698).

5. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half (1/2) width at a time, the slopes that are steeper than four-to-one (4:1) when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the WORK is brought up in layers.

    a. Benching shall be well "keyed" and where practical a minimum of eight (8) feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts.

    b. Material thus cut out shall be recompacted along with the new Embankment Material at CONTRACTOR's expense.

6. The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of eight (8) inches and recompacting to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%) prior to fill placement.

7. Embankment Material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - two percent (2%).

    a. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting.

    b. As the compaction of each layer progresses, continuous leveling and manipulating required to ensure uniform density.

8. For embankments which serve as berms, the downstream portion shall be keyed into the subsurface soils a minimum of three (3) feet to enhance the stability of the slope.

9. Materials which are removed from excavations beneath the water table may be over the optimum moisture content and shall be required to be dried out prior to reusing them.

10. Cross hauling or other action as appropriate will be ordered when necessary to ensure that the best available material is placed in critical areas of embankments,

including the top two (2) feet of all embankments. No additional payment will be made for cross hauling ordered by ENGINEER.

11. Frozen materials shall not be used in construction of embankments.

12. During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.

13. Excavation or embankment (fill), and structural backfill WORK either completed or in a stage of completion that is either eroded or washed away or becomes unstable as a result of either rains, snow, snow melt, channel flows, or lack of proper water control shall be either removed and replaced, recompacted, or reshaped as directed by ENGINEER and in accordance with the DRAWINGS and SPECIFICATIONS at CONTRACTOR's sole expense.

14. Removed unsuitable materials shall be hauled away and disposed of at CONTRACTOR's expense. Placing of replacement materials for removed unsuitable materials shall be purchased, placed, and compacted at CONTRACTOR's expense.

D. Proof Rolling:

1. Proof rolling with a heavy rubber tired roller shall be required, if designated on the DRAWINGS or when ordered by ENGINEER.

2. Proof rolling shall be done after specified compaction has been obtained. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompacted to the requirements for density and moisture at CONTRACTOR's expense.

3. Proof rolling shall be done with equipment and in a manner acceptable to ENGINEER. Proof rolling as shown on the DRAWINGS or as ordered by ENGINEER shall not be measured and paid for separately, but shall be included in the unit prices bid for the WORK.

3.02 EXCAVATION AND BACKFILL FOR STRUCTURES

A. Poor foundation material for any of the WORK shall be removed, by CONTRACTOR, as directed by ENGINEER.

1. CONTRACTOR will be compensated for removal and replacement of such materials in accordance with Muck Excavation.

B. CONTRACTOR is cautioned that construction equipment may cause the natural soils to pump or deform while performing excavation WORK inside and on footings, structural floor slabs, or other structure foundation areas.

C. CONTRACTOR shall remove and replace at CONTRACTOR's expense any foundation materials which are:

1. Saturated by either surface or subsurface flows because of the lack of adequate water control or dewatering work by CONTRACTOR;

2. Frozen for any reason; or

3. Disturbed by CONTRACTOR's WORK or caused to become unacceptable for foundation material purposes by means of CONTRACTOR's equipment, manpower, or methods of WORK.

D. Dewatering shall not be conducted by pumping from inside footings, structural floor slabs, or other structure foundation limits. This may decrease the supporting capacity of the soils.

E. Care shall be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete WORK.

F. Any over-excavated subgrades that are due to CONTRACTOR's actions, shall be brought back to subgrade elevations, as indicated on the DRAWINGS, by CONTRACTOR and at CONTRACTOR's expense in the following manner:

G. For over-excavations of two (2) inches or less, either backfill and compact with approved granular materials; backfill with one-half (1/2) inch crushed rock; or fill with concrete at the time of the appurtenant structure concrete pour.

H. For over-excavations greater than two (2) inches, backfill and compact with an approved granular material.

1. All granular footings, structural floor slabs, or other structure areas shall be compacted with a vibratory plate compactor prior to placement of concrete, reinforcing, or bedding materials.

2. Backfill, and fill within three (3) feet adjacent to all structures and for the full height of walls, shall be selected non-swelling material.

   a. It shall be granular, well graded, and free from stones larger than two (2) inches.

   b. Material may be job excavated, but shall selectivity be required as determined by ENGINEER.

   c. Stockpiled material, other than topsoil from the excavation, shall be used for backfilling unless an impervious structural backfill is specified.

   d. The backfill material shall consist of either clean onsite granular material free of stones larger than two (2) inches in diameter with no more than twenty percent (20%) passing the No. 200 sieve, or equivalent imported materials.

   e. All backfill around the structures shall be consolidated by mechanical tamping.

   f. The material shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard

Proctor Density (ASTM D698) for cohesive soils, or to seventy-five percent (75%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM D4253.

3. Impervious structural backfill shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The WORK of this section consists of controlling groundwater, site drainage, and storm flows during construction. CONTRACTOR is cautioned that the WORK involves construction in and around drainage channels, local rivers, and areas of local drainage. These areas are subject to frequent periodic inundation.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

1.04 SUBMITTALS

A. CONTRACTOR shall submit to the ENGINEER a Water Control Plan 2 weeks prior to execution of the PROJECT. At a minimum, the Water Control Plan shall include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment, methods, standby equipment and power supply, means of measuring inflow to excavations, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.

2. Drawings showing locations, dimensions, and relationships of elements of each system.

3. Design calculations demonstrating adequacy of proposed dewatering systems and components.

4. If system is modified during installation or operation, revise or amend and resubmit Water Control Plan.

PART 2 PRODUCTS

2.01 MATERIALS

A. Onsite materials may be used within the limits of construction to construct temporary dams and berms. Materials such as plastic sheeting, sand bags, and storm sewer pipe may also be used if desired by CONTRACTOR.

PART 3 EXECUTION

3.01 GENERAL

A. For all excavation, CONTRACTOR shall provide suitable equipment and labor to remove water, and keep the excavation dewatered so that construction can be carried on under dewatered conditions.

1. Water control shall be accomplished such that no damage is done to adjacent channel banks or structures.

2. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. CONTRACTOR is responsible for investigating and becoming familiar with all site conditions that may affect the WORK including surface water, potential flooding conditions, level of groundwater and the time of year the work is to be done.

C. CONTRACTOR shall conduct operations in such a manner that storm or other waters may proceed uninterrupted along their existing drainage courses.

1. By submitting a BID, CONTRACTOR acknowledges that CONTRACTOR has investigated the risk arising from such waters and has prepared BID accordingly, and assumes all of said risk.

D. At no time during construction shall CONTRACTOR affect existing surface or subsurface drainage patterns of adjacent property.

1. Any damage to adjacent property resulting from CONTRACTOR’s alteration of surface or subsurface drainage patterns shall be repaired by CONTRACTOR at no additional cost to OWNER.

E. Pumps and generators used for dewatering and water control shall be quiet equipment enclosed in sound deadening devices.

F. CONTRACTOR shall remove all temporary water control facilities when they are no longer needed or at the completion of the PROJECT.

G. All excavations made as part of dewatering operations shall be backfilled with the same type material as was removed and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density (ASTM D698) except where replacement by other materials and/or methods are required.

3.02 CONSTRUCTION

A. Surface Water Control:

1. Surface water control generally falls into the following categories:

a. Normal low flows along the channel.

b. Storm/flood flows along the channel.

c. Flows from existing storm drain pipelines.

d. Local surface inflows not conveyed by pipelines.

2. CONTRACTOR shall coordinate, evaluate, design, construct, and maintain temporary water conveyance systems.

a. These systems shall not worsen flooding, alter major flow paths, or worsen flow characteristics during construction. CONTRACTOR is responsible to ensure that any such worsening of flooding does not occur.

b. CONTRACTOR is solely responsible for determining the methods and adequacy of water control measures.

3. At a minimum, CONTRACTOR shall be responsible for diverting the quantity of surface flow around the construction area so that the excavations will remain free of surface water for the time it takes to install these materials, and the time required for curing of any concrete or grout. CONTRACTOR is cautioned that the minimum quantity of water to be diverted is for erosion control and construction purposes and not for general protection of the construction site.

a. It shall be CONTRACTOR's responsibility to determine the quantity of water which shall be diverted to protect the WORK from damage caused by stormwater.

4. CONTRACTOR shall, at all times, maintain a flow path for all channels.

a. Temporary structures such as berms, sandbags, pipeline diversions, etc., may be permitted for the control of channel flow, as long as such measures are not a major obstruction to flood flows, do not worsen flooding, or alter historic flow routes.

B. Groundwater Control:

1. CONTRACTOR shall install adequate measures to maintain the level of groundwater below the foundation subgrade elevation and maintain sufficient bearing capacity for all structures, pipelines, earthwork, and rockwork.

a. Such measures may include, but are not limited to, installation of perimeter subdrains, pumping from drilled holes or by pumping from sumps excavated below the subgrade elevation.

b. Dewatering from within the foundation excavations shall not be allowed.

2. The foundation bearing surfaces are to be kept dewatered and stable until the structures or other types of work are complete and backfilled.

    a. Disturbance of foundation subgrade by CONTRACTOR operations shall not be considered as originally unsuitable foundation subgrade and shall be repaired at CONTRACTOR's expense.

3. Contractor shall dispose of groundwater as follows:

    a. Obtain discharge permit for water disposal from authorities having jurisdiction.

    b. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

    c. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

    d. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

4. Any temporary dewatering trenches or well points shall be restored following dewatering operations to reduce permeability in those areas as approved by ENGINEER.

END OF SECTION

SECTION 31 23 23

FLOWABLE FILL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish and place controlled low strength material (CLSM) backfill bedding where shown in the DRAWINGS. The pipeline trench shall be excavated to the proper lines, grades, and dimensions and CLSM placed under, along the sides, and on top of the pipe. Unless otherwise shown in the DRAWINGS, a minimum of one (1) foot of CLSM shall be placed over the crown of the pipe.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 19, Dewatering.

2. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. C33, Standard Specification for Concrete Aggregates.

b. C94, Standard Specification for Ready-Mixed Concrete.

c. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.

d. C150, Standard Specification for Portland Cement.

e. C494/C494M Rev A, Standard Specification for Chemical Admixtures for Concrete.

f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

g. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength (CLSM) Test Cylinders.

h. D5971, Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material.

i. D6023, Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).

j. D6024, Standard Test Method for Ball Drop on Controlled Low-Strength Material (CLSM) to Determine Suitability for Load Application.

k. D6103, Standard Test Method for Flow Consistency of Controlled Low-Strength Material (CLSM).

1.04 SUBMITTALS

A. A minimum of two (2) days prior to starting CLSM WORK. Provide product data on the following:

1. CLSM mix design

2. Fly Ash

3. Admixtures

PART 2 PRODUCTS

2.01 MATERIALS

A. General:

1. The CLSM bedding shall consist of a mixture of sand, coarse aggregate, cement and water.

2. Fly ash and approved admixtures may be used to obtain the required properties of the mix.

3. The mix shall have good workability and flowability with self-compacting and self-leveling characteristics.

4. No changes shall be made in the amounts or sources of the approved mix ingredients without the approval of ENGINEER.

5. Product inspection and field-testing of the approved mix may be made by, or on behalf of, OWNER.

B. Cement: All cement used shall be Type II Portland cement which shall conform to the requirements of ASTM C150.

C. Fly Ash: Fly ash may be either Class C or Class F. The fly ash shall conform to ASTM C618.

D. Aggregates:

1. Fine Aggregate: All fine aggregate shall conform to the grading and quality requirements of ASTM C33.

2. Coarse Aggregate: Coarse aggregate shall conform to the grading and quality requirements of ASTM C33 for size No. 476, No. 57, or No. 67.

E. Water: The batch mixing water and mixer washout water shall conform to the requirements of ASTM C94.

F. Admixtures:

1. Chemical admixtures that do not contain calcium chloride and conform to ASTM C494/C494M for concrete may be used in the CLSM mix.

2. All chemical admixtures shall be compatible with the cement and all other admixtures in the batch.

G. CLSM Proportions:

1. Strength: CLSM shall have a minimum twenty-eight (28) day compressive strength of one hundred (100) psi when molded and cured as in conformance with ASTM D4832.

2. The CLSM shall have a minimum cement content of fifty (50) pounds per cubic yard. The water-cementitious materials ratio of the mix shall not exceed three and one-half to one (3.5:1).

3. Air-Entrainment: All CLSM shall be air entrained to a total air content of approximately five percent (5%).

4. Slump: The minimum slump shall be six (6) inches and the maximum slump shall be eight (8) inches when tested in accordance with ASTM D6103.

5. Aggregate: Fine aggregate shall be between fifty percent (50%) and sixty percent (60%) by volume of the total aggregates in the CLSM mix.

6. Consistency:

a. The consistency of the CLSM slurry shall be such that the material flows easily into all openings between the pipe and the lower portion of the trench.

b. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CLSM from flowing down the trench.

c. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.

PART 3 EXECUTION

3.01 GENERAL

A. CLSM shall be placed as closely behind pipe laying operations as possible.

B. CLSM shall not be placed, if, in the judgment of ENGINEER, weather conditions are unsuitable.

C. CLSM shall not be placed when the trench bottom or walls are frozen or contain frozen materials.

D. CLSM shall not be placed when the air temperature is below forty degrees Fahrenheit (40°F) unless the air temperature is thirty five degrees Fahrenheit (35°F) or more and the temperature is rising.

3.02 PLACEMENT

A. Pipe shall be placed on two (2) sandbags and leveled to the proper grade. Precast or other types of rigid pads that constitute a point load are unacceptable.

B. CLSM shall be placed under the pipe from one side so that it flows under the pipe until it appears on the other side.

1. CLSM shall be added to both sides of the pipe until it completely fills the space between the pipe and the sides of the trench, to the depths shown in the DRAWINGS.

2. Rodding, mechanical vibration and compaction of CLSM shall be performed to assist in consolidating the CLSM.

C. When required to prevent uplift, the CLSM shall be placed in two (2) stages as required, allowing sufficient time for the initial set of the first stage before the remainder is placed.

D. CLSM shall be deposited as nearly as practical in its final position and in no way disturb the pipe trench or cause foreign material to become mixed with the CLSM.

E. Soil backfill shall not be placed until the CLSM has reached the initial set.

1. If backfill is not to be placed over the CLSM within eight (8) hours, a six-inch (6") cover of moist earth shall be placed over the CLSM surface.

2. If the air temperature is fifty degrees Fahrenheit (50°F) or less, the moist earth cover should be at least eighteen inches (18") thick.

END OF SECTION

SECTION 31 23 33

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of all labor, equipment, and materials necessary for excavation, trenching, and backfilling for utility lines and other related WORK.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 19, Dewatering.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

2. Colorado Department of Transportation (CDOT).

3. Occupational Safety and Health Administration (OSHA).

1.04 SUBMITTALS

A. Submit certification that bedding and pipe zone material meets SPECIFICATION.

PART 2 PRODUCTS

2.01 MATERIALS

A. Muck Excavation:

1. Muck excavation shall also include the replacement of excavated muck with uniformly graded rock ranging from three-quarter (3/4) inch to one and one-half (1-1/2) inches or as required by ENGINEER.

2. ENGINEER shall determine which type of aggregate or other material shall be used after observing the specific site conditions.

B. Bedding and Pipe Zone Materials:

1. Well-Graded Sand:

Sieve Size	Total Percent Passing by Weight
⅜ - 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

2. Squeegee Sand:

Sieve Size	Total Percent Passing by Weight
⅜ - inch	100
No. 200	0 - 5

3. CDOT #67:

Sieve Size	Total Percent Passing by Weight
1 inch	100
¾ - inch	90 - 100
⅜ - inch	20 - 55
No. 4	0 - 10
No. 8	0 - 5

a. It shall be the responsibility of CONTRACTOR to locate material meeting the SPECIFICATIONS, to test its ability to consolidate to at least seventy-five percent (75%) relative density, and to secure approval of ENGINEER before such material is delivered to the PROJECT.

b. Relative density shall be determined as stipulated in ASTM D4253.

C. Backfill:

1. Use only backfill for trenches which is free from rocks, large roots, other vegetation or organic matter, and frozen material.

2. No rocks greater than three (3) inches in diameter shall be allowed.

D. Cut-Off Walls:

1. Clay Cut-Off Walls: More than fifty percent (50%) shall pass a No. 200 Sieve. The plasticity index shall be greater than twelve (12).

2. Controlled Low Strength Material Backfill: (Flo-Fill, See Section 31 23 23, Flowable Fill).

PART 3 EXECUTION

3.01 GENERAL

A. The following procedures shall be followed by CONTRACTOR in sequencing the WORK:

1. No more than one hundred fifty (150) feet of trench shall be left open at any time.

2. The entire trench shall be backfilled to within fifty (50) feet of the open trench upon conclusion of each day's WORK.

3. The trench shall not be backfilled until the pipe installation is found acceptable by ENGINEER.

4. Trench shall be backfilled within one hundred (100) feet of the pipe installation at all times.

5. Clean-up shall be maintained within four hundred (400) feet of the trench excavation.

B. Prior to placement in the trench, all pipes, fittings, and appurtenances shall be cleaned and examined for defects by CONTRACTOR.

1. If found defective, CONTRACTOR shall reject the defective pipe, fitting, or appurtenance.

2. CONTRACTOR shall advise ENGINEER of all defective materials.

C. Surplus Excavation:

1. All surplus excavation shall be placed, in an orderly manner.

2. If material is stockpiled on private property, written permission shall be obtained from the property owner and provided to ENGINEER.

3.02 OBSTRUCTIONS AND DISPOSAL OF WASTE MATERIAL

A. CONTRACTOR shall remove obstructions that do not require replacement from within the trench or adjacent areas such as tree roots, stumps, abandoned piling, buildings and concrete structures, frozen material, logs, and debris of all types without additional compensation.

B. ENGINEER may, if requested, make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the WORK limits without adversely affecting the intended function of the facility.

C. Excavated materials unsuitable for backfill or not required for backfill shall be disposed of in accordance with local regulations.

3.03 TRENCH EXCAVATION

A. All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line, and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill.

B. Clearance:

1. The trench shall be excavated so that a minimum clearance of six (6) inches is maintained on each side of the pipe for proper placement and densification of the bedding or backfill material.

2. The maximum clearance measured at the spring line of the pipe shall be eighteen (18) inches regardless of the type of pipe, type of soil, depth of excavation, or the method of densifying the bedding and backfill.

C. Except as otherwise dictated by construction conditions, the excavation shall be of such dimensions as to allow for the proper pipe installation and to permit the construction of the necessary pipe connections.

D. Care shall be taken to ensure that the excavation does not extend below established grades.

1. If the excavation is made below such grades, the excess excavation shall be filled in with sand or graded gravel deposited in horizontal layers not more than six (6) inches in thickness after being compacted and shall be moistened as required to within two percent (2%) of the optimum moisture content required for compaction of that soil.

2. After being conditioned to have the required moisture content, the layers shall be compacted to the required density.

E. CONTRACTOR shall stockpile excavated materials in a safe manner. Stockpiles shall be graded for proper drainage.

F. CONTRACTOR shall place and grade the trench base to the proper grade ahead of pipe laying. The invert of the trench shall be compacted to provide a firm unyielding support along entire pipe length.

G. Surplus excavation shall be disposed of by CONTRACTOR at CONTRACTOR's expense.

3.04 PROTECTION

A. Sheeting and Shoring:

1. CONTRACTOR shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures.

2. The latest requirements of OSHA shall be complied with at all times including trenching and confined space entry requirements.

3. CONTRACTOR shall be responsible for underpinning adjacent structures which may be damaged by excavation WORK, including service utilities and pipe chases.

B. Weather and Frost:

1. CONTRACTOR shall protect bottom of excavations and soil adjacent to and beneath foundations from frost.

2. Do not place backfill, fill, or embankment on frozen surfaces.

3. Do not place frozen materials, snow, or ice in backfill, fill, or embankments.

4. Do not deposit, tamp, roll, or otherwise mechanically compact backfill in water.

C. Drainage and Groundwater:

1. The excavation shall be graded to prevent surface water runoff into trench or excavation.

2. Maintain excavations and trenches free from water during construction.

3. Remove water encountered in trenches to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.

4. Divert surface runoff and use sumps, gravel blankets, well points, drain lines, or other means necessary to accomplish the above.

5. Maintain the excavation or trench free from water until the structure, or pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

6. Prevent water from entering into previously constructed pipe.

7. Do not use the pipe under construction for dewatering.

3.05 FOUNDATIONS ON UNSTABLE SOILS

A. If the bottom of the excavation is soft or unstable, and in the opinion of ENGINEER, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to six (6) inches below grade with rock or other approved material, uniformly graded between three-quarter (3/4) inch and one and one-half (1-1/2) inches to provide a firm foundation for the pipe or structure. From six (6) inches below grade to grade, the appropriate bedding material shall be placed to provide support for the pipe or structure.

3.06 PIPE BEDDING

A. After completion of the trench excavation and proper preparation of the foundation, six (6) inches of bedding material shall be placed on the trench bottom for support under the pipe.

B. Bell holes shall be dug deep enough to provide a minimum of two (2) inches of clearance between the bell and the bedding material.

C. All pipes shall be installed in such a manner as to ensure full support of the pipe barrel over its entire length.

D. After the pipe is adjusted for line and grade and the joint is made, the bedding material shall be carefully placed and tamped under the haunches of the pipe.

E. For all types of pipe, the limits of bedding shall be as shown on the trench section details on the DRAWINGS.

F. Bedding shall be compacted to seventy five percent (75%) relative density in accordance with ASTM D4253. Care shall be exercised to ensure sufficient tamping under the pipe to achieve uniform support.

3.07 BACKFILL AND COMPACTION

A. All muck excavation, bedding, and pipe zone material shall be imported unless otherwise designated by OWNER's geotechnical engineer.

B. Pipe:

1. The pipe trench shall be backfilled to the limits as shown on the DRAWINGS.

2. The backfill in all areas shall be compacted by vibrating, tamping, or a combination thereof to seventy five percent (75%) relative density for sand material as determined by the relative density of cohesionless soils test, ASTM D4253, or to ninety five percent (95%) of the Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698.

3. All backfill shall be brought up to equal height along each side of the pipe in such a manner as to avoid displacement.

4. Bedding shall be distributed in 6-inch (6") maximum lifts over the full width of the trench.

5. Wet, soft or frozen material, asphalt chunks, or other deleterious substances shall not be used for backfill.

6. If the excavated material is not suitable for backfill, as determined by ENGINEER, suitable material shall be hauled in and utilized and the rejected material hauled away and disposed of.

7. Backfilling shall be conducted at all times in a manner to prevent damage to the pipe or its coating and shall be kept as close to the pipe laying operation as practical.

8. Backfilling procedures shall conform to the additional requirements, if any, of appropriate agencies or private right-of-way agreements.

C. Unsurfaced Areas: All surface cuts shall be, as a minimum, restored to a condition equal to that prior to construction.

D. Surfaced Areas:

1. All surface cuts shall be, as a minimum, restored to a condition equal to that prior to construction.

2. All gravel or paved streets shall be restored in accordance with the regulations and requirements of the agency having control or jurisdiction over the street, roadway, or right-of-way.

E. Grassed or Landscaped Areas:

1. In landscaped or agricultural areas, topsoil, to a depth of twelve (12) inches, shall be removed from the area of general disturbance and stockpiled.

2. After installation of all pipelines, appurtenances and structures and completion of all backfill and compaction, the stockpiled topsoil shall be redistributed evenly over all disturbed areas.

3. Care should be taken to conform to the original ground contour or final grading plans.

3.08 FIELD QUALITY CONTROL

A. In-place moisture density tests will be performed to ensure trench backfill complies with specified requirements. The following minimum tests will be performed.

1. Trench Bedding: One per two hundred (1 per 200) feet.

2. Backfill: One per two hundred (1 per 200) feet.

B. Backfill Compaction Tests:

1. Backfill compaction tests will be performed until compaction meets or exceeds requirements.

2. The cost of “passing” tests will be paid by OWNER.

3. Costs associated with “failing” tests shall be paid by CONTRACTOR.

C. Pipe bedding will be tested prior to placement of backfill.

D. Testing of all bedding and backfill material will be done in compliance with Occupational Safety & Health Administration (OSHA) - Excavations.

3.09 RESTORATION

A. Scarify surface, reshape, and compact to required density completed or partially completed areas of WORK disturbed by subsequent construction operations or by adverse weather.

B. Maintain and correct backfill, fill, and embankment settlement and make necessary repairs to pavement structures, seeding, and sodding which may be damaged as a result of settlement for the guarantee period.

C. Such maintenance and correction may be performed by subcontract.

D. Upon completion of the WORK, all plants, rubbish, unused materials, concrete forms, and other like material shall be removed from the job site.

E. The site shall be left in a state of order and cleanliness.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of temporary measures needed to control erosion and water pollution. These temporary measures shall include, but not be limited to, berms, dikes, dams, sediment basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods. These temporary measures shall be installed at the locations where needed to control erosion and water pollution during the construction of the PROJECT, and as directed by ENGINEER, and as shown on the DRAWINGS.

B. The Erosion Control Plan presented in the DRAWINGS serves as a minimum for the requirements of erosion control during construction. CONTRACTOR has the ultimate responsibility for providing adequate erosion control and water quality throughout the duration of the PROJECT. Therefore, if the provided plan is not working sufficiently to protect the PROJECT areas, then CONTRACTOR shall provide additional measures as required to obtain the required protection. CONTRACTOR shall include in the BID price for erosion control a minimum of all items shown on the Erosion Control Plan and any additional items that may be needed to control erosion and water pollution.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 19, Dewatering.
2. Section 31 11 00, Clearing and Grubbing.
3. Section 31 14 13, Topsoil Stripping and Stockpiling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Colorado Department of Public Health and Environment (CDPHE).

1.04 SUBMITTALS

A. Submit the following information:

1. Erosion Control Plan.
2. Construction schedule for Erosion Control per Article Scheduling.
3. Sequencing Plan per Article Scheduling.
4. Plan for disposal of waste material per Article Scheduling.

5. Product data for materials proposed for use.

6. All applicable permits for Erosion Control.

1.05 REGULATORY REQUIREMENTS

A. 401 Construction Dewatering Industrial Wastewater Permit (Construction Dewatering Permit 401):

1. CONTRACTOR shall apply for and obtain a Construction Dewatering Permit 401 from the Colorado Department of Public Health and Environment.

2. All costs for this permit shall be the responsibility of CONTRACTOR.

3. This permit requires that specific actions be performed at designated times.

4. CONTRACTOR is legally obligated to comply with all terms and conditions of the permit including testing for effluent limitations.

5. CONTRACTOR shall allow the Colorado Department of Public Health and Environment or other representatives to enter the site to test for compliance with the permit.

6. Non-compliance with the permit can result in stoppage of all WORK.

B. In the event of conflict between these requirements and erosion and pollution control laws, rules, or regulations of other Federal, State, or local agencies, the more restrictive laws, rules, or regulations shall apply.

1.06 SCHEDULING

A. Sequencing Plan:

1. CONTRACTOR shall submit a sequencing plan for approval for erosion control in conformance with CONTRACTOR's overall Construction Plan for approval by OWNER.

2. Changes to the Erosion Control Sequencing Plan may be considered by OWNER only if presented in writing by the CONTRACTOR.

B. Temporary Erosion Control:

1. When so indicated in the CONTRACT DOCUMENTS, or when directed by ENGINEER, CONTRACTOR shall prepare construction schedules for accomplishing temporary erosion control WORK including all maintenance procedures.

2. These schedules shall be applicable to clearing and grubbing, grading, structural WORK, construction, etc.

C. CONTRACTOR shall submit for acceptance the proposed method of erosion control on haul roads and borrow pits and a plan for disposal of waste material.

D. CONTRACTOR shall be required to incorporate all permanent erosion control features into the PROJECT at the earliest practicable time as outlined in the accepted schedule. Temporary erosion control measures shall then be used to correct conditions that develop during construction.

E. WORK shall not be started until the erosion control schedules and methods of operations have been accepted.

PART 2 PRODUCTS

2.01 MATERIALS

A. All materials shall be submitted for approval prior to installation.

B. Materials may include hay bales, straw, fiber mats, fiber netting, wood cellulose, fiber fabric, gravel, and other suitable materials, and shall be reasonably clean, free of deleterious materials, and certified weed free.

C. Grass Seed:

1. Temporary grass cover (if required) shall be a quick growing species, suitable to the area, in accordance with local criteria and permit requirements, which will provide temporary cover, and not compete with the grasses sown for permanent cover.

2. All grass seed shall be approved by ENGINEER and in accordance with local regulations prior to installation.

D. Fertilizer and soil conditioners shall be approved by ENGINEER and in accordance with local regulations prior to installation.

PART 3 EXECUTION

3.01 GENERAL

A. All temporary and permanent erosion and sediment control practices shall be maintained and repaired as needed to ensure continued performance of their intended function.

B. OWNER will monitor CONTRACTOR’s erosion control and WORK methods.

1. If the overall function and intent of erosion control is not being met, OWNER will require CONTRACTOR to provide additional measures as required to obtain the desired results.

2. Costs for any additional erosion control measures shall be paid for at contract unit prices.

C. The erosion control features installed by CONTRACTOR shall be adequately maintained by CONTRACTOR until the PROJECT is accepted.

D. Working In or Crossing Watercourses and Wetlands:

1. Construction vehicles shall be kept out of watercourses to the extent possible.

2. Where in-channel WORK is necessary, precautions shall be taken to stabilize the WORK area during construction to minimize erosion.

    a. The channel (including bed and banks) shall always be restabilized immediately after in-channel WORK is completed.

3. Where a live (wet) watercourse must be crossed by construction vehicles during construction, a Temporary Stream Crossing shall be provided for this purpose.

3.02 PROTECTION OF ADJACENT PROPERTIES

A. Properties adjacent to the site of a land disturbance shall be protected from sediment deposition.

B. In addition to the erosion control measures required on the DRAWINGS, perimeter controls may be required if damage to adjacent properties is likely, and may include, but is not limited to:

1. Vegetated buffer strip around the lower perimeter of the land disturbance.

    a. Vegetated buffer strips may be used only where runoff in sheet flow is expected and should be at least twenty (20) feet in width.

2. Sediment barriers such as straw bales, erosion logs, and silt fences.

3. Sediment basins and porous landscape detention ponds.

4. Combination of above measures.

3.03 CONSTRUCTION

A. Stabilization of Disturbed Areas:

1. Temporary sediment control measures shall be established within five (5) days from time of exposure/disturbance.

2. Permanent erosion protection measures shall be established within five (5) days after final grading of areas.

B. Stabilization of Sediment and Erosion Control Measures:

1. Sediment barriers, perimeter dikes, and other measures intended to either trap sediment or prevent runoff from flowing over disturbed areas shall be constructed as a first step in grading and be made functional before land disturbance takes place.

2. Earthen structures such as dams, dikes, and diversions shall be stabilized within five (5) days of installation.

3. Stormwater outlets shall also be stabilized prior to any upstream land disturbing activities.

C. Stabilization of Waterways and Outlets:

1. All onsite stormwater conveyance channels used by CONTRACTOR for temporary erosion control purposes shall be designed and constructed with adequate capacity and protection to prevent erosion during storm and runoff events.

2. Stabilization adequate to prevent erosion shall also be provided at the outlets of all pipes and channels.

D. Storm Sewer Inlet Protection: All storm sewer inlets which are made operable during construction or which drain stormwater runoff from a construction site shall be protected from sediment deposition by the use of filters.

E. Construction Access Routes:

1. Wherever construction vehicles enter or leave a construction site, a Stabilized Construction Entrance is required.

2. Where sediment is transported onto a public road surface, the roads shall be cleaned thoroughly at the end of each day.

3. Sediment shall be removed from roads by shoveling or sweeping and be transported to a sediment controlled disposal area.

4. Street washing shall be allowed only after sediment is removed in this manner.

3.04 DISPOSITION OF TEMPORARY MEASURES

A. All temporary erosion and sediment control measures shall be disposed of within thirty (30) days after final site stabilization is achieved or after the temporary measures are no longer needed as determined by OWNER.

B. Trapped sediment and other disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion.

C. Substantial Completion of Erosion Control Measures:

1. At the time specified in the CONTRACT DOCUMENTS, and subject to compliance with specified materials and installation requirements, CONTRACTOR shall receive a Substantial Completion Certificate for temporary erosion control measures.

2. Maintenance of Erosion Control Measures after Substantial Completion: CONTRACTOR shall be responsible for maintaining temporary erosion control measures as specified in the DRAWINGS and CONTRACT DOCUMENTS until such time as WORK has been accepted by OWNER as specified in Section 01 77 00, Closeout Procedures.

D. Final Completion and Acceptance of Erosion Control Measures:

1. After ENGINEER and OWNER have determined that the drainage area has stabilized, CONTRACTOR shall remove all remaining temporary erosion control measures.

2. Any damage to the site shall be repaired to the satisfaction of ENGINEER and at no cost to OWNER.

END OF SECTION

SECTION 31 37 00

RIPRAP, BOULDERS, SOIL RIPRAP, AND BEDDING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The WORK includes excavation, grading, and installation of riprap, boulders, soil riprap, and bedding placed at the locations shown on the DRAWINGS. The materials to be used and the construction of such structures shall be as specified herein.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 19, Dewatering.

3. Section 31 23 33, Trenching and Backfilling.

4. Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders, and Grouted Rock Retaining Walls

1.03 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. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.

   b. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

   c. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.

   d. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.

   e. T248, Reducing Field Samples of Aggregate Test Size.

2. ASTM International (ASTM): D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

1.04 SUBMITTALS

A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. RIPRAP

1. Riprap used shall be the type designated on the DRAWINGS and shall conform to the following:

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d_{50}* (inches)
Type VL	70 - 100 50 - 70 35 - 50 2 - 10	12 9 6 2	6**
Type L	70 - 100 50 - 70 35 - 50 2 - 10	15 12 9 3	9**
Type M	70 - 100 50 - 70 35 - 50 2 - 10	21 18 12 4	12**
Type H	70 - 100 50 - 70 35 - 50 2 - 10	30 24 18 6	18
Type VH	70 - 100 50 - 70 35 - 50 2 - 10	41 33 24 9	24

*d_{50} = Mean Particle Size

**Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.

2. The riprap designation and total thickness of riprap shall be as shown on the DRAWINGS. The maximum stone size shall not be larger than the thickness of the riprap.

3. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.

4. The specific gravity of the riprap shall be two and one-half (2.5) or greater.

5. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.

6. The bulk density for the riprap shall be 1.3 ton/cy or greater.

7. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.

8. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.

9. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.

10. Rock shall be free of calcite intrusions.

11. Gradation:

    a. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.

    b. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.

    c. Control of gradation shall be by visual inspection. However in the event ENGINEER determines the riprap to be unacceptable, ENGINEER shall pick two (2) random truckloads to be dumped and checked for gradation.

        1) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost.

12. Color:

    a. The color of the riprap shall be gray with gray/blue hues or other acceptable colors approved by ENGINEER prior to delivery to the PROJECT site.

    b. Color shall be consistent on the entire PROJECT and shall match the color of rock to be used for all other portions of the WORK.

13. Broken concrete or asphalt pavement shall not be acceptable for use in the WORK.

14. Rounded riprap (river rock) is not acceptable, unless specifically designated on the DRAWINGS.

B. BOULDERS

1. Boulders used shall be the type designated on the DRAWINGS and shall conform to the following:

Boulder Classification	Nominal Size (inches)	Range in Smallest Dimension of Individual Rock Boulders (inches)	Maximum Ratio of Largest to Smallest Rock Dimension of Individual Boulders
B18	18	17 - 20	1.50
B24	24	22 - 26	1.50
B30	30	28 - 32	1.50
B36	36	34 - 38	1.50
B42	42	40 - 44	1.50
B48	48	45 - 51	1.50

2. The specific gravity of the boulders shall be two and one-half (2.5) or greater.

3. Boulder specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.

4. The bulk density for the boulder shall be 1.3 ton/cy or greater.

5. The boulders shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.

6. The boulders shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.

7. The boulders shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.

8. Rock shall be free of calcite intrusions.

9. Color:

   a. The color of the boulders shall be gray with gray/blue hues or other acceptable colors approved by ENGINEER prior to delivery to the PROJECT site.

b. Color shall be consistent on the entire PROJECT and shall match the color of rock to be used for all other portions of the WORK.

C. SOIL RIPRAP

1. Rock requirements are to comply with riprap as specified in Article Materials.

2. The soil material shall be native or topsoil and mixed with sixty-five percent (65%) riprap and thirty five percent (35%) soil by volume.

3. Soil riprap shall consist of a uniform mixture of soil and riprap without voids.

D. BEDDING:

1. Gradation for Granular Bedding:

	Percent by Weight Passing Square-Mesh Sieves	
U.S. Standard Sieve Size	**Type I (CDOT Sect. 703.01)**	**Type II (CDOT Sect. 703.09 Class A)**
3 inches	-	90 - 100
1½ inches	-	-
¾ inch	-	20 - 90
⅜ inch	100	-
No. 4	95 - 100	0 - 20
No. 16	45 - 80	-
No. 50	10 - 30	-
No. 100	2 - 10	-
No. 200	0 - 2	0 - 3

2. Granular bedding designation and total thickness of bedding shall be as shown on the DRAWINGS.

3. Granular bedding shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for riprap.

a. Broken concrete asphalt pavement or sledge, shall not be acceptable for use in the WORK. Rounded river rock is not acceptable unless specifically designated on the DRAWINGS.

b. The requirements for the wear test in AASHTO T96 shall not apply.

E. FEATURE BOULDERS:

1. Feature Boulders shall consist of the same material as boulders, differing only by size.

2. Feature Boulders shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for boulders

3. Feature Boulders shall have a minimum dimension of four (4) feet, or as shown on the DRAWINGS.

PART 3 EXECUTION

3.01 PREPARATION

A. Channel slope, bottom, or other areas that are to be protected with riprap, boulders or soil riprap shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface as shown on the DRAWINGS.

B. CONTRACTOR shall excavate areas to receive riprap to the subgrade as shown on the DRAWINGS accounting for granular bedding.

C. CONTRACTOR shall excavate areas to receive boulders or soil riprap to the specified depth (bedding material is not required for boulders and soil riprap).

D. Subgrade Materials:

1. The subgrade materials shall be stable.

2. If unsuitable materials are encountered, they shall be removed and replaced as Muck Excavation in accordance with Section 31 23 00, Excavation and Fill, for subgrade that has been excavated in undisturbed soil.

E. Additional Compaction:

1. Additional compaction shall not be required unless specified by ENGINEER.

2. When subgrade is built up with embankment material it shall be compacted to ninety five percent (95%) maximum density (ASTM D698).

F. Bedding:

1. After an acceptable subgrade is established, bedding shall be immediately placed and leveled to the specified elevation on the DRAWINGS.

2. Immediately following the placement of the bedding material, the riprap shall be placed.

3. If bedding material is disturbed for any reason, it shall be replaced and graded at CONTRACTOR's expense.

4. Contamination:

a. In-place bedding materials shall not be contaminated with soils, debris or vegetation before the riprap is placed.

b. If contaminated, the bedding material shall be removed and replaced at CONTRACTOR's expense.

3.02 PLACEMENT

A. RIPRAP

1. Following acceptable placement of granular bedding, riprap placement shall commence as follows:

a. Machine Placed Riprap:

1) Riprap shall be placed on the prepared slope or channel bottom areas in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids.

2) Riprap shall be machine placed, unless otherwise stipulated in the DRAWINGS or SPECIFICATIONS.

3) It is the intent of these SPECIFICATIONS to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by ENGINEER, the riprap protection shall be placed in conjunction with the construction of embankment or channel bottom with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected.

b. Slope Placement:

1) When riprap is placed on slope, placement shall commence at the bottom of the slope working up the slope.

c. The entire mass of riprap shall be placed on either channel slope or bottom so as to be in conformance with the required gradation mixture and to line, grade, and thickness shown on the DRAWINGS.

d. Riprap shall be placed to full course thickness at one operation and in such a manner as to avoid displacing the underlying bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.

e. All material used for riprap protection for channel slope or bottom shall be placed and distributed such that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.

f. The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials.

g. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the rock layer thickness shall not be allowed.

h. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism.

i. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material.

j. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.

k. CONTRACTOR shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the DRAWINGS at no additional cost to OWNER. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

2. Hand Placed Riprap:

a. Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements of PART 2, above.

b. Hand placed riprap shall also be required when the depth of riprap is less than two (2) times the nominal stone size, or when required by the DRAWINGS or SPECIFICATIONS.

c. After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown on the DRAWINGS.

3. Soil Replacement Over Riprap:

a. Where riprap is designated to be buried, place onsite excavated material that is free from trash and organic matter in riprap voids by washing and rodding.

b. Prevent excessive washing of material into stream.

c. When voids are filled and the surface accepted by ENGINEER, place a nominal six (6) inches of topsoil over the area, or as designated on the DRAWINGS.

d. Fine grade, seed, and mulch per the SPECIFICATIONS.

B. BOULDERS

1. Following excavation and acceptance of subgrade by ENGINEER Boulder placement shall commence as follows:

a. Boulders shall be placed on the prepared subgrade in a manner which will minimize voids.

b. Voids between boulders exceeding 4" shall be chinked.

2. If Boulders are to be grouted, boulders shall be installed according to Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders and grouted Boulder Retaining Walls.

C. SOIL RIPRAP

1. Adjacent stockpiles of riprap and soil shall be created and mixing done at the stockpile location, not at the location where soil riprap is to be placed.

2. Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.

3. With prior approval of ENGINEER, layering the riprap and soil instead of premixing may be allowed if the native soil is granular.

4. Place a first layer of smaller soil riprap of approximate d_{50} thickness. Then place the top layer with surface rocks that are largely d_{50} or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane as described in Paragraph A.

5. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.

6. The soil shall be further wetted to encourage void filling with soil.

7. Any large voids shall be filled with rock and small voids filled with soil.

8. Excessively thick zones of soil prone to washing away shall not be created (for example, no thicknesses greater than six (6) inches).

9. For buried soil riprap, the top surface shall be covered with four (4) inches of topsoil such that no rock points are protruding.

10. The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

D. FEATURE BOULDERS

1. Feature Boulders serve an aesthetic function and as such shall be placed and rotated into final position as directed by ENGINEER in order to achieve the desired result.

3.03 REJECTION OF WORK AND MATERIALS:

A. ENGINEER will reject placed riprap, boulders, soil riprap and bedding that do not conform to this section. CONTRACTOR shall immediately remove and re-lay the riprap, boulders, soil riprap and bedding to conform to SPECIFICATIONS.

B. Riprap, boulders, soil riprap and bedding shall be rejected, which is either delivered to the job site or placed, that does not conform to this section.

C. Rejected riprap, boulders, soil riprap and bedding shall be removed from the PROJECT site by CONTRACTOR at CONTRACTOR's expense.

END OF SECTION

`SECTION 31 37 19

GROUTED BOULDERS, STACKED GROUTED BOULDERS, AND GROUTED BOULDER RETAINING WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This WORK shall consist of installing grouted boulders, stacked grouted boulders, and grouted rock retaining walls constructed at the location (s) shown on the DRAWINGS.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 19, Dewatering.

3. Section 31 23 33, Trenching and Backfilling.

4. Section 31 37 00, Riprap, Boulders, Soil Riprap and Bedding

1.03 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. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.

b. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.

c. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.

2. ASTM International (ASTM):

a. C39, Standard Test Method for Compressive Cylindrical Concrete Specimens.

b. C150, Standard Specification for Portland Cement.

c. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

1.04 DEFINITIONS

A. Terms “boulders,” and “rock,"may be used interchangeably in this section.

1.05 SUBMITTALS

A. CONTRACTOR shall submit a mix design in writing to ENGINEER for approval prior to placement of any grout.

B. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

1.06 QUALITY ASSURANCE

A. Mock-up:

1. Prior to the construction of any grouted rock walls, CONTRACTOR or SUBCONTRACTOR who is constructing the walls for CONTRACTOR shall show ENGINEER an example of similar rock walls that they had constructed previously.

2. After acceptance of this previous WORK, CONTRACTOR or SUBCONTRACTOR shall construct approximately one hundred (100) square feet of grouted rock wall as shown on the DRAWINGS for approval by ENGINEER.

3. If the construction is approved, CONTRACTOR or SUBCONTRACTOR shall construct the rest of the grouted rock wall. If the construction is not approved, CONTRACTOR shall make any changes required by OWNER and ENGINEER to obtain approval, and construct the remainder of the wall as approved.

PART 2 PRODUCTS

2.01 MATERIALS

A. Boulders

1. Boulders shall meet the requirements of Section 31 37 00 Riprap, Boulders, Soil Riprap and Bedding

2. Rhyolite rock shall not be used for any grouted boulders.

3. Gradation:

a. Each load of boulders shall conform to the dimensions specified on the DRAWINGS and in Section 31 37 00 Riprap, Boulders, Soil Riprap, and Bedding

b. Boulders for a boulder edge shall have a maximum ratio of largest to smallest rock dimension shall be 1.5 or as shown on the

DRAWINGS. Grouted walls shall be constructed of rock having a mean diameter of nine (9) inches to eighteen (18) inches.

c. Control of gradation will be by visual inspection.

1) In the event ENGINEER determines the boulders to be unacceptable, ENGINEER will pick two random truckloads to be dumped and checked for gradation.
2) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost to OWNER if the boulders do not meet the specified gradation.
3) If the boulders do meet the gradation specified, OWNER will pay for the equipment and labor required for checking.

4. Color:

a. The color of boulders shall meet the requirements of Section 31 37 00, Riprap, Boulders, Soil Riprap, and Bedding.

B. Grout:

1. Concrete for the grout shall be an approved batch meeting the following requirements:

a. All grout shall have a minimum 28-day compressive strength equal to 3,200 psi.

b. One cubic yard of grout shall contain a minimum of six (6) sacks of Type II Portland cement.

c. A maximum of 25% Type F Fly Ash may be substituted for the Portland cement.

d. Aggregate for the grout shall consist of 70% natural sand (fines) and 30% 3/8-inch rock (coarse).

e. Slump shall be four (4) inches to six (6) inches.

f. Air entrainment shall be 5.5% - 7.5%.

g. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.

h. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.

i. Color Additive in required amounts shall be used when so specified by contract.

PART 3 EXECUTION

3.01 GROUTED BOULDERS AND STACKED GROUTED BOULDERS

A. Grouted boulders shall be placed at the locations as shown on the DRAWINGS and installed with the following requirements:

1. Subgrade:

a. The subgrade to receive each boulder shall be excavated and any unstable material shall be removed.

b. Grouted Boulders shall be placed on subgrade without granular bedding unless approved by ENGINEER.

c. Material approved by ENGINEER shall be placed and compacted in a maximum of four-inch (4") lifts to ninety five percent (95%) of Maximum Standard Proctor Density (ASTM D698) to re-establish the subgrade of each boulder.

d. Unstable material shall be removed from the PROJECT site and disposed of by CONTRACTOR. Removal and replacement of unstable material shall only be completed at the direction of ENGINEER and shall be paid for under Muck Excavation.

e. Subgrade shall be excavated a minimum of 6" to a maximum of 12" behind boulders.

f. Backfill behind boulders shall be compacted to ninety five percent (95%) Maximum Standard Proctor Density (ASTM D698). Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder channel edge.

g. Finished grades and subgrade for boulders shall be determined from the height of each boulder used.

2. Boulders

a. The top of all boulders shall be as indicated on the DRAWINGS.

b. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within two (2) inches in top elevation and two (2) inches along the vertical exposed face or channel side of rock.

c. Boulders shall be placed such that adjacent boulders “touch” each other and voids do not exceed four (4) inches. It is the intent of construction to minimize voids and grout placed between boulders.

d. CONTRACTOR shall, if deemed necessary, support the boulders from falling over before and during the placement of grout, backfill, and completing compaction WORK on either side of the boulder.

e. Smaller rocks shall be “chinked in” to fill all voids behind the boulders. Smaller rocks shall also be used to "chink in gaps larger than four (4) inches. Placement shall be approved by ENGINEER prior to grouting.

3. Grouting:

a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.

b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of twenty-four (24) hours after the grout has been placed.

c. Keep boulders receiving grout wet at all times prior to receiving grout.

d. The concrete grout shall be placed by injection methods by pumping under low pressure, through a two- (2") inch maximum diameter hose to ensure complete penetration of the grout into the void area as detailed on the DRAWINGS. The grout mix shall be stiffened and other measures taken to retain the grout between the boulders.

e. Grout placement shall begin at the bottom of the lowest boulder and proceed upward to ensure no air voids exist between the grout, subbase, and boulders.

f. Grout shall be placed up to a height of one-half (1/2) of the diameter of the top row of boulders or as directed by ENGINEER and shall be placed in the voids and behind the boulders and not on the surface of the rocks.

g. A “pencil” vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. The “pencil” vibrator may be used to smooth the appearance of the surface, but CONTRACTOR shall use a wood float to smooth and grade the grout around the boulders.

h. Grout between boulders shall be recessed one third (1/3) the diameter of the boulders on the side facing the channel.

i. Grout should be troweled out and finished to minimize visibility.

j. Clean and wash any spillage before the grout sets so the visual surfaces of boulders will be free of grout to provide a clean, natural appearance, or if washing does not clean off grout residue, CONTRACTOR shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.

k. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.

3.02 GROUTED BOULDER RETAINING WALLS

A. Grouted boulder retaining walls shall be placed at locations as shown on the DRAWINGS and installed with the following requirements:

1. The grouted boulder walls shall be constructed to the dimensions shown on the DRAWINGS and shall be constructed with a one (1) horizontal to four (4) vertical batter on the front and back face, with a minimum width of one (1) foot at the top of the wall.

2. The stone of the wall shall be laid to form substantial masonry presenting a neat, finished appearance.

3. Headers shall hold the heart of the wall to the face and shall occupy at least twenty percent (20%) of the area and they shall be evenly distributed.

4. The length of stretchers shall not exceed three (3) times their rise.

5. Spalls and pinners shall be used in the backing only where necessary and will not be allowed in the face.

6. Face Stones:

   a. Face stones shall be laid to break joints so that each rock laid rests on two beneath it.

   b. Rock shall be hand graded so that only the larger stones are used in the face.

   c. All face stones shall be pitched to a string line on straight walls or laid to batter stakes for curved walls such that the batter is consistent with respect to all parts of the wall and shall meet the minimum requirements set forth in the detail.

   d. The degree of roughness on the exposed face shall be measured with a six-foot (6') straightedge supported between adjacent projections and stone face.

   e. Variations in excess of three (3) inches, measured from the straight edge to the extreme depression in the stone, will not be permitted.

   f. Rear faces shall present approximately plane surfaces and shall in general conform to the detail.

7. Grouting:

   a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.

   b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and the area will remain dewatered for a period of twenty-four (24) hours after the grout has been placed.

c. The surface of the boulders receiving grout shall be wet at all times prior to receiving grout.

d. Grout shall be placed to fill all voids between, under and the throughout the boulder walls and shall be recessed approximately one-third (1/3) the diameter of the boulders from the face of the wall in order to give a “dry stacked” appearance.

e. A “pencil” vibrator shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the DRAWINGS. The “pencil” vibrator may be used to smooth the appearance of the surface, but CONTRACTOR shall use a wood float to smooth and grade the grout around the boulders.

f. Any “loose” rocks shall be regrouted by machine or hand methods.

g. Clean and wash any spillage before the grout sets on the outside face and top of walls such that the visual surfaces of the rocks are free of grout to provide a clean natural appearance, or, if washing does not clean off grout residue, then CONTRACTOR shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.

h. Grout shall receive cold or hot weather protection in accordance with Section 03 31 00, Structural Concrete.

END OF SECTION

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SECTION 31 62 16

STEEL SHEET PILES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section covers all members to be used in the construction of steel sheet pile. This SPECIFICATION also covers the installation of steel sheet piling and trimming of the sheet pile to the lines and grades shown on the DRAWINGS or as required. This WORK also includes pre-drilling to facilitate driving sheet pile to the designated elevations.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 19, Dewatering.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 318/318R, Building Code Requirements for Structural Concrete and Commentary.

2. American Petroleum Institute (API): Spec 5L, Specification for Line Pipe.

3. ASTM International (ASTM):

a. A36, Standard Specification for Carbon Structural Steel.

b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

c. A139, Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and Over).

d. A252, Standard Specification for Welded and Seamless Steel Pipe Piles.

e. A328, Standard Specification for Steel Sheet Piling.

f. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

g. A690, Standard Specification for High-Strength Low-Alloy Nickel, Copper, Phosphorus Steel H-Piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments.

h. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.

4. American Water Works Association (AWWA):

a. C200, Steel Water Pipe—6 in. (50 mm) and Larger.

5. American Welding Society (AWS):

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

1.04 SUBMITTALS

A. Provide qualifications of proposed sheet pile installer.

B. CONTRACTOR shall provide information from the manufacturer that indicates the sheet piling meets or exceeds the SPECIFICATIONS listed in this section.

C. CONTRACTOR shall submit verification from the manufacturer that the hammer can deliver the required energy.

D. Splice locations, if necessary, shall be reviewed and accepted by ENGINEER prior to installation.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Sheet piling installer shall have, as a minimum, three (3) successful past installations of sheet piling of comparable overall heights and sections and comparable penetration into soils similar to those found on the PROJECT.

PART 2 PRODUCTS

2.01 GENERAL

A. All steel sheet piling shall be new and unspliced material throughout, unless otherwise reviewed and accepted by ENGINEER.

B. Steel sheet piles and special fabricated shapes shall be of a design that ensures continuous interlock throughout the entire length when in place.

2.02 MATERIALS

A. Steel sheet piling shall meet the requirements of ASTM A328, (Grade 50).

B. Steel corners, tees, wyes, and crosses shall meet the requirements of ASTM A328 or ASTM A690.

C. Steel sheet piles required for the PROJECT shall be the type and weight shown on the DRAWINGS. Sheet piling shall be constructed with a weathering finish.

1. Additional length beyond those indicated on the DRAWINGS may be required to provide for trimming of tops of sheet piling.

D. The interlocks between steel sheet pile sections shall be configured such that the average width of the annular space between all contact points of the interlocks shall be a maximum of one-eighth (1/8) inch, as determined by ENGINEER.

E. Steel sheet piles and interlocks shall not have excessive kinks, camber or twist that would prevent the pile from reasonably free sliding to grade.

F. All fabricated connections shall be made with the use of angles or bent plates, as necessary, and shall be adequately welded or connected with high strength bolts as accepted by ENGINEER.

G. Handling Holes:

1. If handling holes are provided, they shall be two (2) standard two and nine-sixteenth (2-9/16) inch diameter handling holes located six (6) inches from one end.

2. The holes shall be plugged by welding a piece of steel over the hole prior to installing any riprap, backfill or drop structure cap.

3. The plated hole shall be watertight.

2.03 STORAGE AND HANDLING

1. Do not subject piles to damage by impact bending stresses in transporting to and storing piles onsite.

2. Store and handle piles such that corrosion protection coating will not be damaged.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin sheet pile installation until the earthwork in the area where the piles are to be driven has been completed to the extent that the grade elevation is at no more than twelve (12) inches above or below the top of the piling elevation as indicated on the DRAWINGS.

3.02 PREPARATION

A. Any fill along the alignment of the sheet pile must be in place to sub-grade elevations and compacted prior to driving the sheet pile.

B. Fill material (except riprap, boulders, bedding and grout) is not to be placed around the sheet pile after the sheet pile is in place.

3.03 INSTALLATION

A. General:

1. All welding or gas cutting shall be in accordance with the current standards of the American Welding Society.

2. Virtual Refusal:

   a. Steel sheet piling shall be driven to the depths shown on the DRAWINGS or to virtual refusal.

   b. Virtual refusal is defined as ten (10) blows per inch with an approved pile hammer.

   c. A pile hammer shall be used to determine virtual refusal.

   d. The hammer shall be operating at the manufacturer's recommended stroke and speed when virtual refusal is measured.

B. Sheet Piling Driving:

1. Steel sheet piling shall be assembled before driving and then driven as a continuous wall, progressively in stages to keep the piles aligned correctly and minimize the danger of breaking the interlock between the sheets.

2. Steel sheet piling shall be driven to form a tight bulkhead.

3. A driving head shall be used and any piling which is damaged in driving or which has broken interlocks between sections shall be pulled and replaced at CONTRACTOR's expense.

4. The piling shall be driven within the following tolerances:

   a. Alignment:

      1) Sheet pile shall be driven to form a relatively straight line between the termini points shown on the DRAWINGS.
      2) Horizontal deviation of any point from a straight line connecting the two ends of the wall section shall be a maximum of six (6) inches.

   b. Plumbness: Each individual sheet pile section shall be driven vertical, within a horizontal tolerance of two percent (2%) of any vertical length measured along the pile.

   c. Elevation:

      1) Tops of sheet pile sections shall be within a tolerance of one (1) inch from plan elevations.
      2) CONTRACTOR shall not be paid for excess sheet pile trimmed off the end of the pile to meet final grade.

C. CONTRACTOR shall brace and/or provide soil grading as necessary during construction operations in order to provide lateral stability for the sheet pile wall. The sheet pile wall has been designed for the soil grades of the final configuration denoted on the DRAWINGS only. Other temporary configurations during the construction period shall not be allowed.

D. Care shall be taken during driving to keep from causing deformations of the top of the piles, splitting of section, or breaking of the interlock between sections. Care shall

also be taken during driving to prevent and correct any tendency of steel sheet piles to twist or get out of plumb.

E. Steel Z piling shall be driven with the ball-end leading. Proper care and planning shall be used to allow for this construction procedure in both immediate and possible future walls.

F. Alternate Z piles shall be reversed end for end for proper interlocking in the “normal” position. Piles shall also be aligned properly to maintain a “normal” driving width.

G. For sheet piles driven into the native soils, pre-drilled soils, or excavated soils a vibratory driver may be used as long as the required depth is obtained.

H. For sheet piles being driven into bedrock, an approved hammer utilizing a minimum hammer energy of 19,000 foot-pounds per square inch of steel section shall be used to obtain the required depth or virtual refusal. The hammer shall be clearly marked so that it can be identified at the job site.

I. Steel sheet pile that is full length as shown on the DRAWINGS and is required to be driven below the specified cutoff elevation shall be spliced with additional steel sheet piling with a full penetration butt weld.

END OF SECTION

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SECTION 32 11 23

AGGREGATE BASE COURSE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The WORK to be performed includes the preparation of the aggregate base course foundation; and the production, stockpiling, hauling, placing, and compacting of aggregate base course.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.
2. Section 31 23 19, Dewatering.
3. Section 32 23 33, Trenching and Backfilling.
4. Section 31 37 19, Grouted Boulders, Stcked Grouted Boulders and Grouted Boulder Retaining Walls.
5. Section 31 62 16, Steel Sheet Piles.
6. Section 32 15 40, Crusher Fine Surfacing.
7. Section 32 16 00, Sidewalks, Curbs, and Gutters.
8. Section 33 05 13, Manholes.
9. Section 33 41 00, Reinforced Concrete Pipe.
10. Section 33 46 00, Subdrainage.

1.03 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. M147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
    b. T11, Standard Method of Test for Materials Finer Than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.
    c. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.

d. T89, Standard Specification for Determining the Liquid Limit of Soils.

e. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.

f. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

g. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.

h. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.

i. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.

j. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.

k. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. ASTM International (ASTM):

a. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).

d. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

e. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

f. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.04 SUBMITTALS

A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

C. CONTRACTOR shall submit tickets for each load of aggregate.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregates: Aggregates for bases shall be crushed stone, crushed slag, crushed gravel or natural gravel that conforms to the quality requirements of AASHTO M147, except that the requirements for the ratio for the minus No. 200 sieve fraction to the minus No. 40 sieve fraction shall not apply. The requirements for the Los Angeles wear test shall not apply to Class 1, 2, and 3. Aggregates for bases shall meet the grading requirements as called out in the DRAWINGS. The liquid limit shall be as shown in the table and the plasticity index shall be ≤6.

B. Gradations:

Standard US Sieve Size	**Percentage by Weight Passing Square-Mesh Sieves**						
	LL < 35			**LL < 30**			
	Class 1	**Class 2**	**Class 3**	**Class 4**	**Class 5**	**Class 6**	**Class 7**
4 inches	--	100	--	--	--	--	--
3 inches	--	95 - 100	--	--	--	--	--
2½inches	100	--	--	--	--	--	--
2 inches	95 - 100	--	--	100	--	--	--
1½inches	--	--	--	90 - 100	100	--	--
1 inch	--	--	--	--	95 - 100	--	100
¾ inch	--	--	--	50 - 90	--	100	--
No. 4	30 - 65	--	--	30 - 50	30 - 70	30 - 65	--
No. 8	--	--	--	--	--	25 - 55	20 - 85
No. 200	3 - 15	3 - 15	20 max.	3 - 12	3 - 15	3 - 12	5 - 15
Note: Class 3 materials shall consist of bank or pit run material.							

PART 3 EXECUTION

3.01 GENERAL

A. Equipment:

1. Equipment shall be capable of performing the WORK as described in this SPECIFICATION. Equipment that is inadequate to obtain the results specified shall be replaced or supplemented as required to meet the requirements of this SPECIFICATION. Any equipment that is used in an improper manner may be cause for rejection of the WORK if in the opinion of ENGINEER the WORK fails to meet the requirements of this SPECIFICATION.

2. Equipment used for compaction shall be the rolling type, vibratory type, or combination of both types, and shall be of sufficient capacity to meet the compaction requirements herein.

3.02 PREPARATION OF FOUNDATION

A. General:

1. The foundation shall be considered to be the finished earth subgrade, subbase course, or base course, as the case may be, upon which any subbase, base, or surface course is to be constructed.

2. Preparation of foundation for construction of a subbase, base, or surface course shall consist of the WORK necessary to restore, correct, strengthen, or prepare the foundation to a condition suitable for applying and supporting the intended course.

3. The foundation shall be prepared and constructed such that it will have a uniform density throughout. It shall be brought to the required alignment and cross section with equipment and methods adapted for the purpose. Upon completion of the shaping and compacting operations, the foundation shall be smooth, at the required density, and at the proper elevation and contour to receive the aggregate base course.

4. Unless otherwise provided, all holes, ruts, and other depressions in the foundation shall be filled with materials similar to those existing in the foundation. High places shall be excavated and removed to the required lines, grade and section.

5. Areas of yielding or unstable material shall be excavated and backfilled with stabilization rock as determined by ENGINEER. Base course material shall not be placed on a foundation that is soft, spongy, or one that is covered by ice or snow. Base course shall not be placed on a dry or dusty foundation where the existing condition would cause rapid dissipation of moisture from the base course material and hinder or preclude its proper compaction. Dry foundations shall have water applied, reworked, and compacted as necessary.

6. ENGINEER may direct CONTRACTOR to make minor adjustments in the finish grade from that shown in the DRAWINGS as may be necessary or desirable to maintain the characteristics of a stabilized foundation by minimizing the amount of cutting into or filling.

B. Roads and Parking Areas: For aggregate base course roads and parking areas, the top six (6) inches of topsoil shall be stripped within the area to be aggregate surfaced. Following stripping of the topsoil, the upper twelve (12) inches of the subgrade shall be scarified and compacted to a minimum of ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698). Onsite material may be used as accepted by ENGINEER, for compacted fill for the aggregate base course. Fill shall be placed within two percent (2%) of optimum moisture content and compacted to a minimum of ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698).

C. Pavements: Aggregate base course used as a foundation for pavements shall be placed on the subgrade within two percent (2%) of optimum moisture and compacted to a minimum of one hundred percent (100%) of the Maximum Modified Proctor Density (ASTM D1557). The top six (6) inches of topsoil shall be stripped within the area to be aggregate surfaced. Following stripping of the topsoil, the upper twelve

(12) inches of the subgrade shall be scarified and compacted to a minimum of ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698). Onsite material may be used, as accepted by ENGINEER, for compacted fill for the aggregate base course. Fill shall be placed within two percent (2%) of optimum moisture content and compacted to a minimum of ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698). Deviations in aggregate base course under pavements of more than one-quarter (1/4) inch in ten (10) feet, measured with a ten-foot (10') straight edge, shall be corrected prior to pavement construction.

D. Earth Subgrade: When the foundation is an earth subgrade it shall be prepared by removing all vegetation, excavating and removing materials, filling depressions, scarifying, shaping, smoothing and compacting to meet the required grade, section and density. Stones over six (6) inches in greatest dimension shall be removed.

3.03 PLACEMENT

A. The aggregate base course shall be constructed to the width and section shown in the DRAWINGS. If the required compacted depth of base course exceeds six (6) inches, the base shall be constructed in two (2) or more layers of approximate equal thickness. The maximum compacted thickness of any one (1) layer shall not exceed six (6) inches.

B. Each layer shall be constructed as far in advance of the succeeding layer as ENGINEER may direct. The WORK shall, in general, proceed from the point on the PROJECT nearest the point of supply of the aggregate in order that the hauling equipment may travel over the previously placed material, and the hauling equipment shall be routed as uniformly as possible over all portions of the previously constructed courses or layers of the base course.

C. The material shall be deposited on the soil foundation, or previously placed layer, in a manner to minimize segregation and to facilitate spreading to a uniform layer of the required section. In the event that blending of materials is necessary to provide required gradation and properties of the material, and is done in the roadway, the same shall be accomplished by mixing the aggregate and blending material by means of blade graders, discs, harrows, or other equipment to effect a uniform distribution and gradation throughout the finished mixture. Excessive mixing and grading that will cause segregation between the coarse and fine materials is prohibited.

3.04 COMPACTION

A. After a layer or course has been placed and spread to the required thickness, width and contour, it shall be compacted. If the material is too dry to readily attain the required density, it shall be uniformly moistened to the degree necessary during compaction operations for proper compaction.

B. Compaction of each layer shall continue until the required density specified in Article Preparation of Foundation is reached. The surface of each layer shall be maintained during compaction operations in such a manner that a uniform texture is produced and aggregates firmly keyed.

C. All areas where proper compaction is not obtainable due to segregation of materials, excess fines, or other deficiencies in the aggregate shall be reworked as necessary or

the material removed and replaced with aggregates that will meet this SPECIFICATION.

D. The surface of each layer shall be kept true and smooth at all times.

3.05 MIXING

A. Unless otherwise specified, CONTRACTOR shall mix the aggregate by any one of the three following methods:

1. Stationary Plant Method: Aggregate base course and water shall be mixed in an approved mixer. After mixing, the aggregate shall be transported to the PROJECT site while it contains the proper moisture content and shall be placed on the roadbed by means of an approved spreader.

2. Travel Plant Method: After the material for each layer has been placed through an aggregate spreader or windrow-sizing device, it shall be uniformly mixed by a traveling mixing plant.

3. Road Mix Method: After material for each layer has been placed, the materials shall be mixed while at optimum moisture content by motor graders or other approved equipment until the mixture is uniform throughout.

3.06 SHOULDER CONSTRUCTION

A. Shoulders shall be constructed with base course material to conform to the elevation and section shown in the DRAWINGS. No equipment shall be used which by its design or through its manner of operation will damage the pavement or curbs. Insofar as practicable, the base course material shall be placed directly on the shoulder area. Materials that are deposited outside the shoulder area, if not contaminated, shall be recovered and placed within the required limits. CONTRACTOR shall not be compensated for materials not recovered as determined by ENGINEER.

B. Materials shall not be deposited on the pavement or surfacing during placing unless specifically permitted by ENGINEER.

C. The base course material as placed shall be spread and compacted to the required density in layers not exceeding six (6) inches in compacted thickness. Any material inadvertently placed on the pavement shall be broomed from the pavement. The result shall not effect a change in the gradation of the shoulder material.

END OF SECTION

SECTION 32 15 40

CRUSHER FINES SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The WORK to be performed includes the preparation, stockpiling, hauling, placing, and compacting of crusher fines as indicated on the DRAWINGs and specified herein.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 32 11 23, Aggregate Base Course

1.03 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. M147, Standard Specification for Materials for Aggregate and Soil Aggregate Subbase, Base, and Surface Courses.

b. T11, Standard Method of Test for Materials Finer Than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.

c. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.

d. T89, Standard Specification for Determining the Liquid Limit of Soils.

e. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.

f. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

g. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.

h. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.

i. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.

j. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.

k. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. ASTM International (ASTM):

a. C136, Standard Test Method for Sieve Analysis of fine and Coarse Aggregates

b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).

d. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

e. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

f. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

g. D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

h. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

1.04 SUBMITTALS

A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

B. CONTRACTOR shall submit certification from the supplier certifying the crusher fines, or approved equal, meets the requirements of this Specification.

C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

D. CONTRACTOR shall submit samples and or shop drawings for the following

1. Aggregate strength

2. Aggregate color.

E. CONTRACTOR shall submit the manufacturer, Material Safety Data Sheet (MSDS), Name, Trade Name, trademark, and conformance to state law of all herbicides or other chemicals.

1.05 QUALITY ASSURANCE

A. Initial testing required to determine compliance with the requirements for the work of this section will be paid for by the OWNER. Should any tests fail, the Contractor shall pay for all further testing necessary in that area to achieve requirements.

B. General Warranty: The special warranty specified in this article shall not deprive the OWNER of other rights the OWNER may have under other provisions of the CONTRACT DOCUMENTS

C. Special Warranty: Submit a written warranty executed by INSTALLER agreeing to repair or replace components of crusher fines surface, or approved equal that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:

1. Premature wear and tear.

2. Failure of system to meet performance requirements.

D. Warranty Period: CONTRACTOR shall provide warranty for the performance of the product. CONTRACTOR shall warranty installation of product for the time of one year from completion and acceptance of the WORK by the OWNER or OWNERs representative.

PART 2 PRODUCTS

2.01 AGGREGATE BASE COURSE

A. Aggregate Base Course shall be furnished and installed as required and specified under Section 31 23 00, Earthwork and Trenching and Section 32 11 23 Aggregate Base Course to a minimum 6” compacted depth.

2.02 HERBICIDE

A. Herbicide shall be Casoron 4G granular weed and grass killer or approved equal.

2.03 CRUSHER FINES

A. **Aggregates:** Crushed stone shall consist of inert materials that are hard, durable, with stone free from surface coatings and deleterious materials.

B. R-value minimum of 70 determined by ASTM D 2488 Methodology (R-value is a measure of wear resistance).

C. **Sand equivalent:** - an engineering measurement of the proportion of sand to silt and clay will stay at a range of 30-55, as determined by ASTM D 2419 methodology.

D. **Gradations:**

1. Gradation shall meet the gradation below or approved equal as approved by ENGINEER.

Standard US Sieve Size	Percentage Passing by Weight
½ inch	100
⅜ inch	100
No. 4	65-80
No. 8	48-63
No. 16	40-49
No. 30	30-40
No. 50	20-27
No. 100	10-18
No. 200	10-12
Note: Materials shall consist of bank or pit run material.	

PART 3 EXECUTION

3.01 GENERAL

A. Equipment:

1. Equipment shall be capable of performing the WORK as described in this SPECIFICATION. Equipment that is inadequate to obtain the results specified shall be replaced or supplemented as required to meet the requirements of this SPECIFICATION. Any equipment that is used in an improper manner may be cause for rejection of the WORK if in the opinion of ENGINEER the WORK fails to meet the requirements of this SPECIFICATION.

2. Equipment used for compaction shall be the rolling type, vibratory type, or combination of both types, and shall be of sufficient capacity to meet the compaction requirements herein.

3.02 LAYOUT OF WORK

A. The Contractor shall stake or otherwise delineate the proposed alignment of the path according to the drawings. Obtain approval of the OWNER prior to proceeding with excavation and subgrade preparation.

B. Cut/fill bench for the crusher fines as shown on the drawings.

C. Cut existing grade to a minimum of seven (7) inches deep or as shown on the drawings within limits of paving. Wet and roll subgrade to obtain a firm, uniform, compacted subgrade. Keep cut sides vertical and true to line horizontally with a uniform width.

3.03 WEED CONTROL

A. Herbicide/Chemical Applications

1. Apply Casoron 4G granular weed and grass killer or approved equal to prepared subgrade per manufacturer's recommendations.

2. Apply Casoron 4G granular weed and grass killer at a rate of 250 - 300 pounds per acre. Apply approved equal at manufacturers recommended rate.

3. Herbicides or other chemicals shall be applied using well-maintained equipment by individuals working for CONTRACTOR who are properly licensed by any State and/or Federal Agency having jurisdiction over such applications. It shall be the responsibility of the CONTRACTOR to be knowledgeable of any and all current laws and regulations pertaining to herbicide and other chemical applications, and to notify OWNER or OWNERs Representative immediately if any request for herbicide or chemical applications by OWNER or OWNERs Representative is inappropriate as they pertain to these laws and regulations.

4. Herbicides or other chemicals shall not be applied during periods when wind or other physical conditions cause the herbicides or chemicals to be transported a distance of more than five (5) feet from the immediate area where they are being placed. It shall be the responsibility of the CONTRACTOR to stop WORK immediately and notify the OWNER or OWNERs Representative if any weather or other physical condition exists, which would make the application of herbicides or other chemicals inappropriate.

5. All herbicides or other chemicals used shall be applied at a rate and strength, and by the method recommended by the manufacturer of the product being used.

3.04 SUB-GRADE PREPARATION

A. Aggregate Base Course shall be a minimum of 3" thick compacted Class 6 Base Course as Specified in Section 32 11 23, installed at 95% relative compaction on top of subgrade.

B. Make any corrections necessary to base furnished and installed under Section 31 23 00, Earthwork and Trenching and Section 32 11 23 Aggregate Base Course to bring Class 6 Aggregate Base Course to the sections and elevations shown on the DRAWINGS.

C. Pre-soak Class 6 Aggregate Base Course with water prior to installing crusher fines or approved equal as needed to compact Class 6 aggregate base course.

D. Make sure proper drainage is available to ensure no standing water on the surface or adjacent to crusher fines including downspouts, when placed under roof overhang.

3.05 PLACEMENT AND COMPACTION

A. The CONTRACTOR is responsible for controlling placement of the material; no additional compensation will be made for material placement in excess of the specified thickness or width.

B. Do not install crusher fines material during rain or snow. Do not install crusher fines on sub-grade that has standing water.

C. If the required compacted depth of the crusher fines exceeds 6 inches (6"), place course in two or more layers of approximately equal thickness. The minimum thickness of any one layer shall be four inches (4").

D. Add water to ±2% wet of optimum moisture content. Use roller or mechanical hand tamper for compaction. Compact to 95% Standard Proctor Density (ASTM D698-70) to a uniform thickness.

1. Use plate compactor on edges and hard to get areas.

2. Loose material shall not be present on final surface.

E. Top of path shall be flush with adjacent grade. Remove any excess gravel on edges. Ensure that there are no low spots, high spots, or standing water on or adjacent to path.

3.06 SURFACE FINISHING

A. Use a smooth steel wheel roller for the final rolling of top surface of Crusher Fines. Water surface and evenly spread loose stones before final rolling. Make minimum of two complete passes over area to embed stones. Correct soft spots developed during rolling.

B. Compacted surface shall be smooth and free from waves and other irregularities. Unsatisfactory portions of base course shall be torn up, reworked, re-laid, and rerolled at no additional expense to the Owner.

3.07 INSPECTION

A. Finished surface shall be uniform and solid, with no evidence of chipping or cracking.

B. Compacted paving material shall be firm to the full depth of pavement with no soft areas.

C. Loose material shall not be present on the surface

D. No ruts shall be visible on the surface of the pavement.

E. Pavement sections that do not meet this specification, shall be repaired or replaced at the CONTRACTOR's expense.

3.08 REPAIRS

A. Excavate damaged area to depth of crusher fines paving material and square off sidewalls.

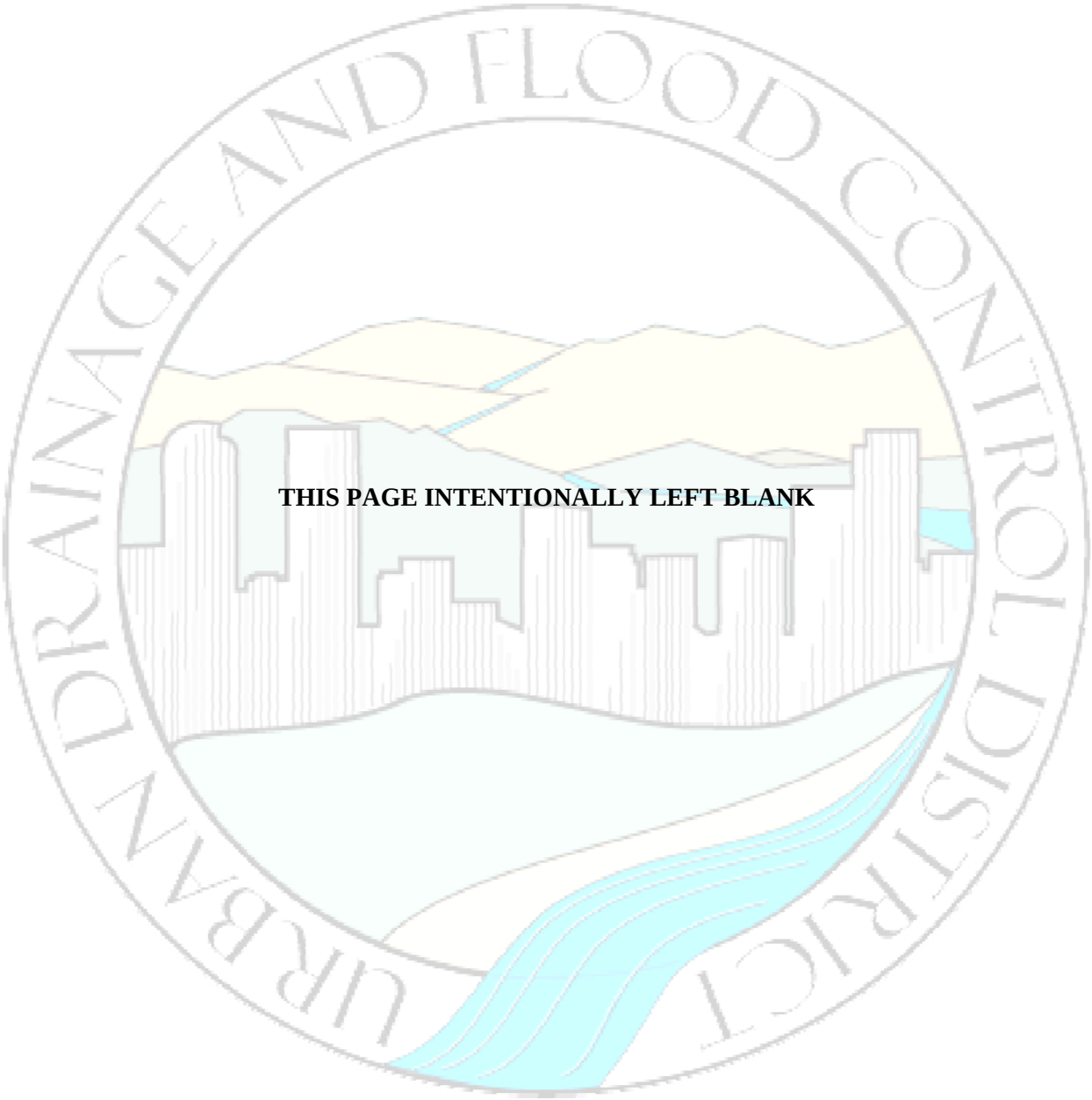
B. If area is dry, moisten damaged portion lightly and scarify.

C. Apply crusher fines to excavated area to finished grade.

D. Compact with an 8” to 10” hand tamp or 1000 lb. roller.

E. Repaired surface shall be smooth and free from waves and other irregularities. Unsatisfactory portions of base course shall be torn up, reworked, re-laid, and rerolled at no additional expense to the Owner.

END OF SECTION



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SECTION 32 15 41

STABILIZED CRUSHER FINES SURFACING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The WORK to be performed includes the preparation of the StaLok paving material or approved equal; and the production, stockpiling, hauling, placing, and compacting of StaLok material or approved equal as indicated on the DRAWINGs and specified herein.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 01 25 00, Substitution Procedures

2. Section 31 23 00, Excavation and Fill.

3. Section 32 11 23, Aggregate Base Course

1.03 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. M147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

b. T11, Standard Method of Test for Materials Finer Than 75µm (No. 200) Sieve in Mineral Aggregates by Washing.

c. T27, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.

d. T89, Standard Specification for Determining the Liquid Limit of Soils.

e. T90, Standard Specification for Determining the Plastic Limit and Plasticity Index of Soils.

f. T96, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

g. T99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in) Drop.

h. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 kg (10-lb) Rammer and a 457 mm (18-in) Drop.

i. T190, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.

j. T265, Standard Method of Test for Laboratory Determination of Moisture Content of Soils.

k. T310, Standard Specification for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

2. ASTM International (ASTM):

a. C136, Standard Test Method for Sieve Analysis of fine and Coarse Aggregates

b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3)).

c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3(2,700 kN-m/m3)).

d. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

e. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.

f. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

g. D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

h. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

1.04 SUBMITTALS

A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

B. CONTRACTOR shall submit sieve analysis of crusher fines aggregate.

C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

D. CONTRACTOR shall submit samples and or shop drawings for the following

1. Aggregate strength.

2. Aggregate color.

E. CONTRACTOR shall submit the following manufacturers information

1. Literature that explains color, performance and previous applications.

2. Specifications for paving material.

3. Installation specifications, instructions and directions

4. Performance specifications for material

5. Written Warranty

6. Written maintenance instructions

F. Construction Samples

1. CONTRACTOR shall construct mock-up panels or areas for each different type of paving system as specified herein to demonstrate ability to achieve types of setting bed, joints, pattern, color and texture required herein, unless mock-up panel construction is waived by the OWNER or OWNERs Representative.

2. CONTRACTOR shall construct a 12' x 24' sample of finished path, using StaLok Paving material or approved equivalent for approval by OWNER or OWNERS representative.

a. Schedule mock up construction for acceptance by OWNER or OWNERs Representative at least 30-days prior to application of paving surfaces represented by the mock up.

b. Locate mock – up panel(s) in areas as directed by OWNER or OWNERs representative.

c. Mock-ups will continue to be constructed at no cost to owner until mock up is accepted by OWNER or OWNERS representative.

d. Accepted mock – up will become standard for inspection and acceptance of future work based on:

1) Texture

2) Color

3) Workmanship

e. The same setting bed and joint mixes used in the accepted mock-up will be used in the final work unless otherwise directed by OWNER or OWNERs representative.

f. Protect accepted mock-up form damage until the completion and acceptance of the WORK by the OWNER or OWNERs representative.

g. Mock-up panel(s) will be removed from site at the completion of the project, unless otherwise directed by OWNER or OWNERs representative.

1.05 QUALITY ASSURANCE

A. INSTALLER Qualifications: INSTALLER must provide evidence to indicate successful experience in installation of StaLok Paving Material or approved equal or approval of the manufacturer.

B. INSTALLERs shall be pre-approved for installation and execution of this WORK by the OWNER or OWNERS Representative prior to installation.

1.06 QUALITY ASSURANCE

A. General Warranty: The special warranty specified in this article shall not deprive the OWNER of other rights the OWNER may have under other provisions of the CONTRACT DOCUMENTS

B. Special Warranty: Submit a written warranty executed by INSTALLER agreeing to repair or replace components of StaLok Paving Material, or approved equal, that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, the following:

1. Premature wear and tear, provided the material is maintained in accordance with the manufacturer's written maintenance instructions.

2. Failure of system to meet performance requirements.

C. Warranty Period: CONTRACTOR shall provide warranty for the performance of the product. CONTRACTOR shall warranty installation of product for the time of one year from completion and acceptance of the WORK by the OWNER or OWNERs representative.

D. CONTRACTOR shall provide, for a period of sixty days, unconditional maintenance and repairs as required by the OWNER or OWNER's representative after acceptance of the WORK by the OWNER or OWNERs Representative, provided the material is not damaged through the negligence of the OWNER and OWNER's Representatives.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. StaLok Paving Material is provided by the following manufacturer:

1. Stabilizer Solutions, Inc. 33 South 28th Street, Phoenix, AZ 85304; Phone: (602) 225-5900, 1(800) 336-2468; Fax: (602) 225-5902; Website: www.stabilizersolutions.com; Email: info@stabilizersolutions.com.

B. Alternative manufactures shall be approved by OWNER or OWNERs Representative.

2.02 STALOK AGGREGATE

A. **Aggregates:** Crushed stone shall consist of inert materials that are hard, durable, with stone free from surface coatings and deleterious materials.

B. **Gradations:**

U.S. Standard Sieve Size	Percentage Passing by Weight
½ inch	98-100
⅜ inch	90-100
No. 4	65-80
No. 8	48-63
No. 16	40-49
No. 30	30-40
No. 50	20-27
No. 100	10-18
No. 200	10-12

C. R-value minimum of 70 determined by ASTM D 2488 Methodology (R-value is a measure of wear resistance).

D. Sand equivalent: - an engineering measurement of the proportion of sand to silt and clay, will stay at a range of 30-55, as determined by ASTM d 2419 methodology.

2.03 AGGREGATE BASE COURSE

A. Dense graded crushed stone base shall be furnished and installed as required and specified under Section 31 23 00, Earthwork and Trenching and Section 32 11 23 Aggregate Base Course to a minimum 6" compacted depth.

2.04 HERBICIDE

A. Herbicide shall be Casoron 4G granular weed and grass killer or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. **Equipment:**

1. Equipment shall be capable of performing the WORK as described in this SPECIFICATION. Equipment that is inadequate to obtain the results specified shall be replaced or supplemented as required to meet the requirements of this SPECIFICATION. Any equipment that is used in an improper manner may be cause for rejection of the WORK if in the opinion

of ENGINEER the WORK fails to meet the requirements of this SPECIFICATION.

2. Equipment used for compaction shall be the rolling type, vibratory type, or combination of both types, and shall be of sufficient capacity to meet the compaction requirements herein.

3.02 LAYOUT OF WORK

A. The Contractor shall stake or otherwise delineate the proposed alignment of the path according to the drawings. Obtain approval of the OWNER prior to proceeding with excavation and subgrade preparation.

B. Cut/fill bench for the stabilized crusher fines as shown on the drawings.

C. Cut existing grade to a minimum of nine (9) inches deep or as shown on the drawings within limits of paving. Wet and roll subgrade to obtain a firm, uniform, compacted subgrade. Keep cut sides vertical and true to line horizontally with a uniform width.

3.03 WEED CONTROL

A. Herbicide/Chemical Applications

1. Apply Casoron 4G granular weed and grass killer or approved equal to prepared subgrade per manufacturer's recommendations. Contractor shall contact stabilized crusher fines manufacturer prior to placing herbicide to ensure compatibility of proposed herbicide with the StaLok or approved equal stabilized crusher fines material.

2. Apply Casoron 4G granular weed and grass killer at a rate of 250 - 300 pounds per acre. Apply approved equal at manufacturers recommended rate.

3. Herbicides or other chemicals shall be applied using well-maintained equipment by individuals working for CONTRACTOR who are properly licensed by any State and/or Federal Agency having jurisdiction over such applications. It shall be the responsibility of the CONTRACTOR to be knowledgeable of any and all current laws and regulations pertaining to herbicide and other chemical applications, and to notify OWNER or OWNERS Representative immediately if any request for herbicide or chemical applications by OWNER or OWNERs Representative is inappropriate as they pertain to these laws and regulations.

4. Herbicides or other chemicals shall not be applied during periods when wind or other physical conditions cause the herbicides or chemicals to be transported a distance of more than five (5) feet from the immediate area where they are being placed. It shall be the responsibility of the CONTRACTOR to stop WORK immediately and notify the OWNER or OWNERs Representative if any weather or other physical condition exists, which would make the application of herbicides or other chemicals inappropriate.

5. All herbicides or other chemicals used shall be applied at a rate and strength, and by the method recommended by the manufacturer of the product being used.

6. CONTRACTOR shall submit to ENGINEER the manufacturers, Material Safety Data Sheets (MSDS), Name, Trade Name , trademark, and conformance to state law of all herbicides or other chemicals.

3.04 SUB-GRADE PREPARATION

A. Base shall be a minimum of 6" thick compacted Class 6 Base Course as Specified in Section 32 11 23, installed at 95% standard compaction on top of subgrade.

B. Make any corrections necessary to base furnished and installed under Section 31 23 00, Earthwork and Trenching and Section 32 11 23 Aggregate Base Course to bring Class 6 Aggregate Base Course to the sections and elevations shown on the DRAWINGS.

C. Pre-soak Class 6 Aggregate Base Course with water prior to installing StaLok Paving Material or approved equal as need to compact Class 6 aggregate base course.

D. Make Sure Proper Drainage is available to ensure no standing water on the surface or adjacent to StaLok Paving Material or approved equal, including downspouts, when placed under roof overhang.

3.05 BLENDING

A. StaLok Paving Material is a solely owned patented process.

B. Blending Procedures for StaLok Paving Material are performed only by a licensed StaLok Paving Material blender and can only be sold through Licensed StaLok Paving Material dealers. It is a pre-blended bulk material.

C. Approved equal material shall be obtained from manufacturer pre-blended or blended on site per manufacturer's recommendations.

3.06 PLACEMENT AND COMPACTION

A. Consult manufacturer if installing on a slope.

B. Do not install pavement material during rain or snow. Do not install pavement on sub-grade that has standing water.

C. Do not place StaLok Pavement Material or approved equal at temperatures below 30^{o} F unless directed by OWNER or Owners representative with approval from manufacturer

D. StaLok Paver Material may form clods at temperatures less than 60^{o} F. Break up clods with machinery. Clods will break apart on their own if left in sun to warm.

E. Place StaLok Paving Material at a minimum 2", maximum 3" compacted depth. Using a Paver Box, Paver, Crawler Paver, Asphalt Paver, Drag Box Paver, Pavement

Profiler, Slip Form Paver, Pav-Saver Place Spreader or approved equal, Compact StaLok Paving Material.

1. Compaction can be achieved by a 5-ton double drum roller
2. Compact material making 8 – 10 passes
3. Use plate compactor on edges and hard to get areas.
4. Loose material shall not be present on final surface.

F. Approved equal pavement material shall be placed and compacted per the manufacturers recommendations.

3.07 WATERING

A. Water the area with a light spray following compaction. CONTRACTOR shall take care not to disturb the aggregate surface with the spray action.

3.08 INSPECTION

A. Finished surface shall be uniform and solid, with no evidence of chipping or cracking.

B. Compacted paving material shall be firm to the full depth of pavement with no soft areas.

C. Loose material shall not be present on the surface

D. No ruts shall be visible on the surface of the pavement.

E. Approved equal material shall be inspected by ENGINEER per the manufactures specifications.

F. Pavement sections that do not meet this specification, manufactures application methods, instructions, installation guidance, or specifications shall be repaired or replaced at the CONTRACTOR's expense.

3.09 MAINTENANCE

A. Remove debris, such as paper, grass clippings, leaves, dirt or other deleterious material by mechanically blowing or hand raking the surfaces needed.

B. Plowing programs required during winter months shall involve the use of a rubber baffle on the plow blade or wheels on the plow that maintain a 1/4” gap \between the blade and the paving surface.

3.10 REPAIRS

A. Excavate damaged area to depth of StaLok Paving Material, or approved equal, and square off sidewalls.

B. If area is dry, moisten damaged portion lightly and scarify.

C. Apply pre-blended StaLok Pavement Material, or approved equal, to excavated area to finished grade.

D. Compact with an 8” to 10” hand tamp or 1000 lb. roller.

END OF SECTION

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SECTION 32 16 00

SIDEWALKS, CURBS, AND GUTTER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete WORK shall consist of air entrained Portland cement constructed on a prepared subgrade in accordance with these SPECIFICATIONS. The completed WORK shall conform to the thicknesses and typical cross-sections shown on the DRAWINGS. The completed WORK shall conform to the lines and grades shown on the DRAWINGS or to those established by ENGINEER at the job site.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 19, Dewatering.

3. Section 31 23 33, Trenching and Backfilling.

1.03 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. M6, Standard Specification for Fine Aggregate for Hydraulics Cement Concrete.

b. M80, Standard Specification for Coarse Aggregate for Hydraulics Cement Concrete.

c. M148, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

d. M154, Standard Specification for Air-Entraining Admixtures for Concrete.

e. M171, Standard Specification for Sheet Materials for Curing Concrete.

f. M182, Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.

g. M194M/M194, Standard Specification for Chemical Admixtures for Concrete.

h. T22, Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens.

i. T23, Standard Method of Test for Making and Curing Concrete Test Specimens in the Field.

j. T26, Standard Method of Test for Quality of Water to Be Used in Concrete.

k. T27, Sieve Analysis of Fine and Coarse Aggregates

l. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

m. T11, Standard Method of Test for Clay Lumps and Friable Particles in Aggregate.

n. T119M/T119, Standard Method of Test for Slump of Hydraulic Cement Concrete.

o. T121M/T121, Standard Method of Test for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.

p. T141, Standard Method of Test for Sampling Freshly Mixed Concrete.

q. T152, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.

r. T176, Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.

s. T199, Standard Method of Test for Air Content of Freshly Mixed Concrete by the Chace Indicator.

2. ASTM International (ASTM):

a. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

b. C920, Standard Specification for Elastomeric Joint Sealants.

3. Colorado Department of Transportation (CDOT):

a. Section 703.01, Fine Aggregate for Concrete.

b. CP30, Sampling of Aggregates.

c. CP31A, Sieve Analysis of Fine and Coarse Aggregates.

d. CP60, Determining Surface Moisture in Fine and Coarse Aggregates.

1.04 SUBMITTALS

A. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

C. Contractor shall submit mix design for concrete in writing to ENGINEER for approval prior to placement of concrete.

D. CONTRACTOR shall submit batch tickets for each load of concrete. Tickets shall show weight of all materials and additives used in each batch.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete Conformance:

1. Concrete shall conform to the following requirements:

Concrete Requirements	
28-Day Field Compressive Strength	3,500 psi
Cement/Fly Ash	600 lbs./cu. yd.
Max. Water/Cement Ratio	0.53
Air Content % Range	5-8
Maximum Slump	4"
Fine Aggregate (max. % of total Aggregate)	50%

2. This material shall consist of a mixture of coarse and fine aggregates, Portland cement, water and other materials or admixtures as required. The type of cement shall be Type I, II, or I/II unless sulfate conditions dictate otherwise. If sulfate conditions exist, Type V cement shall be used.

B. Concrete Aggregates: The grading and composition requirements for coarse and fine aggregates for concrete shall conform to the following tables.

Coarse Aggregates for Portland Cement Concrete	
Sieve Size or Test Procedure	**% Passing or Test Requirement**
1 inch	100
¾ inch	90-100
⅜ inch	20-55
No. 4	0-10
No. 8	0-5
% Wear	45, Max
Clay Lumps * Friable Particles, %	2.0, Max
Coal & Lignites, %	0.5, Max
Sodium Sulfate Soundness %	12, Max

Fine Aggregates for Portland Cement Concrete	
Sieve Size or Test Procedure	**% Passing or Test Requirement**
⅜ inch	100
No. 4	95 - 100
No. 16	45 - 80
No. 50	10 - 30
No. 100	2 - 10
No. 200	3, Max
Friable Particles, %	1.0, Max
Coal & Lignite, %	1.0, Max
Deleterious Material (AASHTO T112),%	3, Max
Sand Equivalent (AASHTO T176),%	80, Min
Fineness Modules	2.50 - 3.50
Sodium Sulfate Soundness, %	20.0, Max

C. Coarse Aggregate for Concrete: Coarse aggregates shall conform to the requirements of AASHTO M80, except that the percentage of wear shall not exceed forty-five (45) when tested in accordance with AASHTO T96. Coarse aggregate shall conform to the grading in above table.

D. Fine Aggregate for Concrete: Fine aggregates shall meet Colorado Department of Transportation, Section 703.01 requirements and gradation as shown above. Fine aggregate for concrete shall conform to the requirements of AASHTO M6. The amount of deleterious substances removable by elutriation shall not exceed three percent (3%) by dry weight of fine aggregate when tested in accordance with AASHTO T11, unless otherwise specified. The minimum Sand Equivalent, as tested in accordance with AASHTO T176 shall be eighty (80), unless otherwise specified. The Fineness Modules shall not be less than two and five-tenths (2.50) nor greater than three and five-tenths (3.50), unless otherwise approved.

E. Fly Ash and Water: Upon approval based on a satisfactory trial mix, CONTRACTOR shall have the option of substituting approved fly ash for Portland cement, up to a maximum of twenty percent (20%) by weight. The total weight of cement and fly ash shall not be less than the specified mix design.

1. Fly ash for concrete shall conform to the requirements of ASTM C618, Class C or Class F. All chemical requirements of ASTM C618 Table 1-A shall apply with the exception of footnote A.

    a. Class C fly ash will not be permitted where sulfate resistant cement is required.

    b. CONTRACTOR shall submit certified laboratory test results for the fly ash. Test results that do not meet the physical and chemical requirements may

result in the suspension of the use of fly ash until the corrections necessary have been taken to ensure that the material meets the SPECIFICATIONS.

2. Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substance injurious to the finished product. Water shall be tested in accordance with, and shall meet the suggested requirements of AASHTO T26. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be enclosed so as to exclude silt, mud, grass, or other foreign materials.

F. Concrete Curing Materials and Admixtures:

1. Curing Materials: Curing materials shall conform to the following requirements as specified:

a. Burlap Cloth made from Jute or Kenaf: AASHTO M182.

b. Liquid Membrane-Forming Compounds Curing Concrete: AASHTO M148.

c. Sheet Materials for Curing Concrete: AASHTO M171.

d. Straw shall not be used for curing unless approved by ENGINEER.

2. Air-Entraining Admixture: Air-entraining admixtures shall conform to the requirements of AASHTO M154. Admixtures which have been frozen will be rejected. No chloride containing additives shall be permitted.

3. Chemical Admixtures: Chemical admixtures for concrete shall conform to the requirements of AASHTO M194M/M194. Admixtures which have been frozen will be rejected.

4. Joint Fillers: The joint fillers shall meet the requirements of ASTM C920.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. The subgrade shall be excavated or filled to the required grades and lines. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with suitable material with ENGINEER's approval. Filled sections shall be compacted and compaction shall extend a minimum of six (6) inches outside the form lines.

B. The moisture content of the subgrade shall be brought within +/- two percent (2%) of optimum moisture content and compacted to ninety-five percent (95%) of the maximum standard Proctor density (ASTM D698) for subgrade materials classified as A-4 through A-7 or ninety five percent (95%) of modified proctor density for materials classified as A-1 through A-3.

3.02 CONCRETE PLACEMENT

A. General:

1. Concrete transported in truck mixers or truck agitators shall be delivered to the site of the WORK and completely discharged within a period of ninety (90) minutes after the cement comes in contact with the mixing water or with the combined aggregates containing free moisture in excess of two percent (2%) by weight.

2. The concrete shall be placed either by an approved slip form/extrusion machine, by the formed method, or by a combination of these methods.

3. The subgrade shall be conditioned to provide a uniformly moist surface when concrete is placed.

B. Machine Placement: The slip form/extrusion machine shall be so designed to place, spread, consolidate, screed, and finish the concrete in one (1) complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogenous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

C. Formed Method:

1. The vertical face of previously sawed and adjacent asphalt pavement may NOT be used as a forming surface. CONTRACTOR shall use forms on front and back of all curb and gutter, sidewalks and crosspans.

2. The forms shall be of metal or other suitable material that is straight and free from warp, having sufficient strength to resist the pressure of the concrete without displacement and sufficient tightness to prevent the leakage of mortar. Flexible or rigid forms of proper curvature may be used for curves having a radius of one hundred (100) feet or less. Division plates shall be metal. Where directed by ENGINEER, CONTRACTOR shall use a thin metal back form to preserve landscaping, sprinklers, etc. Form shall be straight and rigid and shall be approved by ENGINEER prior to use on PROJECT.

3. The front and back forms shall extend for the full depth of the concrete. All of the forms shall be braced and staked so that they remain in both horizontal and vertical alignment until their removal. No wooden stakes will be allowed. They shall be cleaned and coated with an approved form-release agent before concrete is placed against them. The concrete shall be deposited into the forms without segregation and then it shall be tamped and spaded or mechanically vibrated for thorough consolidation. Low roll or mountable curbs may be formed without the use of a face form by using a straight edge and template to form the curb face. When used, face forms shall be removed as soon as possible to permit finishing. Front and back forms shall be removed without damage to the concrete after it has set.

4. Should the removal of adjacent asphalt pavement be required beyond that shown in the asphalt patch detail to properly correct failed concrete sections, CONTRACTOR shall remove and replace said asphalt pavement to such an extent as to provide a smooth repair. ENGINEER shall be notified prior to commencing any additional asphalt removal.

3.03 FINISHING

A. The plastic concrete shall be finished smooth by means of a wood float and then it shall be given final surface texture using a light broom or burlap drag. Concrete that is adjacent to forms and formed joints shall be edged with a suitable edging tool to the dimensions shown on the DRAWINGS.

3.04 JOINTING

A. Contraction Joints:

1. Contraction and construction joints shall be placed at the standard spacing of ten (10) feet in curb, gutter, sidewalks, crosspans, trickle channel, etc. A minimum spacing of five (5) feet shall be allowed for repairs.

2. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals not exceeding ten (10) feet for curb and gutter or five (5) feet for sidewalk. Joint depth shall average at least one-fourth (1/4) of the cross-section of the concrete.

3. Contraction joints may be sawed, hand-formed, or made by one-eighth inch (1/8") thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be hand-formed either by (1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete, or (2) inserting one-eighth inch (1/8") thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete. Where division plates are used to make contraction joints, the plates shall be removed after the concrete has set and while the forms are still in place.

B. Expansion Joints:

1. Expansion joints shall be constructed at right angles to the curb line at immovable structures and at points of curvature for short radius curves. Filler material for expansion joints shall conform to requirements of the requirements of ASTM C920 and shall be furnished in a single one-half inch (1/2") thick piece for the full depth and width of the joint.

2. Expansion joints in a slip-formed curb or curb-and-gutter shall be constructed with an appropriate hand tool by raking or sawing through partially set concrete for the full depth and width of the section. The cut shall be only wide enough to permit a snug fit for the joint filler. After the filler is placed, open areas adjacent to the filler shall be filled with concrete and then troweled and edged. CONTRACTOR may choose to place the filler and pour the concrete around it.

3. Alternately, an expansion joint may be installed by removing a short section of freshly extruded curb-and-gutter immediately, installing temporary holding

forms, placing the expansion joint filler, and replacing and reconsolidating the concrete that was removed. Contaminated concrete shall be discarded.

4. Construction joints may be either butt or expansion-type joints. Curbs or combined curbs-and-gutters constructed adjacent to existing concrete shall have the same type of joints as in the existing concrete, with similar spacing; however, contraction joint spacing shall not exceed ten (10) feet.

3.05 PROTECTION

A. CONTRACTOR shall always have materials available to protect the surface of the plastic concrete against rain. These materials shall consist of waterproof paper or plastic sheeting. For slip-form construction, materials such as wood planks or forms to protect the edges shall also be required. Concrete damaged by rain shall be required to be removed and replaced at CONTRACTOR's expense.

B. Concrete being placed in cold weather during which the temperature may be expected to drop below thirty-five degrees Fahrenheit (35°F), shall be suitably protected to keep the concrete from freezing until it is at least ten (10) days old. Concrete injured by frost action shall be required to be removed and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall be responsible for correcting any vandalism or defacement (graffiti) that occurs on the concrete prior to final acceptance.

3.06 CURING

A. Concrete shall be cured for at least seven (7) days after placement to protect against loss of moisture, rapid temperature change, and mechanical injury prior to any overlay or reconstruction work. Moist burlap, waterproof paper, white polyethylene sheeting, white liquid membrane compound, or a combination thereof may be used as the curing material. Membrane curing shall not be permitted in frost-affected areas when the concrete will be exposed to deicing chemicals within thirty (30) days after completion of the curing period.

3.07 BACKFILLING

A. The spaces in front and back of curbs shall be refilled with suitable material to the required elevations after the concrete has set sufficiently. The fill material shall be thoroughly tamped in layers.

3.08 SEALING

A. Where required, concrete shall be sealed with a mixture of one-half (1/2) linseed oil and one-half (1/2) diesel fuel, unless otherwise specified by ENGINEER.

3.09 TOLERANCE

A. Forms shall not deviate from true line by more than one-quarter (1/4) inch at any point.

B. Mixed concrete shall be not less than fifty degrees Fahrenheit (50°F), nor more than eighty degrees Fahrenheit (80°F) at the time of placement in forms, unless otherwise directed.

C. If air temperature is thirty-five degrees Fahrenheit (35°F) or less at the time of placing, ENGINEER shall require water and/or aggregate heated to not less than seventy degrees Fahrenheit (70°F), or more than one-hundred fifty degrees Fahrenheit (150°F).

D. Finished joints shall not deviate more than one-quarter (1/4) inch in the horizontal alignment from a straight line.

E. Any localized humps and or depressions greater than one-quarter (1/4) inch shall require removal and replacement of the WORK in question at CONTRACTORS expense

F. No ponding of water greater than three-eighths (3/8) inch shall be allowed.

G. Combination curb, gutter and walk and/or vertical curb and gutter flowline depth shall not vary from adopted standards by more than +/- one-half (1/2) inch, measured vertically from the top of curb to the gutter invert.

H. Pedestrian walks shall have a minimum of two percent (2.0%) and a maximum of two and one half percent (2.5%) slope toward the roadway.

I. Heave or settlement of sidewalk, relative to separate curb pour, greater than one-half (1/2) inch shall be cause for corrective action. This provision shall not apply to transverse sidewalk joints.

3.10 QUALITY CONTROL

A. Testing: Concrete testing and testing laboratory services required shall conform to the following unless otherwise determined by ENGINEER.

Section Type of Test	**Project Acceptance Frequency**	**Point of Sampling Acceptance**	**Procedures**	
			Test Sampling	**Project Testing**
Sidewalks (Concrete Aggregate Gradation)	1/1000 square yards or fraction thereof for each size aggregate of concrete placed	Stockpile, Belt or Bin	CDOT CP30	CDOT CP31A
Curbing (Concrete Aggregate Gradation)	1/2000 lineal feet or fraction thereof for each size aggregate of concrete placed		CDOT CP30	CDOT CP31A
Moisture Content (Fine Aggregate)	1 per day and as often as needed for quality control		CDOT CP30	CDOT CP60

Section Type of Test	Project Acceptance Frequency	Point of Sampling Acceptance	Procedures	
			Test Sampling	Project Testing
Moisture Content (Coarse Aggregate)	1 per day min. where moisture content is greater than +0.5% from SSD condition	Stockpile, Belt or Bin	CDOT CP30	CDOT CP60
Slump	1 set of tests for every 1000 square yards or fraction thereof of concrete placed per a day	The slump, air content, unit weight and compressive strength tests shall be carried out on the first truck of concrete for the daily placement and thereafter in conformance with this table by sampling from the mixer discharge or pumper truck discharge hose	AASHTO T141	AASHTO T119M/ T119
Air Content	1 set of tests for every 1000 square yards or fraction thereof of concrete placed per a day		AASHTO T141 T199	AASHTO T152
Yield and Cement	4 tests for every 2000 lineal feet or fraction thereof of concrete placed per a day		AASHTO T141	AASHTO T121M/ T121
Compressive (Sidewalks)	1 set (4) of cylinders per 1000 square yards or fraction thereof of concrete placed per day		AASHTO T141 T23	AASHTO T22
Compressive (Curbing)	1 set (4) of cylinders per 2000 lineal feet or fraction thereof of concrete placed per day		AASHTO T141 T23	AASHTO T22

B. Repair:

1. Prior to backfilling and after forms are removed, honeycombed, defective or damaged areas of concrete shall be repaired. Repairs shall be made within seven (7) days after the forms are removed.

2. At the time of final acceptance inspection, the repair of all cracks shall be completed.

   a. Cracks that are less than one-quarter (1/4) inch wide, exhibit no horizontal or vertical shifting, and do not meet the conditions in 2, 3, and 4, below may, at the discretion of the OWNER, be sealed by routing approximately three-quarter (3/4) inch to one (1) inch deep by one-quarter (1/4) inch wide and filling with Sikaflex 1-A or equivalent.

   b. Any crack that extends through a joint shall require removal and replacement of the entire cracked area.

   c. Any longitudinal cracked section of concrete shall require complete removal and replacement of that section between joints.

d. Repair action for hairline cracks as determined in 1, above, may be waived at the discretion of OWNER. For the purpose of this section, a hairline crack is one that is reasonably immeasurable and without separation as determined by ENGINEER.

3.11 CLEAN-UP

A. The surface of the concrete shall be thoroughly cleaned upon completion of the WORK and prior to the substantial completion walk through, and the site left in a neat and orderly condition.

END OF SECTION

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SECTION 32 31 00

FENCES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section shall consist of furnishing and installing new fence and/or removing and salvaging existing fence and restoring the same in conformance with the lines and grades and requirements shown on the DRAWINGS. Wherever the materials to be removed are not in good condition, as judged by the ENGINEER, or wherever CONTRACTOR has damaged the materials during the process of removal, equal or better quality fencing materials than the existing shall be furnished and installed by CONTRACTOR.

1.02 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. M111M/M111, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

   b. M133, Standard Specification for Preservatives and Pressure Treatment Processes for Timber.

   c. M181, Standard Specification for Chain-Link Fence.

   d. M232M/M232, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

   e. M281, Standard Specification for Steel Fence Posts and Assemblies, Hot-Wrought.

2. ASTM International (ASTM):

   a. A116, Standard Specification for Metallic-Coated, Steel-Woven Wire Fence Fabric.

   b. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.

   c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.

   d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.

   e. B211, Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire.

f. F537, Standard Specification for Design, Fabrication, and Installation of Fences Constructed of Wood and Related Materials.

3. Federal Specification (FED): FCGS-02-1, Fencing, Wire and Post, Metal (Chain-link Fence Posts, Top Rails and Braces).

PART 2 PRODUCTS

2.01 MATERIALS

A. Timber: All timber materials for new fencing shall be No. 1 grade cedar.

B. Barbed Wire: Steel barbed wire shall conform to the requirements of ASTM A121 Class I. Aluminum barbed wire shall be manufactured in accordance with ASTM B211 with alloy 5052-O for the line wire and alloy 5052-H38 for the barbs.

C. Woven Wire: Woven wire shall conform to the details and requirements shown on the DRAWINGS and to the following:

1. Zinc-coated steel woven wire shall conform to the requirements of ASTM A116, coating Class I.

2. Aluminum-coated steel woven wire shall conform to the requirements of ASTM A116, coating Class I.

3. Fittings and attachments shall be zinc coated to conform to the requirements of AASHTO M232M/M232.

D. Chain Link Fabric: Chain link fabric and required fittings and hardware shall conform to the requirements of AASHTO M181 for the kind of metal, sizes of wire and mesh specified. Zinc coating for steel fabric shall conform to ASTM A392, Class I and aluminum coating for steel fabric to ASTM A491, Class I.

E. Snow Fence: Wire-bound picket fence shall conform to the requirements of ASTM F537. Posts shall conform to the requirements of AASHTO M281.

F. Construction Fence: Construction fence shall be bright orange woven plastic mesh, four feet (4') minimum in height.

G. Fence Posts:

1. Wood posts shall conform to the details and dimensions indicated on the DRAWINGS. Wood posts shall be straight, sound, and seasoned with ends sawed off square or as indicated. All knots shall be trimmed flush with the surface. Wood posts shall be peeled and treated with preservative in accordance with AASHTO M133. When native cedar posts are called for on the DRAWINGS, the requirements for peeling and for treating may be omitted.

2. All dimension timber and lumber required for fences or gates shall be sound, straight, and free from knots, splits, and shakes. It shall be of the species and grades indicated on the DRAWINGS.

3. Concrete posts shall be made of concrete of the class specified, and shall contain steel reinforcement as shown on the DRAWINGS.

4. Steel posts shall be galvanized in accordance with AASHTO M111M/M111. Fittings, hardware, and other appurtenances not specifically covered by the DRAWINGS and SPECIFICATIONS shall be standard commercial grade, and in accordance with current standard practice. Pipe material for fence posts shall conform to the requirements shown on the DRAWINGS and to the requirements of Class 1 Pipe, Grade A or Grade B, of FED FCGS-02-01.

5. Construction fence posts shall be studded steel tee posts.

H. Nails: All nails used for construction shall be galvanized.

PART 3 EXECUTION

3.01 REMOVAL OF EXISTING FENCE

A. All rails, braces, posts, and the like shall be removed and disposed of or salvaged by CONTRACTOR to allow construction of the PROJECT as described on the DRAWINGS.

3.02 CONSTRUCTION OR REPLACEMENT OF FENCE

A. General:

1. CONTRACTOR shall perform such clearing and grubbing as may be necessary to construct or replace the fence to the required grade and alignment as shown on the DRAWINGS.

2. At locations where breaks in a run of fencing are required, appropriate adjustments in fence alignment and/or post spacing shall be made to satisfy requirements or conditions encountered.

B. Posts and Rails: Posts shall be securely embedded into the ground to meet the proper alignment and elevations. Posts shall be embedded in concrete as shown on the DRAWINGS. Posts and rails shall be held in proper positions by secure bracing until such time as the concrete has set sufficiently to hold the posts. Materials shall not be installed on posts, or stress placed on bracing until the concrete has set sufficiently to withstand the stress. The complete fence shall be plumb and in straight alignment as shown on the DRAWINGS or as directed by ENGINEER.

C. Construction Fence: Construction fence posts shall be installed at ten (10) feet on center and the plastic mesh shall be attached to each post at top, bottom, and center using plastic ties. A twelve and one-half (12-1/2) gage wire strand shall be installed along the top and bottom of the fence for added stability. The plastic mesh shall be attached to the top and bottom strand wires in three (3) equally spaced locations between each post using plastic ties. Construction fence shall be installed along the limits of disturbance. Construction fence shall remain in place and be repaired as necessary throughout construction.

END OF SECTION

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SECTION 32 34 00

PEDESTRIAN AND LIGHT VEHICLE BRIDGES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section contains requirements for a fully engineered clear span bridge and shall be the minimum standards for design and construction. Clear span length and width of the bridge shall be as shown on the DRAWINGS.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 00, Excavation and Fill.

2. Section 31 23 19, Dewatering.

3. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC).

2. ASTM International (ASTM):

a. A36/A36M, Standard Specification for Carbon Structural Steel.

b. A242, Standard Specification for High-Strength Low-Alloy Structural Steel.

c. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

d. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

e. A490, Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.

f. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance.

g. A606, Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance.

3. American Wood Preservers' Association (AWPA): P5, Standard for Waterborne Preservatives.

4. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code – Steel.

5. The Society for Protective Coatings (SSPC): SP6, Commercial Blast Cleaning.

6. Uniform Building Code (UBC).

7. West Coast Lumber Inspection Bureau (WCLIB).

1.04 SUBMITTALS

A. Submit complete SHOP DRAWINGS to ENGINEER for review.

B. Submit manufacturer's certification of compliance with referenced standards.

1.05 QUALITY ASSURANCE

A. Bridge design shall be signed and sealed by a Registered Colorado Professional Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery requirements with manufacturer.

B. Comply with manufacturer's requirements for unloading, lifting, and placement.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Continental Bridges; 1-800-328-2047.

2. Big 'R' Manufacturing; 1-800-234-0734.

3. Excel Bridges; 1-800-548-0054.

4. Bridge America; 1-320-763-5600.

5. Steadfast Bridges; 1-800-749-7515.

2.02 DESIGN REQUIREMENTS

A. General:

1. Bridge shall meet the referenced standards as called for in the following paragraphs.

2. All allowable design stresses shall be in compliance with the SPECIFICATIONS of the design, fabrication, and erection of structural steel for

buildings by the American Institute of Steel Construction (AISC) and Uniform Building Code (UBC).

3. Minimum height of fifty four (54) inches (top of truss top chord), or as shown on the DRAWINGS.

4. Maximum horizontal opening in railing of nine inches or as shown on the DRAWINGS.

5. Unless otherwise shown on the DRAWINGS, the minimum loading shall be as follows:

   a. Uniform live load of sixty pounds per square foot (60 psf).

   b. Concentrated live load of ten thousand (10,000) pounds vehicle weight on bridge plus thirty percent (30%) impact.

   c. Minimum wind load of twenty-five (25) pounds per square foot (psf).

   d. Horizontal pressure as if enclosed surface.

   e. Railing load of fifty pounds per linear foot (50 lbs/lf) of horizontal load.

6. Mounting plates shall allow for thermal expansion.

B. Dimensions and Requirements:

1. Length: As shown on DRAWINGS.

2. Width: Clear unobstructed inside width as shown on DRAWINGS.

3. Railings: Install for full length of bridge.

4. Camber: Five percent (5%) of one-half (1/2) of span (if required) or as shown on the DRAWINGS.

5. Abutments: Bridge to accommodate abutment elevations noted on the DRAWINGS.

6. Decking: All decking shall be secured to the bridge members along the centerline of the bridge with a minimum of two (2) screws per board or as shown on the DRAWINGS.

7. Rub Rails: Nominal two-inch by six-inch (2" x 6") wood rub rails on inside of bridge shall be placed thirty two (32) inches above the top of the bridge deck or as shown on the DRAWINGS.

C. Materials:

1. Metal Fabrication:

   a. Material thickness and design of member shall be fully engineered for the length and style of each bridge requirement specified.

b. Bridge shall be fabricated from high strength low-alloy atmospheric corrosion-resistance ASTM A606 Type 4 steel, self-weathering, (U.S.S. Cor Ten) ASTM A242, or ASTM A588/A588M structural steel shapes and tubing (FY = fifty thousand pounds per square inch [50,000 psi]).

c. Bolts and nuts shall be in accordance with SPECIFICATIONS for structural joints using ASTM A325 or ASTM A490 bolts. Anchor bolts shall be ASTM A307 or ASTM A36/A36M.

d. E8018 Series electrodes or equivalent shall be used for welding.

2. Wood Decking: All standard bridges shall have nominal three-inch by twelve-inch (3" x 12") planks of west coast region Douglas Fir or No. 1 Southern Yellow Pine, selected structural planks graded according to WCLIB standard grading or equal. Decking shall be treated to AWPA P5 or equal. Preservatives utilized shall be Chromated Copper Arsenate (CCA) or Ammoniacal Copper Arsenate (ACA) or equal.

3. Concrete Decking: As shown on the DRAWINGS.

2.03 FABRICATION

A. Workmanship, fabrication, and shop connections shall be in accordance with AWS and AISC specifications.

B. All welding shall be done by welders certified for AWS D1.1/D1.1M structural welding requirements.

C. Welding electrodes for self-weathering, corrosion-resistant steel shall have the same weathering characteristics as E5018 or equivalent.

D. All boldly exposed members shall have mill scale removed according to SSPC SP6.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install bridge and decking per manufacturer’s recommendations. Wood decking shall be “rattle proof” and installed to the greatest extent possible to prevent warping. Confirm that concrete abutments have obtained sufficient strength before placement of steel structure.

END OF SECTION

SECTION 32 80 00

IRRIGATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, materials, supplies, equipment, tools and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the irrigation system, the guarantee/warranty, the installation details, and as specified herein. This shall include repair to existing landscape irrigation systems for all areas disturbed by construction. Complete coverage of all turf areas and irrigation of all planting areas shall be performed using equipment similar to that existing onsite. Items of WORK specifically included are:

1. Procuring all applicable licenses, permits, and fees.

2. Inspecting WORK site prior to construction and ascertaining utility locations.

3. Installing irrigation system, including pumps, filters, sleeving, and other appurtenances.

4. Connecting electrical power supply to the irrigation control system.

5. Maintaining system until final acceptance.

1.02 GENERAL

A. CONTRACTOR shall make an inspection of the PROJECT site where the WORK is to be performed and become aware of the ground structure and obstacles which may be encountered and all other relevant matters in connection with the WORK prior to the submitting a BID(s).

B. CONTRACTOR is expected to base the BID on equipment and materials consistent with the existing irrigation system and in the event there are materials and/or equipment in the BID which do not conform with these specified by OWNER, CONTRACTOR shall be responsible for furnishing such materials and/or equipment which meet such qualifications at no change in the BID price.

C. Substitutions are not encouraged and as a general rule will not be allowed. Substitutions will only be considered following BID award.

D. Precautions have been taken to ensure accuracy and conformance of the CONTRACT DOCUMENTS with the design concept of the PROJECT. Nevertheless, CONTRACTOR shall be responsible for confirming and correlating actual job site dimensions, for acquiring information that pertains solely to the fabrication process or to techniques of construction, and for coordinating the WORK with all other trades.

E. Beginning WORK of this section implies acceptance of existing conditions. There shall be no extra compensation by reason of any matter or thing concerning conditions about which CONTRACTOR may be informed prior to bidding.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. International Association of Plumbing and Mechanical Officials (IAPMO).

2. National Electrical Code (NEC).

3. Underwriters Laboratories, Inc. (UL).

4. Uniform Plumbing Code (UPC).

1.04 SUBMITTALS

A. Materials List: Include pipe, fittings, mainline components, water emission components, and control system components. Quantities of materials need not be included.

B. Manufacturer's Data: Submit manufacturer's catalog cuts, specifications, and operating instructions for equipment shown on the materials list.

1.05 DELIVERY, STORAGE, AND HANDLING

A. CONTRACTOR shall exercise care in handling, loading, and unloading the pipe and fittings. Pipe shall be stored in accordance with the manufacturer's recommendations regarding skids, blocking, etc. to prevent damage to the pipe.

1.06 GUARANTEE AND REPLACEMENT

A. The purpose of this guarantee/warranty is to ensure that OWNER receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.

1. For a period of one (1) year from the date of final completion and commencement of the formal maintenance period, guarantee/warranty irrigation materials, equipment and workmanship against defects. Fill and repair depressions. Restore landscape or structural features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by a defective item. Make repairs within three (3) days of notification from ENGINEER.

2. CONTRACT DOCUMENTS govern replacements the same as new WORK. Make replacements at no cost in CONTRACT price.

3. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

PART 2 PRODUCTS

2.01 GENERAL

A. Unless otherwise stipulated in the SPECIFICATIONS, all equipment, materials and articles incorporated in this PROJECT are to be new and in the best grade of their respective kinds for the purpose.

B. When the CONTRACT DOCUMENTS call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, CONTRACTOR shall provide the quality and size required by the CONTRACT DOCUMENTS.

C. Work and materials shall be in accordance with the latest edition of the National Electrical Code, Uniform Plumbing Code as published by the Western Plumbing Officials Association, and applicable laws and regulations of the governing authorities.

2.02 PIPE AND TUBE

A. Mainline: PVC Class 200 SDR-21 (match existing).

B. Lateral Lines: PVC CC160 SDR-26 (match existing).

2.03 MAINLINE COMPONENTS

A. Point-of-Connection (P.O.C.) Assembly: As shown in the installation details or matches existing.

B. Isolation Gate Valve Assembly: As shown in the installation details.

C. Quick Coupling Valve Assembly: As shown in the installation details.

2.04 SPRINKLER IRRIGATION COMPONENTS

A. Automatic Remote Control Valves Assembly for Sprinkler Laterals: As shown in the installation details. Match existing heads.

B. Sprinkler Assembly: As shown in the DRAWINGS and installation details.

2.05 PIPE SLEEVE

A. Pipe Sleeve: PVC Schedule 40.

2.06 THRUST BLOCK

A. Concrete for thrust blocks shall meet the following:

1. PSI: Minimum of three thousand five hundred (3,500).

2. Water/cement Ratio: Not greater than fifty-three hundredths (0.53).

3. Air Content: Range between four and eight percent (4-8%).

4. Slump: Maximum of four (4) inches.

2.07 CONTROL SYSTEM COMPONENTS

A. Irrigation Controller Unit:

1. As presented in the DRAWINGS and installation details.

2. Wire markers are to be pre-numbered or labeled with indelible non-fading ink, made of permanent, non-fading material.

3. Primary surge protection arrestors as per manufacturer's recommendations.

B. Control Wire:

1. Type: Electric wire from the controller unit, to each remote control valve shall be American Wire Gauge (AWG) No. 14 solid copper, Type UF cable, UL approved for direct underground burial. Common wire shall be AWG No. 12 solid copper, Type UF cable, UL approved for underground burial.

2. Color: Wire color shall be continuous over its entire length. Use white for common ground wire. Use easily distinguished colors for other control wires. Spare control wires shall be of a color different from that of the active control wire.

3. Splices: As presented in installation details.

2.08 ACCESSORIES

A. CONTRACTOR shall provide to OWNER operating keys, servicing tools, test equipment, other items and spare parts indicated in the General Notes on the DRAWINGS.

PART 3 EXECUTION

3.01 GENERAL

A. Appoint a competent resident superintendent to be onsite whenever the WORK is in progress. The superintendent shall not be replaced without notice to ENGINEER.

B. CONTRACTOR is responsible for locating and avoiding underground utilities, for notifying all appropriate agencies prior to beginning excavation, and for any damage caused by CONTRACTOR. CONTRACTOR is required to notify ENGINEER and the utility company should there be any damage to utilities.

C. ENGINEER and OWNER shall at all times have access to the WORK wherever it is in preparation or progress and CONTRACTOR shall provide proper facilities for such access and inspection.

D. ENGINEER shall have the right to reject materials and workmanship or require their correction. Any rejected or faulty WORK shall be repaired or replaced at no cost to OWNER.

E. Record Drawings:

1. CONTRACTOR shall keep an up-to-date set of DRAWINGS on the job site detailing changes made during construction.

2. After completion of the PROJECT, CONTRACTOR shall furnish OWNER with an “as-built” drawing. The “as-built” drawing shall show the correct location of all piping, valves, heads and control line locations. Instruction sheets and parts lists covering all operating equipment shall be bound in a folder and furnished to OWNER.

3.02 PREPARATION

A. CONTRACTOR shall protect all existing site development including, but not limited to, existing buildings, equipment, underground utilities, walls, materials, etc. Any existing site development damaged by willful or negligent acts of CONTRACTOR or any of CONTRACTOR’s employees shall be replaced or repaired at no expense to OWNER and in a manner satisfactory to ENGINEER before PROJECT acceptance is given. This provision applies to onsite damage as well as to that which may occur to adjacent properties.

B. Until the PROJECT has been accepted, CONTRACTOR shall erect and maintain shoring, barricades, guards, warning signs, and lights as necessary or required for the protection of the public, the WORK, and the workers. To the same ends, provide WORK area safety and institute side security measures, as needed.

C. CONTRACTOR shall stake out the irrigation system. Items staked include sprinklers, pipe, control valves, manual drains, pumping plant, controller, and isolation valves. After staking out the system, OWNER shall be contacted for approval before trenching.

3.03 EXCAVATION AND BACKFILL

A. General: All excavation shall be done by open cut except where boring is permitted or required. All trenches shall be straight with bottoms on uniform slopes. The trench shall be graded along its entire length to ensure firm bedding of the pipe.

B. Excavation: CONTRACTOR shall do all necessary excavation for the proper installation of the WORK. Over-excavation shall be backfilled and hand-tamped prior to installation of the pipe. Any pumping, bracing or shoring shall be included in the unit cost for excavation. CONTRACTOR shall excavate to permit the pipes to be laid at the intended elevations and to permit workspace for installing connections and fittings.

C. Minimum Cover (Distance from Top of Pipe or Control Wire to Finish Grade):

1. 36-inch minimum over mainline pipe.

2. 18-inch over lateral pipe.

3. 12-inch over lateral pipe to pop-up sprinklers.

4. 12-inch over lateral pipe to rotary sprinklers.

D. Backfill: The material excavated from the trenching may be used for backfill when meeting the following standards. The material placed directly on top of the pipe to a depth of six (6) inches shall be free of all foreign matter and rock. After this, rock two (2) inches in diameter or less will be allowed in the backfill material. All rock or foreign matter not incorporated in the backfill material shall be hauled off the site at CONTRACTOR's expense. In the event clean backfill material from the excavation is insufficient, CONTRACTOR shall import clean fill material as needed.

E. Compaction. All trenches shall be compacted within the pipe area by hand-tamping or by water puddling. If water is used to compact the ditch, it shall be applied after the backfill has been brought to the top of the pipe. After the initial backfill has been properly placed and tamped around the pipe, the remaining backfill material may be placed and compacted by machine. All trenches shall be compacted to the density of the surrounding material. Special attention shall be given to traffic areas to protect the pipe and to avoid future settlement because of poor compaction. Any settlement occurring within the guarantee period shall be repaired at no additional cost to OWNER.

3.04 PIPE INSTALLATION

A. General:

1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and debur. Clean pipe ends.

2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.

B. Mainline Pipe and Fittings:

1. Threaded Plastic Pipe: Use only strap-type friction wrenches for threaded plastic pipe.

2. PVC Rubber-Gasketed Pipe: Use pipe lubricant. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.

3. PVC Solvent Weld Pipe:

a. Use primer and solvent cement. Join pipe in a manner recommended by the manufacturer and in accordance with accepted industry practices.

b. Cure for thirty (30) minutes before handling and twenty four (24) hours before allowing water in pipe.

c. Snake pipe from side to side within the trench.

C. Lateral Pipe and Fittings:

1. Threaded Plastic Pipe: Use only strap-type friction wrenches for threaded plastic pipe.

2. PVC Solvent Weld Pipe:

a. Use primer and solvent cement. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.

b. Cure for thirty (30) minutes before handling and twenty four (24) hours before allowing water in pipe.

c. Snake pipe from side to side within the trench.

D. Permissible Deflection at Joints: Whenever it becomes necessary to deflect the pipe from a straight line in either a horizontal or vertical plane, the degree of deflection shall be within the limits set forth by the manufacturer and shall be approved by OWNER.

E. Deviations for Utility Structures: Whenever existing utility structures, conduits, ducts, pipes or other obstructions to grade and alignment of the pipe are encountered, they shall be permanently supported, protected, removed, relocated or reconstructed by CONTRACTOR through the cooperation of the utility company involved.

F. Deviations for Existing Tree Roots: Avoid cutting tree roots larger than one (1) inch in diameter.

G. Thrust Blocking: All pipe, fittings, and valves shall be carefully placed in the trenches with concrete thrust blocks to be poured at all fittings that result in a change of flow direction in the main line on pipe larger than three (3) inches. Any concrete that is judged to be of inferior quality shall be replaced at OWNER's request. The thrust blocks shall be left exposed for forty eight (48) hours for inspection.

H. Sleeves: All pipe under pavement shall be in sleeves PVC Schedule 40 and shall be sized two (2) times the diameter of pipe being sleeved.

3.05 SPRINKLER INSTALLATION

A. General. All sprinklers shall be installed by CONTRACTOR at the locations indicated on the DRAWINGS. It shall be the responsibility of CONTRACTOR to notify OWNER or OWNER's representative of any deviation which may affect the spacing or location of the sprinkler heads. Unless written permission is given, CONTRACTOR shall not extend the head spacing beyond one hundred percent (100%) head-to-head coverage.

B. Sprinkler Heads. All sprinkler heads shall be installed in strict accordance with the manufacturer's recommendations. Provide a swing pipe assembly for each sprinkler head. Prior to the installation of the nozzles, all piping shall be thoroughly flushed. Sprinklers shall be installed at grade.

3.06 CONTROL EQUIPMENT

A. General: All manual and/or automatic control valves, automatic controllers, pressure reducing valves, check valves, vacuum breakers, and other control equipment shall be installed at the locations shown on the DRAWINGS or as specified by OWNER. In addition to these SPECIFICATIONS, CONTRACTOR shall follow the local code

requirements. In the event that a discrepancy exists between these SPECIFICATIONS and the local codes, the adopted code shall prevail.

B. Automatic Valves. Use brand model and size noted on DRAWINGS. Automatic control valves shall be installed in accordance with the manufacturer's recommendations. Install as indicated on the DRAWINGS and installation details.

1. Flush mainline before installation of remote control valve assembly (RCV).

2. Install where indicated on the DRAWINGS. Wire connectors and waterproof sealant shall be used to connect control wires to remote control valve wires. Install connectors and sealant per the manufacturer's recommendations.

3. Adjust RCV to regulate the downstream operating pressure.

C. Irrigation Controller Unit:

1. The location of the controller units shall be as shown on the DRAWINGS.

2. Install one valve output surge protection arrestor on each control wire and one for the common wire.

3. Attach wire markers to the ends of control wires inside the controller unit housing. Label wires with the identification number (see DRAWINGS) of the remote control valve to which the control wire is connected.

4. Connect control wires to the corresponding controller terminal.

D. Control Wire:

1. Bundle control wire where two (2) or more are in the same trench. Bundle with pipe wrapping tape spaced at ten-foot (10') intervals.

2. Control wiring may be pulled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling. Minimum burial depth equals minimum cover as shown on the DRAWINGS.

3. Provide a twenty-four inch (24") excess length of wire in an eight-inch (8") diameter loop at each ninety degree (90°) change of direction, at both ends of sleeves, and at one-hundred foot (100') intervals along continuous runs of wiring. Do not tie wiring loop. Coil the twenty-four inch (24") length of wire within each remote control valve box.

4. Install common ground wire and one control wire for each remote control valve. Multiple valves on a single control wire are not permitted. Install control wires along the entire length of the mainline. Provide a twenty-four inch (24") length of wire from each end of the spare control wires coiled in the control enclosure and provide a twenty-four inch (24") length of coiled wire for each spare control wire in a six-inch (6") round valve box at each distal end of the mainline pipe.

5. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in a valve box

which contains an irrigation valve assembly, or in a separate six-inch (6") round valve box.

6. Unless noted on DRAWINGS, install wire parallel with and under PVC mainline pipe.

7. Protect wire not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill six (6) inches above the wiring.

3.07 FIELD QUALITY CONTROL

A. Major Inspections: CONTRACTOR shall obtain approval of ENGINEER at these points in construction before proceeding to next operation.

1. Trenching and Mainline Installation, Including Thrust Blocks: ENGINEER shall review thrust blocking and observe a pressure test of the mainline before any backfilling.

2. Head Layout: ENGINEER shall review irrigation head layout before installation of the heads.

3. Final Punch List: ENGINEER shall prepare a punch list at the completion of construction and observe coverage, controller, and pump operation and other appropriate system functions.

B. Periodic Spot Checks:

1. ENGINEER may make periodic spot checks to observe the WORK in progress.

2. Follow-up visits will occur as needed.

3. Check for proper operation/coverage of sprinkler system.

C. System Adjustment: Adjustment of the sprinkler heads, control systems, and performance tests shall be done by CONTRACTOR to provide OWNER with a professional, complete installation. All performance tests shall be made in the presence of OWNER or OWNER's representatives. CONTRACTOR shall pay particular attention to coverage and system operation. Any areas which do not conform to designed operation requirements because of unauthorized changes or poor installation practices shall be immediately corrected by CONTRACTOR at no additional cost to OWNER.

D. Acceptance:

1. Once the system is operating in conformance with these SPECIFICATIONS, OWNER will issue written final acceptance of the system.

2. In unusual cases, OWNER may elect to accept the system even though the corrections on the final punch list have not been made by CONTRACTOR. In such cases, the cost of completing the WORK will be deducted from CONTRACTOR's final payment in accordance with the BID SCHEDULE.

3. If the system is not in acceptable condition by the end of the watering season, CONTRACTOR is responsible for winterizing the system and restarting it the following spring.

4. OWNER is not required to make partial or staged acceptances of the irrigation system.

3.08 RESURFACING

A. In areas where it becomes necessary to remove the existing pavement on sidewalks, roads, paths or driveways, it shall be replaced by CONTRACTOR with a similar surfacing at least equal to the quality of the original. Prior to replacement, all exposed edges shall be trimmed to a neat straight line (saw cut) to provide an unobtrusive patch.

3.09 CLEANING

A. Upon completion of WORK, remove from the site all machinery, tools, excess materials, and rubbish.

END OF SECTION

SECTION 32 91 13

TOPSOIL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This work consists of placing of topsoil or wetland topsoil upon constructed cut and fill slopes or in designated areas after grading operations are complete.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 02 41 13 Selective Site Demolition
2. Section 31 11 00 Clearing and Grubbing
3. Section 31 41 13 Topsoil Stripping and Stockpiling
4. Section 31 23 00 Excavation and Fill
5. Section 31 25 00 Erosion and Sedimentation Controls
6. Section 32 93 00 Landscape Planting
7. Section 32 92 19 Seeding

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

a. ASTM International (ASTM):

b. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.

c. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.04 SUBMITTALS

A. Informational Submittals:

1. Certified Topsoil Analysis Reports:

a. Indicate quantities of materials required to bring onsite

b. Provide ceritification of topsoil compliance with gradation requirements.

c. Provide ceritification of topsoil compliance with Chemical attribute requirements.

d. Provide certification of topsoil compliance with minimum ammonium bicarbonate DPTA (chelate) extractable nutrient requirements.

1.05 SEQUENCING AND SCHEDULING

A. TOPSOIL

1. Topsoil shall be placed directly upon completed cut and fill slopes whenever conditions and the progress of construction will permit.

B. WETLANDS TOPSOIL

1. CONTRACTOR shall prepare the wetland relocation site to elevations specified in the DRAWINGS or as approved by ENGINEER prior to excavating the wetlands topsoil. If ENGINEER determines that this is not possible, then CONTRACTOR shall stockpile wetlands topsoil material in an approved area, to remain undisturbed until the relocation site has been prepared.

2. Wetland topsoil shall be placed within twenty four (24) hours in the wetland relocation site.

PART 2 PRODUCTS

2.01 MATERIALS

A. TOPSOIL

1. Topsoil shall consist of natural, friable, sandy loam, native upland topsoil with characteristics as defined in Section 2.01 sub-section 3. Topsoil shall be obtained from pre-approved on-site collection areas or pre-approved imported materials from off site.

2. Topsoil shall have the following characteristics; resulting from a current agronomic and full textural class analysis of a topsoil sample collected from the actual soil proposed to be used. The results of the tests shall be submitted to the ENGINEER and must include sample date and reference the collection location.

3. Composition shall be in general accordance with ASTM D5268 subject to the following:

a. Gradation

Texture Class	% of Total Weight	Average %
Sand (0.05-2.0 mm dia. range)	25 - 75	50
Silt (0.002-0.05mm dia. range)	15 - 40	27.5
Clay (< 0.002 mm dia. range)	15 - 30	22.5

b. Chemical Attributes

Chemical Attribute	Range
pH	6.8 - 7.5
Organic Matter	1% - 3%
Salinity	EC<2 mmhos/cm

c. Topsoil shall contain the following minimum ammonium bicarbonate DPTA (chelate) extractable nutrients.

Nutrient	Concentration
Nitrogen	5 ppm air dried basis
Phosphorous	5 ppm
Potassium	30 ppm
Iron (Fe)	5 ppm

B. WETLANDS TOPSOIL

1. Wetlands topsoil shall meet the requirements of Section 2.01 A above.

2. Topsoil collected from wetlands sites shall be used only in wetlands areas.

3. Wetlands Topsoil salvaged from the site shall not be used as topsoil outside of areas designated on the DRAWINGS.

C. Source: Stockpile material onsite, in accordance with Section 31 14 13 Topsoil Stripping and Stockpiling. Import topsoil if onsite material is insufficient in quantity, or quality.

2.02 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.

PART 3 EXECUTION

3.01 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the WORK.

B. Topsoil shall be placed directly upon completed cut and fill slopes whenever conditions and progress of construction permit.

C. Approved topsoil shall be placed at locations and to the thickness as designated in the CONTRACT DOCUMENTS. Prior to final placement of topsoil, any areas compacted by construction activities shall be decompacted to at least 85 Proctor by repeated ripping in rows twelve inches (12”) or less, apart, to a depth of twelve inches (12”). All subsoil areas, including any graded areas or cut slopes should be

roughened with furrows four to six inches (4”-6”) deep to key the topsoil into the subsoil.

D. Water shall be applied to the topsoil in a fine spray by nozzles or spray bars so the topsoil areas will not be washed or eroded.

E. Uniformly distribute topsoil to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

F. Material shall be free from objects larger than 1-1/2 inches maximum dimension including hard clods of heavy clay, shale, decomposed shale or other subsoil, noxious weed parts (roots, seeds, or shoots), grass, refuse, stumps, roots, brush, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

G. Placed topsoil shall be stabilized immediately by:

1. Preparing and seeding with the approved seed mixture and mulch,

2. Installing perimeter silt fence and/or straw wattles,

3. Roughening and application of 2500 pounds per acre hydromulch with 150 pounds per acre approved tackifier and later seeding and mulching, per the plans.

3.02 WETLANDS TOPSOIL PLACEMENT

A. All subsoil areas, including any graded areas or cut slopes should be roughened with furrows four to six inches (4”-6”) deep to key the topsoil into the subsoil.

B. Wetlands topsoil salvaged from the site shall be placed in locations specified on the DRAWINGS to a depth of eighteen inches (18") or as otherwise designated.

C. Wetland topsoil in an unworkable condition due to excessive moisture, frost or other conditions shall not be placed until it is suitable for spreading.

D. Water shall be applied to the topsoil in a fine spray by nozzles or spray bars so the topsoil areas will not be washed or eroded.

E. After the wetland topsoil is spread all large stiff clods, rocks, roots and other foreign matter shall be cleared and disposed of by the CONTRACTOR.

END OF SECTION

SECTION 32 92 19

SEEDING

PART 1 GENERAL

1.01 DESCRIPTION

A. The WORK under this section consists of the revegetation with seeded grasses. CONTRACTOR shall furnish all labor, materials, equipment, tools, and transportation required to complete the WORK, and shall perform all operations in connection with and reasonably incidental to establishing, maintaining, and warranting the reseeded areas.

B. All WORK shall be completed in accordance with these SPECIFICATIONS, the DRAWINGS and CONTRACT DOCUMENTS, and in a manner consistent with accepted horticultural practices. All permits, licenses, and fees associated with any WORK under this CONTRACT are the responsibility of CONTRACTOR, unless otherwise noted.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 41 13 Topsoil Stripping and Stockpiling
2. Section 31 23 00 Excavation and Fill
3. Section 31 25 00 Erosion and Sedimentation Controls
4. Section 32 93 00 Landscape Planting

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Association of Official Seed Analysts (AOSA).

1.04 SUBMITTALS

A. CONTRACTOR shall be required to submit statements of guarantee and/or certifications from vendors who supply seed, mulches, tackifiers, and fertilizers.

B. CONTRACTOR shall furnish to ENGINEER a signed statement certifying that the seed furnished is from a lot that has been tested by a recognized laboratory for seed testing within six (6) months prior to the date of delivery.

C. Seed container labels shall be submitted to ENGINEER at the completion of PROJECT.

D. CONTRACTOR shall submit to ENGINEER the manufacturers guaranteed chemical analysis, name, trade name, trademark, and conformance to state law of all fertilizers and herbicides.

E. Submit compost sample for approval.

1.05 DELIVERY, STORAGE, AND HANDLING

A. All materials shall be furnished in original manufacturers shipping bags or containers and remain in these bags or containers until they are used. All materials shall be stored in a manner that will prevent them from coming into contact with precipitation, surface water, or any other contaminating substance.

B. Fertilizer: It shall be delivered in original, unopened containers, unless provisions are made and approved by ENGINEER for bulk deliveries to the site of the WORK.

C. Herbicide: It shall be delivered in original, unopened containers, unless provisions are made and approved by ENGINEER for bulk deliveries to the site of the WORK. All herbicides will be stored in a manner that satisfies local, State and Federal Guidelines for Herbicide Storage.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials used shall be new and without flaws or defects of any type, and shall be the best of their class and kind. Seeds shall be prepared for sale during the year of installation.

B. All materials and equipment furnished shall be free of noxious weeds including, but not limited to Russian knapweed, diffuse knapweed, Canada thistle, field bindweed, Johnsongrass, leafy spurge, kochia, or any state-listed noxious weed species.

C. Any materials that have become wet, moldy, or otherwise damaged in transit or in storage shall not be used.

2.02 SEED

A. Seed shall be only that which is specified by ENGINEER or PLANT ECOLOGIST (refer to DRAWINGS). All seed shall be mixed by a wholesale seed supplier in order to obtain the specified mixture and application rate required by ENGINEER or PLANT ECOLOGIST. No species substitutions shall be permitted without prior approval of the ENGINEER or PLANT ECOLOGIST.

B. All seed shall conform to all current State and Federal regulations and shall be subject to the testing provisions of the Association of Official Seed Analysts.

C. All seed and seed mixes shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the common, scientific, and variety name(s) of the seed(s), the lot number, point of origin, net weight, percent of weed content, and the guaranteed percentage of purity and germination.

D. All seed shall be guaranteed for purity and germination, free of noxious weed seed and supplied on a Pure Live Seed (PLS) basis.

2.03 FERTILIZER

A. Fertilizer shall be as shown on the DRAWINGS. All fertilizer shall be a standard commercial product of uniform composition, free flowing and conforming to applicable State and Federal laws.

B. No cyanamide compounds shall be permitted in fertilizers.

2.04 MULCH

A. The type of mulching material to be used shall be crimped weed-free straw. At least seventy percent (70%) of the mulch by weight shall be ten (10) inches or more in length. Mulch shall not contain any noxious weed, must, mold, cake, or decay. No hay may be used on the PROJECT unless approved in advance by the PLANT ECOLOGIST.

2.05 ORGANIC TACKIFIER/BINDER

A. Organic tackifier/binder shall be applied as shown on the DRAWINGS.

2.06 EROSION CONTROL NETTING, BLANKETS, MATS, FABRICS

A. Erosion control blankets, mats, or other commercial products for stabilizing land disturbed areas may be required in certain areas. If so, the type, manufacturer, and installation method for these products shall be specified by ENGINEER or PLANT ECOLOGIST.

2.07 WATER

A. All water used on the PROJECT shall be free of any substances harmful to plant germination and growth or to the environment in general. CONTRACTOR shall be responsible for furnishing and applying water that meets these requirements. ENGINEER or PLANT ECOLOGIST may, at CONTRACTOR's expense, submit samples of water used on the PROJECT for laboratory analysis (of a reasonable number and kind) to ensure the quality of the water. Onsite water shall not be used unless approved by OWNER or OWNERS REPRESENTATIVE.

2.08 TOPSOIL

A. Topsoil shall meet the requirements of Section 32 91 13

2.09 ORGANIC COMPOST (SOIL AMENDMENT)

A. For use as a component for seed establishment use a well decomposed, stable, weed free organic matter source, derived from agricultural food, or industrial residuals' biosolids (treated sewage sludge); yard trimmings, or source-separated or mixed solid waste. The product shall contain no substances toxic to plants and shall be reasonably free (less than one percent [<1%] by dry weight) of man-made foreign matter. Compost shall be processed at sustained high heat so that any weed seeds contained within it shall no longer be viable and it shall possess no objectionable odors and shall not resemble the raw material from which it was derived.

B. Compost shall have the following characteristics:

1. pH Range: 5.5 - 8.0.

2. Moisture Content: 35% - 55%.

3. Particle Size: Pass through 1-inch screen or smaller.

4. Stability: Stable to highly stable, providing nutrients for plant growth.

5. Maturity/Growth Screening: Demonstrate ability to enhance plant growth.

6. Soluble Salt Concentrations: 2.5 dS (mmhos/cm) or less preferred.

7. Organic Matter Content: 30% - 70%.

8. Suggested Source: A-1 Organic, Eaton, Colorado (970) 454-3492 or an approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Contractor's Site Responsibilities: It shall be the responsibility of CONTRACTOR to locate and protect all utilities, structures, roadways, parking areas, fences, survey markers, and existing vegetation (such as, trees and shrubs) on all WORK sites. Any damage caused by CONTRACTOR or SUBCONTRACTORS shall be immediately repaired or corrected by CONTRACTOR at no expense to OWNER.

B. Timing of the Work: Seeding shall be completed as soon as practical after the completion of final grading. CONTRACTOR shall coordinate the actual start of the seeding operation with ENGINEER or PLANT ECOLOGIST. Seeding shall occur between September 15 and April 15, unless otherwise permitted by the ENGINEER or PLANT ECOLOGIST

C. Notice to Proceed: CONTRACTOR shall inform ENGINEER when they are ready to commence permanent revegetation. Upon agreement with CONTRACTOR's preparation for this WORK ENGINEER shall provide CONTRACTOR with a Notice to Proceed. CONTRACTOR shall begin and complete the WORK as specified in this section.

D. Performance of the WORK: All WORK is to be performed by personnel thoroughly familiar with proper and accepted methods for soil preparation, herbicide applications, fertilizing, seeding, and mulching. All WORK is to be performed under the direct supervision of CONTRACTOR's superintendent, who shall be thoroughly familiar with the provisions of this CONTRACT.

E. Project Monitoring: CONTRACTOR shall notify ENGINEER prior to the commencement of any WORK under this section. ENGINEER shall monitor the progress of the WORK throughout the CONTRACT period, and shall assist in determining where soils samples, as required in Article Submittals**,** are to be collected. ENGINEER or PLANT ECOLOGIST shall also collect samples of the seed used on the PROJECT, and may collect samples of fertilizers, soil additives, water, or other materials as they deem necessary to ensure the PROJECT SPECIFICATIONS are met.

3.02 SOIL/SEEDBED PREPARATION, SOIL AMENDMENTS

A. All ripping and tilling operations shall be done in a direction which follows the natural contour of the land on slopes of three to one (3:1) or less. Soils on slopes greater than three to one (3:1) shall be prepared for planting in a manner specified by ENGINEER. Any irregularities in the ground surface resulting from soil preparation operations shall be corrected and sloped to drain.

B. Limit subgrade preparation to areas that shall be planted in the immediate future.

C. Prior to spreading salvaged topsoil and seeding, thoroughly till or rip to a depth of twelve (12) inches all areas compacted by access, staging, or construction traffic. Till all remaining areas to a depth of six (6) inches. Channel bottom areas are to be ripped to a depth of at least twelve (12) inches on approximately two- (2-) to four- (4-) foot centers. The soils shall be worked until no clods greater than two (2) inches in diameter remain, unless directed otherwise by ENGINEER. Remove rocks and other objects three (3) inches or greater in any dimension.

D. Spread topsoil to depth required to meet grades and elevations shown on DRAWINGS after light rolling and natural settlement.

E. Either mix soils with soil amendments and fertilizers before spreading or apply soil amendments or fertilizers on surface of spread topsoil and till thoroughly into top four (4) inches before planting. Mix soil amendments at the rate that is indicated on the DRAWINGS. Delay mixing fertilizer if planting does not follow placing of planting soil within a few days.

F. Organic Compost:

1. Organic Compost Soil Amendment shall be applied at a rate of three (3) cubic yards per one-thousand (1,000) square feet or as shown on the DRAWINGS.

2. Organic Compost shall only be applied if required and designated on the DRAWINGS.

G. Prior to seeding, grade the areas to be seeded to a smooth, even surface with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Soils shall meet grades and elevations shown on DRAWINGS after light rolling and natural settlement. Limit fine grading to areas that can be planted in the immediate future.

H. Moisten prepared areas to be seeded prior to planting when soils are dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy conditions. Restore prepared areas if eroded or disturbed after fine grading and before planting.

3.03 SEEDING

A. General: ENGINEER or PLANT ECOLOGIST shall be on site during seeding operations and will collect representative samples of the seed used on any PROJECT for testing/compliance purposes. CONTRACTOR shall notify ENGINEER or PLANT ECOLOGIST when seeding is to take place so these samples can be obtained (seed tags from all mixtures shall also be supplied to the ENGINEER or PLANT ECOLOGIST).

B. Drill Seeding:

1. All seed is to be drilled one-quarter (1/4) inch to one-half (1/2) inch into the soil at the specified pure live seed (PLS) per acre rate with a mechanical grass drill with depth bands and an agitator in the seed box. Rows shall be spaced not more than seven (7) inches apart. CONTRACTOR shall drill one-half (1/2) of the required PLS per acre in one compass direction, and then drill the remaining half of the required PLS per acre in a direction ninety degrees (90°) to the first half.

2. Following drill seeding of all areas, the forb patch seed mix and the grass/shrub patch seed mix should be broadcast in the areas specified on the DRAWINGS. All forb and grass/shrub patch areas shall be both drill seeded with the appropriate upland or riparian mix as specified on the DRAWINGS and then immediately broadcast with the appropriate forb or grass/shrub patch seed mix prior to mulch application

C. Broadcast Seeding:

1. Some portions of PROJECT areas may be inaccessible to a drill. In these areas, which shall be agreed upon by CONTRACTOR and ENGINEER or PLANT ECOLOGIST, seed shall be uniformly broadcast at twice the specified PLS per acre and covered with soil to a depth of one-quarter (1/4) inch to one-half (1/2) inch by hand raking or harrowing by some other means acceptable to ENGINEER or PLANT ECOLOGIST.

2. Broadcast seeding shall be accomplished using hand-operated “cyclone-type” seeders or rotary broadcast equipment attached to construction or revegetation machinery. All machinery shall be equipped with metering devices. Broadcasting by hand shall be acceptable on small, isolated sites. Prior to hand broadcast seeding, divide the seed required into two portions. Apply the first half of the seed and then follow up by applying the second portion to ensure complete coverage by seed. When broadcast seeding, passes shall be made over each site to be seeded in a manner to ensure an even distribution of seed. When using hopper type equipment, seed shall be frequently mixed within the hopper to discourage seed settling and uneven planting distribution of species.

3. Broadcast seeding shall take place immediately following the completion of final seedbed preparation techniques and upon inspection and approval of ENGINEER. Broadcast seeding should not be conducted when wind velocities would prohibit even seed distribution.

3.04 FERTILIZATION

A. Any fertilizers specified by ENGINEER or PLANT ECOLOGIST shall be applied and mixed with the soil as specified in Article Soil/Seedbed Preparation, Soil Amendments. In some instances, as directed by ENGINEER or PLANT ECOLOGIST, fertilizers shall be spread evenly on the surface of the soil rather than tilled into the top four (4) inches. All fertilizers shall be applied using standard application equipment at rates indicated by required soils tests (Article Submittals), or in some cases as specified by ENGINEER or PLANT ECOLOGIST.

3.05 MULCHING

A. Straw mulch shall be applied immediately after seeding has been completed with a mechanical spreader at a rate not less than one and one-half (1-1/2) tons per acre, and not more than two (2) tons per acre. Straw mulch shall then be anchored to the soil with a standard commercial crimper which shall crimp the fiber four (4) inches or more into the soil. Failure to apply designated mulch at the specified rate may result in the ENGINEER or PLANT ECOLOGIST requiring the CONTRACTOR to remobilize and complete the specified WORK at no additional cost to the OWNER.

3.06 HERBICIDE/CHEMICAL APPLICATIONS

A. All noxious weed growth on the site shall be controlled by the CONTRACTOR during the construction period and until the final inspection by spot application of herbicides which have been pre-approved by the ENGINEER or PLANT ECOLOGIST. Spot application of herbicides means detailed application of only the targeted weed species by wand or wick with a backpack applicator. No herbicides shall be permitted for general application (broadcast) during a time when it would cause detrimental impact to germination or establishment of the seeded grasses.

B. Herbicides or other chemicals, if required, shall be applied using well-maintained spraying equipment by individuals working for CONTRACTOR who are appropriately licensed by any State and/or Federal agency having jurisdiction over such applications. It shall be the responsibility of CONTRACTOR to be knowledgeable of any and all current laws and regulations pertaining to herbicide and other chemical applications, and to advise ENGINEER or PLANT ECOLOGIST immediately if any requests for these applications made by ENGINEER or PLANT ECOLOGIST are inappropriate as they pertain to these laws and regulations. Herbicide application shall be conducted by trained weed control personnel who also can recognize the targeted weed species.

C. Herbicides and other chemicals shall not be applied during periods when wind or other physical conditions cause the herbicides or chemicals to be transported a distance of more than five (5) feet from the immediate area where they are being placed. It shall be the responsibility of CONTRACTOR to stop WORK immediately and to notify ENGINEER or PLANT ECOLOGIST if any weather or other physical condition exists which would make the application of herbicides or other chemicals inappropriate.

D. All herbicides or other chemicals used (except solid fertilizers, Article Fertilizers) shall be applied at a rate and strength, and by the method recommended by the manufacturer of the product being used. Failure to properly apply herbicides (spot treatment) may result in the ENGINEER or PLANT ECOLOGIST requiring the CONTRACTOR to reseed the damaged area at no cost to the OWNER.

3.07 EROSION CONTROL NETTING, BLANKETS, MATS, FABRICS

A. Slopes over three to 1 (3:1), concave areas on slopes, drainage swales, areas along the edges of hard surfaces (trails and roads), and any other areas which may rill, shall be mulched with jute netting or other erosion control fabric as specified in DRAWINGS. These fabrics shall be installed only after the installation area is graded smooth. All clods or rocks shall be removed from the area, so that the fabric will lie flat on the surface of the soil and not bridge over it. The edges of the fabric shall be secured by

two- (2-) foot wooden stakes installed two (2) feet on center along all edges and seams. Seams shall overlap one (1) foot and the body of the fabric shall be further secured to the soil surface on three- (3-) foot centers. The fabric shall not be stretched tight.

3.08 FIELD QUALITY CONTROL

A. Final Acceptance:

1. When WORK has been completed for the PROJECT, CONTRACTOR and ENGINEER shall inspect the site together and determine the total area of the WORK, and whether or not the WORK is complete and has been done in accordance with CONTRACT DOCUMENTS and SPECIFICATIONS. If mutual agreement cannot be reached on these issues, the determinations made by ENGINEER shall be final. Deficiencies in the WORK, if any, shall be noted and a checklist of these deficiencies given to CONTRACTOR by ENGINEER. CONTRACTOR shall immediately correct any deficiencies listed on the checklist at no cost to OWNER.

2. When all checklist items are completed to the satisfaction of ENGINEER, ENGINEER shall issue a Certificate of Final Acceptance. CONTRACTOR shall then submit these items for payment to OWNER based on the original project BID prices and any CHANGE ORDERS which have been agreed to and signed by both parties.

3.09 CLEANING

A. All WORK sites shall be kept clean and free from all debris. At the conclusion of WORK at any site, CONTRACTOR shall remove and haul from the site all excess materials, debris, and equipment. Any damage (for example, damaged fencing, damaged road surfaces, excessive tire furrows, mud tracked onto pavement) resulting from CONTRACTOR's activities shall be repaired by CONTRACTOR to ENGINEER's satisfaction at no expense to OWNER.

END OF SECTION

SECTION 32 93 00

LANDSCAPE PLANTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, materials, supplies, equipment, tools and transportation; perform all operations to complete installation of the plantings; and guarantee all plantings. The WORK shall include, but not be limited to the following:

1. Procurement of all applicable licenses, permits, and fees.
2. Ascertainment of utility locations prior to construction.
3. Site inspection.
4. Planting of trees, shrubs, and wetland plants.
5. Soil preparation and fine grading.
6. Staking and guying of trees.
7. Mulching of all trees.
8. Cleanup, inspection, and approval.
9. Guarantee of all plantings.

1.02 GENERAL

A. No substitutions for specified materials shall be accepted in the base BID. Alternative BID proposals, which propose material substitutions, may be submitted for consideration by ENGINEER or PLANT ECOLOGIST. Alternative proposals shall be fully supported by necessary documentation showing compatibility/comparability with specified materials.

B. Additional WORK shall be paid for at CONTRACT unit prices. If unit prices are not available, the WORK shall be paid for on a time and material basis or for an agreed to lump sum amount.

C. Precautions have been taken to ensure accuracy and conformance of the CONTRACT DOCUMENTS with the design concept of the PROJECT. Nevertheless, CONTRACTOR shall be responsible for confirming and correlating actual job site dimensions, for acquiring information that pertains solely to the fabrication process or to techniques of construction, and for coordinating the WORK with all other trades.

1.03 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 41 13 Topsoil Stripping and Stockpiling
2. Section 31 23 00 Excavation and Fill
3. Section 31 25 00 Erosion and Sedimentation Controls
4. Section 32 93 00 Landscape Planting
5. Section 32 92 19 Seeding

1.04 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Nursery and Landscape Association (ANLA): ANSI Z60.1, American Standard for Nursery Stock.

1.05 SUBMITTALS

A. CONTRACTOR shall direct submittals and samples, if noted, to ENGINEER and receive approval in writing before WORK commences.

B. Submit Topsoil certifications as required in Section 32 91 13 Topsoil

C. Submit Weed free Certification and mulch sample for approval.

D. Submit organic compost certification of characteristics for approval.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Digging, Wrapping, and Handling:

1. Plants shall be dug and prepared for shipment in a manner that shall not cause damage to branches, shape, and future development after planting.

2. Balled and burlapped plants shall be nursery grown stock adequately balled with firm, natural balls of soil in sizes and ratios conforming to the American Standard for Nursery Stock as cited below. Balls shall be firmly wrapped with non-treated burlap, secured with wire or jute. Broken or flattened or otherwise misshaped or otherwise damaged root balls will not be accepted.

B. Plants are to be delivered to the site with tags bearing the botanic name as indicated by the plant list.

C. Plant Protection: Plants shall be handled so that roots are adequately protected at all times from drying out and from other injury. Plant materials shall be securely tarped during transportation to prevent wind burn. Protect root balls and pots of plants which cannot be planted within twelve (12) hours of delivery with soil or other suitable materials. Where possible, store plants in the shade. Keep all plant roots moist before, during, and after planting. Plants shall be watered as soon as they arrive on the site and shall be kept moist until they are planted.

D. Protect all materials used for construction from damage, deterioration, or loss of any kind while in storage and construction.

1.07 GUARANTEE AND REPLACEMENT

A. Guarantee trees, shrubs, ground covers, and other plant materials to root and thrive free from defects from any cause until final acceptance of PROJECT.

B. Replace plants when they are no longer in a satisfactory condition as determined by ENGINEER prior to final acceptance. This includes plants that die back and loose the form and size originally specified.

1. Make replacements within seven (7) days of notification from ENGINEER.

2. Replace trees in the spring planting season only, unless approved otherwise. Remove dead plants within two (2) days of notification.

C. All replacements shall be of the same kind and size as originally specified and shall be installed as described in the CONTRACT DOCUMENTS. Repairs and replacements shall be made at no expense to OWNER.

D. Guarantee shall apply to originally specified and installed plants and other landscape materials, and any replacements made during the construction period.

PART 2 PRODUCTS

2.01 GENERAL

A. All materials used for construction shall be new and without flaws or defects of any type, and shall be the best of their class and kind.

B. A complete list of plantings and necessary landscape material is provided on the DRAWINGS.

2.02 SOIL AMENDMENTS/FERTILIZERS/MULCHES/EDGING

A. Topsoil:

1. topsoil shall meet the requirements of Section 32 91 13 Topsoil.

2. In-Situ: Soil in-place on the site, such as tree pit excavation, may be used provided it is free from roots, limbs, rocks, construction debris, and other foreign material.

B. Improved Planting:

1. Mix (Prepare Soil): Backfill planting pits and planters using an improved soil mix consisting of the following:

a. Eighty five percent (85%) onsite or imported topsoil.

b. Fifteen percent (15%) organic compost.

C. Fertilizer:

1. Trees and Shrubs: Osmocote Sierrablen, nine- (9-) month slow-release.

2. Turf Grasses: 18-46-0 at five pounds (5#) per thousand square feet (1,000 SF).

3. Native Grasses: Biosol at a rate of twenty pounds (20#) per thousand square feet (1000 SF).

D. Herbicide: Coordinate type of herbicide with ENGINEER.

E. Mulch: Three- (3-) inch depth shredded cedar mulch or equal cedar mulch; free from noxious weed seed and all foreign material harmful to plant life. Chips or other angular bark chips are not acceptable.

F. Edging: Steel edging, inter-locking fourteen (14) gauge by four- (4-) inch painted steel.

G. Organic Compost: Compost shall have the following characteristics:

1. pH Range: 5.5-8.0.

2. Moisture Content: 35% - 55%.

3. Particle Size: Pass through one- (1-) inch screen or smaller.

4. Stability: Stable to highly stable, providing nutrients for plant growth.

5. Maturity/Growth Screening: Demonstrate ability to enhance plant growth.

6. Soluble Salt Concentrations: 2.5 dS (mmhos/cm) or less preferred.

7. Organic Matter Content: 30% – 70%.

8. Suggested Source: A-1 Organic, Eaton, Colorado (970) 454-3492 or an approved equal.

2.03 WATER

A. CONTRACTOR shall provide water for planting during the construction period.

2.04 TREES, SHRUBS, AND GROUND COVERS

A. Quantities: Furnish plants in quantities required to complete the WORK as indicated on the DRAWINGS.

B. Quality: Use plants which are symmetrical and typical of their species; healthy, well-branched, and well-proportioned in respect to height and width; free from disease, injury, insects, and weak roots; and, conforming to the requirements of the ANLA ANSI Z60.1. All plants are subject to inspection.

C. Botanic and Common Names: Nomenclature is in conformance with standard horticultural practice in the area. Trees, shrubs, and herbaceous plant materials designated as native shall NOT be hybrid varieties.

2.05 MATERIALS FOR STAKING, GUYING, AND WRAPPING TREES

A. Tree Stakes: Six- (6-) foot long metal T-Posts.

B. Guying and Staking Wire: Galvanized steel twelve (12) gauge wire.

C. Webbing: Two- (2-) inch nylon webbing or rubberized cloth.

2.06 GRASS SEED

A. Refer to Section 32 92 19, Seeding.

PART 3 EXECUTION

3.01 GENERAL

A. CONTRACTOR shall appoint a competent resident superintendent. The superintendent shall be on site whenever the WORK is in progress. The superintendent shall not be replaced without notice to ENGINEER. Workers shall be competent in performance of WORK they are assigned.

B. Coordination: Coordinate WORK with other trades to ensure proper sequencing of construction.

C. Planting Time and Completion:

1. Plants shall be planted only when weather and soil conditions permit and in accordance with locally accepted practices, and as approved by ENGINEER or PLANT ECOLOGIST.

2. Trees shall be planted in same growing season in which they were dug.

3.02 PREPARATION

A. Preplanting Observation of Materials:

1. ENGINEER or PLANT ECOLOGIST shall observe and approve plant material before planting. This observation may be either at the site, nursery, or holding area, at the option of ENGINEER OR PLANT ECOLOGIST. Materials planted prior to approval are subject to rejection. Observation of materials may be sequenced by major planting areas to accommodate efficient planting operations. Acceptance of plant material at the nursery or holding area does not preclude rejection at the site. All rejected materials shall be removed from the site, replaced, and reinspected before planting.

2. All fertilizers, backfill, seed, mulches, and soil amendments shall be reviewed at the site by ENGINEER or PLANT ECOLOGIST before they are used in planting operations. ENGINEER shall check invoices to verify specified quantities have been delivered.

B. Site Inspection:

1. CONTRACTOR, Landscape Contractor, and ENGINEER shall inspect site prior to being accepted by ENGINEER as complete and acceptable for the Landscape Contractor to proceed.

2. Beginning WORK of this section implies acceptance of existing conditions.

C. Grades: Grades have been established under WORK of another section to within one (1) inch, plus or minus, of required finished grades. Verify that grades are within one (1) inch, plus or minus, of required finished grades. Notify ENGINEER prior to commencing soil preparation WORK if existing grades are not satisfactory, or assume responsibility for conditions as they exist.

D. Contaminated Soil: Do not perform any soil preparation work in areas where soil is contaminated with cement, plaster, paint or other construction debris. Bring such areas to the attention of ENGINEER and do not proceed until the contaminated soil is removed and replaced.

E. Dimensions: All scaled dimensions are approximate. Before proceeding with any WORK, carefully check and verify all dimensions and quantities and immediately inform ENGINEER of any discrepancy between the DRAWINGS and/or specifications and actual conditions.

F. Protection of Existing Features:

1. Protect all existing site development including, but not limited to, existing buildings, equipment, underground utilities, walls, materials, or vegetated areas including, but not limited to, trees, native grasslands, wetlands, or shrublands. Any existing site development damaged by willful or negligent acts of CONTRACTOR or any of CONTRACTOR's employees shall be replaced or repaired at no expense to OWNER and in a manner satisfactory to ENGINEER or PLANT ECOLOGIST before PROJECT acceptance is given.

2. The above provision applies to onsite damage as well as to that which may occur to adjacent properties.

3. Until the PROJECT has been accepted, erect and maintain shoring, barricades, guards, warning signs, and lights as necessary or required for the protection of the public, the WORK, and the workers. To the same ends, provide traffic control and institute site security measures, as needed.

4. CONTRACTOR shall be responsible for adhering to the following tree protection standards during construction:

a. During the construction stage, CONTRACTOR shall not cause, or permit the cleaning of equipment or material, or the storage or disposal or waste material including, but not limited to, paints, solvents, asphalt, concrete, mortar, or any other material harmful to the life of a tree, within the drip line or root zone of each tree, or group of trees.

b. No damaging attachments, wires, signs, permits, or other objects may be fastened by any means to any tree preserved on this PROJECT.

5. Tree areas, shrublands, grasslands, or existing landscape areas within the PROJECT area shall be fenced and excluded from use for vehicle traffic, staging, or parking, unless specifically designated for these purposes on the DRAWINGS or by the ENGINEER.

3.03 SOIL PREPARATION

A. Weed and Debris Removal: All ground areas to be planted shall be cleaned of all weeds and debris prior to any soil preparation or grading work. Any growing noxious weeds on the site shall be pretreated with approved herbicide prior to grading. Annual or biennial weeds over two (2) feet tall shall be mowed, raked, and removed prior to grading. Weeds and debris shall be disposed of off the site.

B. Moisture Content: Soil shall not be worked when moisture content is so great that excessive compaction occurs, nor when it is so dry that dust will form in the air or clods will not break readily. Water shall be applied, if necessary, to bring soil to an optimum moisture content for tilling and planting.

C. Prior to spreading salvaged topsoil and seeding, thoroughly till or rip to a depth of twelve (12) inches all areas compacted by access, staging, or construction traffic. Till all remaining areas to a depth of six (6) inches. Channel bottom areas are to be ripped to a depth of at least twelve (12) inches on approximately two- (2-) to four- (4-) foot centers. The soils shall be worked until no clods greater than two (2) inches in diameter remain, unless directed otherwise by ENGINEER. Remove rocks and other objects three (3) inches or greater in any dimension.

D. Soil Conditioning: After soil preparation has been completed and high and low spots graded, add soil amendments as indicated below and rototill, making repeated passes with the cultivator to the depth specified until the amendments have been thoroughly mixed.

1. Organic Compost Soil Amendment shall be applied at a rate of three (3) cubic yards per one-thousand (1,000) square feet or as shown on the DRAWINGS.

2. Organic Compost shall only be applied if required and designated on the DRAWINGS.

3.04 FINE GRADING

A. When weeding, soil preparation, and soil conditioning have been completed and soil has been thoroughly water settled, all planting areas shall be smooth-graded, ready for placement of plant materials and for seeding.

1. Grades: Finish grades shall conform to site grading plans and produce a smooth, even surface without abrupt changes, including the interface with the adjacent undisturbed landscape. Minor adjustments of finish grades shall be made at the direction of ENGINEER or PLANT ECOLOGIST, if required.

2. Drainage: All grades shall provide for natural runoff of water without low spots or pockets. Flow-line grades shall be accurately set and shall be not less than two percent (2%) gradient wherever possible.

3. Shrub Areas: Finished grades shall be one and one-half (1-1/2) inches below top of adjacent pavement, headers, curbs, or wall, unless otherwise indicated on the DRAWINGS.

4. Lawn Areas: Finished grade shall be three-quarters (3/4) inch below top of adjacent pavement, curbs, or headers.

5. Slopes: Tops and toes of all slopes shall be rounded to produce a gradual and natural-appearing transition between relatively level areas and slopes.

6. Wetland Mitigation Areas: In wetland mitigation areas, all areas shall be graded to within six (6) inches of the expected water surface elevation or closer, if otherwise specified on the detailed DRAWINGS. ENGINEER or PLANT ECOLOGIST may require a survey of wetland planting site if there is any question to accuracy of the final grade. No wetland plantings shall be placed over six (6) inches above the expected water surface elevation or more than six (6) inches below the expected water surface elevation.

B. Inspection of turf/turf bed and grading shall occur before sodding and/or seeding.

3.05 SHRUB AND TREE PLANTING

A. Established Location: ENGINEER or PLANT ECOLOGIST shall approve location of trees and shrubs before any planting occurs.

B. Planting Pits:

1. Dig planting pits two (2) times the size of the soil ball and the depth of the soil ball, unless planting native cottonwoods in non-irrigated areas (see 3 below).

2. Roughen sides of the pit to remove any compacting or glazing.

3. Native plains cottonwood trees (*Populus sargentii*, syn. = *P. deltoides* subsp *monilifera*) to be planted in non-irrigated areas along water courses shall be deep planted to ensure good root contact with groundwater and promote substantial root support. Deep planted trees shall be installed with up to one third (1/3) the height of the tree placed into a hole with the base of the root ball resting upon the level of the top of the groundwater. It shall be verified that the root ball of the tree is placed in the capillary fringe (moist soil) just above the saturated soil zone (groundwater level). Deep planted trees shall be placed back from the edge of a water body far enough to permit at least a two- (2-) foot deep rooting zone above the water table. Deep planted trees are required to have, at least, two (2) feet of soil above the ground water level, to provide a stable root zone for the mature trees. Areas with heavy clay soils are not suitable for deep planting of cottonwoods.

4. Figure A below shows a typical installation of a deep planted native cottonwood tree.

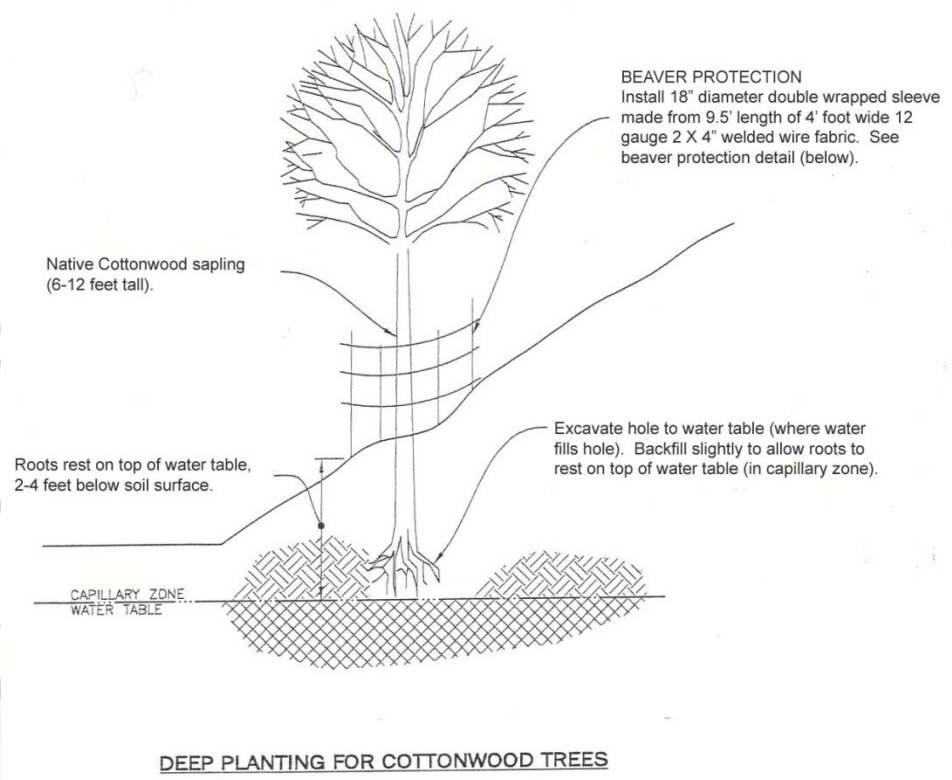

Figure A

C. Existing Tree Roots:

1. When the cutting of tree roots is necessary, each final cut shall be made as cleanly as possible for all roots over three (3) inches in diameter using the following method:

   a. The line of excavation shall be drawn out and appropriate excavation equipment used to clear the area at least six (6) inches in front of the actual finished excavation line. Roots can then be cut using tools such as axes, stump grinders, or trenchers.

   b. Each root over three (3) inches in diameter shall then be cut cleanly back to the final excavation line using a stump grinder operated by an experienced, licensed arborist. A sharp hand or bow saw is acceptable for roots under three (3) inches in diameter. Axes and trenchers do not cut roots cleanly and shall not be used for final root cuts.

2. The ENGINEER or PLANT ECOLOGIST, shall be contacted prior to removal of branches over four (4) inches in diameter. All branches shall be cut with a sharp pruner or saw. All cuts shall be cleanly made back to the next crotch or tree, leaving the bark collar intact at the base of the cut.

D. Backfill Material: Tree and shrub planting pits shall be backfilled with the specified improved planting mix. (Refer to Paragraph 2.02.B.)

E. Planting:

1. On all other tree and shrub planting (other than native plains cottonwoods), excavate planting pit to depth such that the top of the root ball, when planted, shall be at finish grade.

2. For balled and burlapped materials, untie and remove burlap from top third of root ball on balled and burlapped material. Remove wire baskets from top and sides of root ball. Remove twine from around tree trunks.

3. Backfill one-half (1/2) of pit with backfill mixture and water thoroughly before placing any more backfill. Do not work wet soil.

4. Fertilize trees and shrubs with specified fertilizer at the rate recommended by the manufacturer.

5. Backfill the rest of the planting pit with backfill mixture. Water thoroughly on day of planting. Do not work wet soil.

6. Stake or guy all trees.

7. ENGINEER will check mulch, tree staking, and tree wrapping where appropriate.

3.06 WETLAND PLANTINGS

A. Wetland or other potted plant materials shall be well watered before installation. Wetland plant materials shall be kept wet at all times, until installed.

B. Wetland plant materials shall be planted within six (6) inches of the expected normal water surface elevation. In sandy soils wetland plant materials may require planting within less than two (2) inches of the normal water surface, depending upon the species. Contact PLANT ECOLOGIST to verify proper grade prior to wetland plant installation.

C. Holes for installing 10 T or small tubeling plants may be created with a dibble or sharpened dowel. Open the holes just large enough to insert the entire plant and all the nursery soil at least one-half (1/2) inch below the native soil. The holes should not be formed more than one-half (1/2) inch deeper than the tubes. Once inserted, the hole shall be backfilled or tamped from the side with a mallet to secure the plant. If waterfowl grazing is a possibility, each plant (graminoids only) shall be trimmed to two (2) inches prior to installation and each plant shall be secured by an eight- (8-) inch landscape staple to discourage pulling by the waterfowl. Areas to be covered by erosion control mat following planting shall be planted with trimmed plants (grasses and grass-like plants trimmed to a two- (2-) inch height while in the pots, then seeded (if required) with fabric installation completed over the top of the installed plants.

3.07 MULCHING

A. Mulch all tree plantings in irrigated landscapes with four (4) inches deep recycled cedar mulch, unless otherwise indicated on the DRAWINGS. Trees or shrubs planted in non-irrigated areas shall be surrounded with a watering dish. Trees or shrubs planted on slopes in non-irrigated areas shall be surrounded with a watering dish which shall be open on the uphill side to permit accumulation of runoff. The dishes in natural areas shall be mulched with no more than one (1) inch of wood chip mulch and may be seeded along with the adjacent area.

3.08 FIELD QUALITY CONTROL

A. Final Walk-Through:

1. The final walk-through shall be performed at the completion of all planting operations under this CONTRACT.

2. At the time of the final walk-through, the Landscape Contractor shall have planting areas free of debris. Plant basins shall be in good repair. Debris and litter shall be cleaned up, and walkways, curbs, and roads shall be cleared of soil and debris. The inspection shall not occur until these conditions are met.

3. ENGINEER or PLANT ECOLOGIST will identify any deficiencies in the form of a punch list.

4. ENGINEER will give written notice of final acceptance when WORK has been performed in compliance with the CONTRACT DOCUMENTS.

5. Correct deficiencies within the first ten (10) days of the final walk-through. Correct WORK in accordance with the CONTRACT DOCUMENTS at no cost to OWNER.

6. Final acceptance shall not be given until all deficiencies are corrected. The Landscape Contractor shall maintain site until final acceptance.

3.09 CLEANING

A. Remove from the site excess soil resulting from tree planting and mulching operations.

END OF SECTION

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SECTION 32 93 43

SOIL BIOENGINEERING OR SHORELINE STABILIZATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, materials, supplies, equipment, tools and transportation; perform all operations to complete installation of live willow stakes, willow fascines, willow brush layering, willow bundles and cottonwood poles; and guarantee all plantings.

B. Live stakes and poles are straight branches or saplings that have been cut and pruned from dormant living woody plant material (plants that have lost their leaves for the winter).

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 41 13 Topsoil Stripping and Stockpiling
2. Section 31 23 00 Excavation and Fill
3. Section 31 25 00 Erosion and Sedimentation Controls
4. Section 32 93 00 Landscape Planting
5. Section 32 92 19 Seeding

1.03 GENERAL

A. No substitutions for specified materials will be accepted in the BID. Alternative BID proposals, which propose material substitutions, may be submitted for consideration by ENGINEER or PLANT ECOLOGIST. Alternative proposals shall be fully supported by necessary documentation showing compatibility/comparability with specified materials.

B. Additional WORK will be paid for at the CONTRACT unit price. If the CONTRACT unit price is not available, the WORK will be paid for on a time and material basis or for an agreed to lump sum amount.

1.04 STORAGE AND HANDLING

A. Cuttings shall be kept moist, cool, and shaded at all times until installed. Cuttings shall be stored at between thirty-five degrees (35°) and fifty degrees (50°) Fahrenheit for no longer than one (1) week. Cuttings shall be stored in protected locations where they are shaded and sheltered from sun and wind. The butt end (bottom end) of cuttings shall be submerged in water during storage. Prior to planting, all cuttings shall have butt ends (not tops) placed in water for a minimum of twenty-four (24) hours, but not longer than fourteen (14) days. The upper end of cuttings shall never

be submerged. Plastic trashcans may be used for storing willow or cottonwood cuttings. Cuttings shall be protected from freezing and drying at all times and protected from direct sunlight. Cuttings are never to be stored horizontally in water.

B. Cuttings shall not be dropped or otherwise mishandled. Minor broken and damaged cuttings shall be pruned prior to planting. Major damage will be cause for rejection.

C. Cuttings shall be covered with tarp or burlap during any transportation in vehicles.

1.05 GUARANTEE AND REPLACEMENT

A. Guarantee plantings to root and thrive free from defects from any cause until final acceptance of the PROJECT.

B. Replace plants when they are no longer in a satisfactory condition as determined by ENGINEER prior to final acceptance. This includes plants that die back and lose the form and size originally specified.

1. Make replacements within seven (7) days of notification from ENGINEER.

2. Replace plants in the dormant season only, unless approved otherwise. Remove dead plants within two (2) days of notification.

C. All replacements shall be of the same kind and size as originally specified and shall be installed as described in the CONTRACT DOCUMENTS. Repairs and replacements shall be made at no expense to OWNER.

D. Guarantee shall apply to the originally specified and installed plants and other landscape materials, and any replacements made during the construction period.

PART 2 PRODUCTS

2.01 CUTTINGS

A. Willow materials shall be sandbar willow (*Salix exigua* species) and cottonwood material shall be native plains cottonwood (*Populus deltoide, syn. = P. sargentii*), live wood at least two (2) years old. Avoid current year’s suckers and current year's growth.

B. Willow cuttings shall be one-half- (1/2-) inch to one- (1-) inch diameter, of the following lengths:

1. Willow brush layering cuttings shall be five (5) feet to six (6) feet long.

2. Willow stakes shall be two (2) feet long.

3. Willow fascines cuttings shall be at least three (3) feet long.

4. Willow bundle cuttings shall be four (4) feet long.

5. Cottonwood poles shall be one (1) to three (3) inches in diameter and ten (10) to eighteen (18) feet long.

C. Plant materials shall be harvested from on-site sources. Any offsite sources are to be accepted by ENGINEER.

2.02 ACCESSORIES

A. Beaver Protection Sleeve: Eighteen- (18-) inch diameter; fabricate from forty-eight- (48-) inch wide, two- (2-) inch by four- (4-) inch 12-gauge welded wire fabric, approximately nine and one-half (9-1/2) feet long and fastened to three (3) six-(6-) foot lengths of one-half- (1/2-) inch diameter rebar with two (2) hog ring fasteners.

PART 3 EXECUTION

3.01 GENERAL

A. CONTRACTOR shall appoint a competent resident superintendent. The superintendent shall be experienced in the specified techniques of woody plant installation and be on-site whenever the WORK is in progress. The superintendent shall not be replaced without notice to ENGINEER. Workers shall be competent in performance of the WORK they are assigned.

B. Materials planted prior to approval are subject to rejection. All rejected materials shall be removed from the site, replaced and reinspected before planting.

C. ENGINEER or PLANT ECOLOGIST shall accept the location of all willow plantings before installation.

D. Planting Time and Completion:

1. Willows and cottonwoods shall be planted only when weather and soil conditions permit and in accordance with locally accepted practices, and as accepted by ENGINEER. Cuttings shall not be planted when freezing temperatures are forecast twenty-four (24) hours in advance or when the ground is frozen or otherwise unsuitable.

2. Willows and cottonwoods shall be harvested and planted in the dormant season, February 1 to April 1. However, best success is achieved when harvested and planted in March. Live plant materials shall be properly stored and installed no more than two (2) weeks following collection.

3.02 PREPARATION

A. Site Inspection:

1. CONTRACTOR, the Landscape SUBCONTRACTOR, ENGINEER, and PLANT ECOLOGIST shall inspect site prior to being accepted by ENGINEER or PLANT ECOLOGIST as complete and acceptable for the Landscape SUBCONTRACTOR to proceed.

2. Beginning WORK of this section implies acceptance of existing conditions.

B. ENGINEER or PLANT ECOLOGIST shall inspect live woody cuttings for acceptability upon arrival at the PROJECT site.

3.03 HARVESTING

A. ENGINEER will observe and approve onsite harvesting areas or offsite source of plant materials.

B. Use extreme care to avoid damage to all remaining plants in harvest areas and the cuttings themselves. Only forty percent (40%) of harvest plants shall be removed for cuttings.

C. All plant material shall be collected and installed in dormant condition. Cuttings shall be harvested with sharp pruning shears or sharp saws. Cuts are to be made near the soil surface. All material shall be handled with care to avoid bark stripping and trunk wood splitting. Older, stiff or dying stems or stems with dead inner wood shall not be used. For willow stakes and bundles, all side branches and any leaves shall be trimmed from cuttings. Branches shall be left on cuttings for fascines and brush layering. Live cuttings shall be bound together with twine at the collection site for ease of handling and protection during transport. The harvesting site shall be left clean and tidy; excess woody debris material shall be promptly removed from the site. Any soil disturbance outside of construction limits caused by accessing areas for willow or cottonwood harvesting shall be ripped and re-seeded with the specified seed mixture and rate. There will be no additional payment for such disturbance.

3.04 PLANTING WILLOW STAKES

A. Planting locations shall be staked by CONTRACTOR for approval by ENGINEER or PLANT ECOLOGIST prior to planting.

B. Live stakes shall be single sticks. They shall be twenty-four (24) inches long, taken from the lower stems of healthy, actively growing plants, approximately one-half (1/2) to one (1) inch in diameter. Cut the apical buds plus several inches off the cutting before planting it. (The apical bud at the tip of the branch releases a plant growth hormone which discourages lateral bud development.) All side branches shall be trimmed. Bark on lower portion of the stems shall be sprayed lightly with white paint to identify lower ends for planting. Do not dip ends of cuttings into paint; butt ends shall not be painted.

C. Cuttings shall be planted in a staggered pattern or random pattern in the locations shown on the DRAWINGS at the designated density. Prepare a pilot hole to the groundwater depth by hammering a rebar, dibble bar, or stinger, or other approved method, into the soil. Place cutting gently upright into the hole, ensuring that the base end is at or below the ground water level. Cuttings shall protrude from the ground four (4) to six (6) inches. At least two-thirds (2/3) of each cutting shall be inserted into the soil.

D. Holes shall be backfilled with an approved soil, as necessary, so that no voids remain around the cutting. If willow stakes are to be inserted through an erosion fabric, backfill of planting holes is still required. Watering shall be done between backfill lifts to ensure all voids are filled. Do not bury top of cutting. Tamp surface around the cutting to secure it in place. Cuttings which move freely within holes will be rejected.

E. Access corridors for heavy equipment used to facilitate digging of pilot holes for willow stakes (such as within riprap), and all disturbed or compacted soil shall be ripped and scarified prior to final seeding.

F. Figure A below shows a typical installation of a live willow staking.

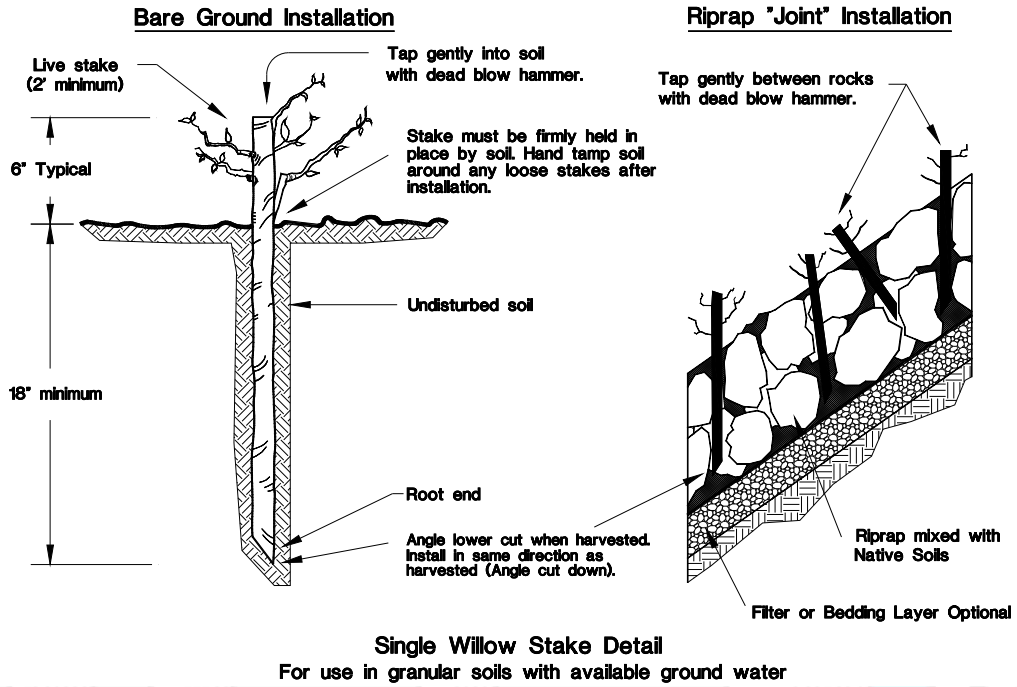


Figure A

3.05 WILLOW BRUSH LAYERING

A. Dig a two- (2-) foot deep by one- (1-) foot wide trench at the locations shown on the DRAWINGS. The depth may need to be adjusted to ensure that the bottom of the trench is within the wet soil (ground water level).

B. Place a six- (6-) inch thick densely packed layer of willow cuttings five (5) feet to six (6) feet long into the trench, top end up, leaning toward the creek, as shown in the details. The ends of all willow cuttings shall be in the groundwater.

C. Backfill the trench so that no voids remain around the stems of the cuttings. Watering should be done between backfill lifts to ensure all voids are filled. Do not bury tops of cuttings. Tamp surface around the cutting to secure it in place.

3.06 LIVE WILLOW FASCINES

A. A continuous fascine shall be built in a prepared trench, as opposed to individual willow bundles laid end-to-end. CONTRACTOR shall contact ENGINEER or PLANT ECOLOGIST prior to beginning the WORK to arrange for oversight and guidance during the construction of fascines. Trimmings of young suckers and some smaller branches may be included in the fascines, but half of the stems in the fascines shall be at least one-half (1/2) inch in diameter. Complete live willow fascines shall be ten (10) inches in diameter, with the growing tips and butt ends oriented in alternating directions. Cuttings shall be staggered in the fascines so that the growing

tips are evenly distributed throughout the length of the bundle. Soil shall be worked into the fascines to fill the voids (stems shall be in close contact) and fascines shall be compressed and tightly tied with biodegradable rope or twine of sufficient strength and durability. Fascines shall be tied at two- (2-) foot intervals.

B. The trench shall be dug into the base of the slope approximately one- (1-) foot deep or as specified in DRAWINGS. The coir mat shall be laid in the empty trench with the bulk of the fabric along the lower (water) side of the trench. The fabric shall be staked securely into the trench on two- (2-) foot intervals with two- (2-) foot wooden stakes. Lay twine crossways in the trench at approximately two- (2-) foot intervals, overlapping the sides of the trench sufficient length to wrap around the fascine and tie. Lay the cuttings within the trench as noted above. Backfill the trench with sand or soil; filling voids between the cuttings. Tie the twine securely around the fascine. The coir mat blanket for the adjacent slope shall be wrapped around the fascine as shown in the DRAWINGS. The trench on each side of the fascine shall be backfilled with compacted topsoil. The top of the fascine shall be slightly visible when the installation is complete.

C. Fascines shall be staked firmly in place with one row of two- (2-) foot long diagonally cut two- (2-) inch by four- (4-) inch wooden stakes every twenty-four (24) inches, alternating sides of the fascine. Tapered ends of adjacent fascines shall be overlapped so that the overall fascine diameter is uniform and continuous. Two (2) stakes shall be used at each fascine overlap such that a stake is driven between the last two ties of each fascine.

D. Figure B below shows a typical installation of live willow fascines.

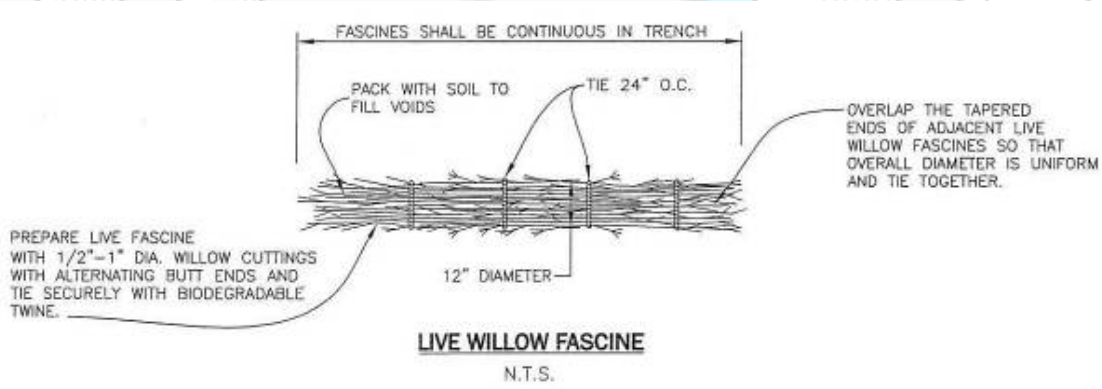


Figure B

3.07 WILLOW BUNDLING

A. Bundles shall consist of five (5) to seven (7) cuttings bound into two- (2-) to three- (3-) inch diameter bundles. Bundles shall be planted with tops of cuttings all oriented up, at elevations to be determined by ENGINEER or PLANT ECOLOGIST with four- (4-) foot spacing or as indicated in DETAIL. Bundles shall be inserted directly into the soil or between rock riprap until they penetrate the groundwater and still protrude four (4) to eight (8) inches from the soil surface. In no case shall the cuttings protrude more than eight (8) inches above the soil surface. In the case of joint planting in riprap, the protruding measurement shall be taken from the soil level between the rocks and not from the top of rock. If tamping is necessary, care shall be taken to prevent splitting of the cuttings. Backfill around the installed bundle with the

original soil to eliminate air voids, then tamp the ground lightly around the bundle with a hammer to hold it securely in place. After the bundles are fully inserted into the soil, the top one (1) to two (2) inches of each cutting shall be pruned if necessary, to a clean, non-damaged cut.

B. Figure C below shows a typical installation of willow bundling. Bundles, which are loose or not fully surrounded by lightly packed soil, will be rejected.

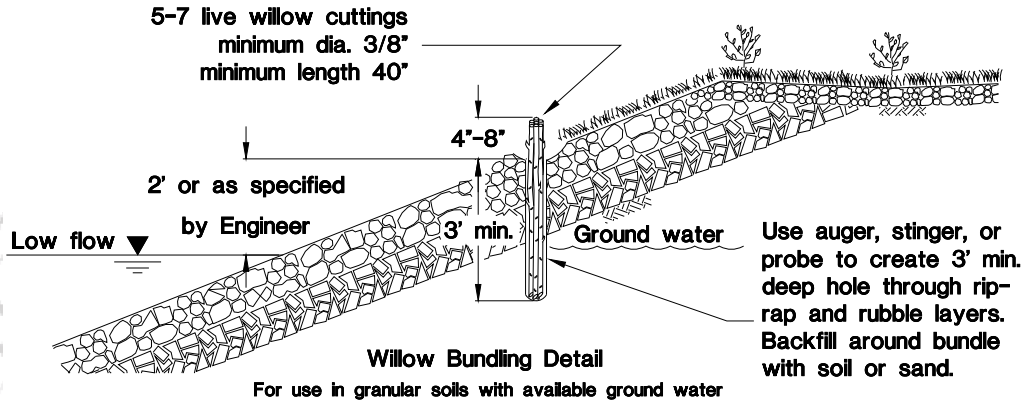


Figure C

3.08 COTTONWOOD POLING

A. Poles shall be planted at locations shown on the DRAWINGS or as determined by ENGINEER or PLANT ECOLOGIST. Cottonwood poling is possible only in naturally "sub irrigated" areas with a shallow water table, generally two (2) to four (4) feet below the ground surface. Cottonwood poles also shall not be planted into areas with less than two (2) feet of moist aerated soil *above* the saturated soil (groundwater level). Four (4) to six (6) feet of the poles shall be inserted into the soil, with the lower foot or two of pole extending below the surface of the water table. Poles shall extend from four (4) to twelve (12) feet above the soil surface after planting, with one-third (1/3) to one-half (1/2) of the pole buried below the surface. Reduce the number of branches on the pole by trimming most of the smaller branches, starting below the upper tip on the top of pole. Do not cut the upper-most tip. There shall be at least six (6) to eight (8) upper branches, plus the tip, remaining on the trimmed pole. Prepare a pilot hole by using an auger, stinger, or probe to bore to a minimum depth of six (6) feet or as directed by ENGINEER or PLANT ECOLOGIST. The pilot hole shall be of sufficient diameter to facilitate easy insertion of cottonwood pole. Backfill around the installed vertical pole with loose sand to eliminate air voids, then tamp the ground lightly around the pole with a hammer to hold it securely in place. A slight saucer shall be formed around each pole to capture and hold precipitation. The upslope side of the saucer shall be open to receive run off and the lower portion of the saucer shall intersect the pole.

B. Figure D below shows typical native cottonwood poling detail in rip rap. (Note: Installation of cottonwood poles may also occur into soil.)

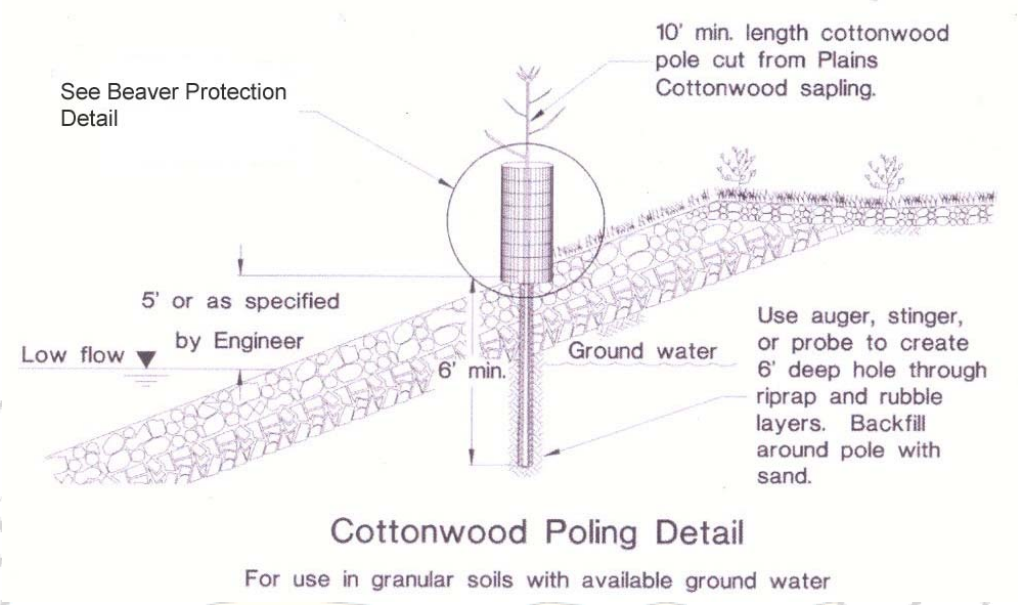


Figure D

C. Unless otherwise accepted by ENGINEER or PLANT ECOLOGIST, each cottonwood pole or newly planted cottonwood tree shall be protected against beaver damage by the installation of an eighteen- (18-) inch diameter, double wrapped beaver protection sleeve made from a nine and one–half- (9-/1/2-) foot length of forty-eight- (48-) inch wide, two- (2-) by four- (4-) inch 12-gauge welded wire fabric which has been fastened with at least two (2) hog rings to each of three (3), six- (6-) foot lengths of one-half- (1/2-) inch diameter rebar, inserted at least two (2) feet into the soil on either side of the tree.

D. Figure E below shows a typical installation of a beaver protection cage.

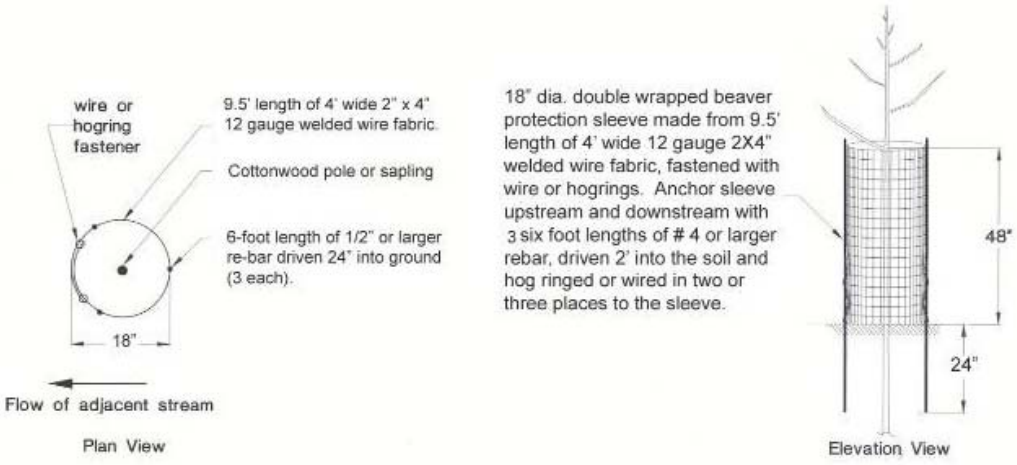


Figure E

3.09 FIELD QUALITY CONTROL

A. Acceptance:

1. The final walk-through shall be performed at the completion of all planting operations under this CONTRACT.

2. At the time of the final walk-through, the Landscape SUBCONTRACTOR shall have planting areas free of debris, and leftover woody plant materials and trimmings. Plant basins shall be installed properly and in good repair. Debris and litter shall be cleaned up, and walkways, curbs, and roads shall be cleared of soil and debris. The inspection shall not occur until these conditions are met.

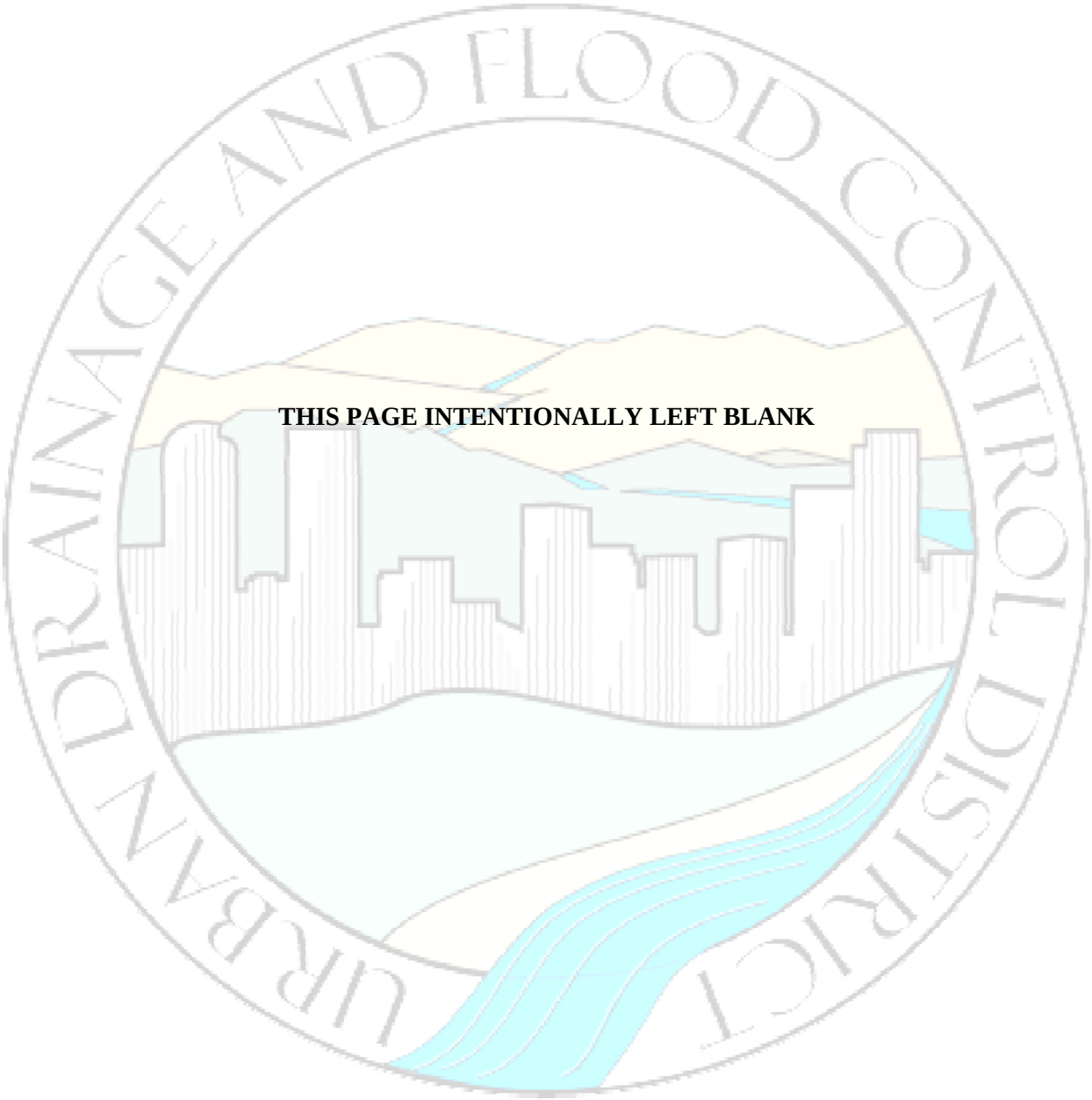
3. ENGINEER or PLANT ECOLOGIST will identify any deficiencies in the form of a punch list.

4. ENGINEER or PLANT ECOLOGIST will give WRITTEN NOTICE of final acceptance when WORK has been performed in compliance with the CONTRACT DOCUMENTS.

5. Deficiencies shall be corrected within the first ten (10) days of the final walk-through. Correct WORK in accordance with the CONTRACT DOCUMENTS at no cost to OWNER.

6. Final acceptance will not be given until all deficiencies are corrected. The Landscape SUBCONTRACTOR shall maintain the site until final acceptance.

END OF SECTION



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SECTION 33 05 13

MANHOLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish and install precast concrete manhole base, sections, adjusting rings, steps, and manhole ring and cover, complete.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 07 91 00, Manhole Preformed Joint Seals.

2. Section 31 23 00, Excavation and Fill.

3. Section 31 23 19, Dewatering.

4. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

a. A48/A48M, Standard Specification for Gray Iron Castings.

b. C150, Standard Specification for Portland Cement.

c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.

1.04 SUBMITTALS

A. CONTRACTOR shall submit manufacturer's technical descriptions of manhole sections, steps, rings, and covers.

B. CONTRACTOR shall submit repair materials and methods to ENGINEER for review and approval.

C. Material and procedures to be used in structure abandonment shall be approved by ENGINEER.

PART 2 PRODUCTS

2.01 MATERIALS

A. Precast Manhole Sections:

1. Precast reinforced concrete manhole top sections shall be produced using Type II Portland cement, or as approved by ENGINEER, and be fabricated in accordance with ASTM C478.

2. Flexible plastic sealant, RAM-NEK, or equivalent, shall be required for all horizontal mating surfaces between precast top sections and precast slab tops of meter vaults.

3. Manhole sections shall be clearly marked with the information specified for product marking in ASTM C478.

4. Imperfections in the precast concrete manhole base or sections shall be reviewed by ENGINEER prior to repair.

B. Manhole Frames and Covers:

1. Manhole frames and covers shall be three hundred and thirty-eight (338) pounds or greater, twenty-four-inch (24") inside diameter, as manufactured by D & L, Model A-1161 with closed pick hole or approved equal.

2. Frost proof covers if required shall be D & L, Model A-1019 with closed pick hole or approved equal. The ring and cover shall conform to ASTM A48/A48M Class 35B.

3. Watertight frames and covers if required shall be NEENAH R-1915/R-1916 Series (as applicable) or approved equal.

C. Manhole Steps:

1. Manhole steps shall be polypropylene and be cast into the manhole wall at the same time the manhole section is cast.

2. The manhole steps shall be approximately nine (9) inches wide and thirteen (13) inches long and weigh approximately two (2) pounds.

3. The steps shall be located no more than twenty eight (28) inches from the top of the finished manhole nor more than eighteen (18) inches from the floor and be spaced no greater than twelve (12) inches apart.

4. The step shall have a skid-resistant surface and be designed mechanically to prevent sideslip.

D. Joints: All precast concrete joints shall be made with a preformed joint sealer or grout. All joints that are made with the joint sealer shall also be pointed with mortar on the inside of the section.

1. Mortar:

a. Mortar used in jointing precast concrete manhole sections shall be composed of one (1) part Portland cement and not more than three (3) nor less than two (2) parts of fine aggregate. Portland cement shall meet the requirements of ASTM C150, Type II. Hydrated lime or masonry cement shall not be used.

b. Fine aggregate shall consist of well-graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances such as calcium chloride. The fine aggregate shall be thoroughly washed and shall be uniformly graded from coarse to fine with a minimum of ninety five percent (95%) passing the #4 sieve and a maximum of seven percent (7%) passing the #100 sieve.

c. All mortar shall be fresh for the WORK at hand. Mortar that has begun to set shall not be used.

2. Joint Seals: Precast concrete manhole section joint seals shall meet the requirements of Section 07 91 00, Manhole Preformed Joint Seals.

PART 3 EXECUTION

3.01 GENERAL

A. The manhole shall be constructed on a properly compacted subgrade and in such a manner that the center of the manhole coincides with the intersection of the projected centerlines of the inlet and discharge pipelines. The surface shall be level to permit proper construction of the riser sections.

B. Changes in size and grade of channels for gravity pipelines shall be made gradually and evenly using concrete made with ASTM C150, Type II Portland cement. The invert channels may be formed directly in the concrete manhole base or may be constructed by laying sewer pipe through the manhole and cutting out the top half (1/2) of the pipe after the concrete has cured and reached design strength. The floor of the manhole outside of the channels shall slope upward from the springline of the pipeline to the wall of the manhole at not less than one (1) inch per foot nor more than two (2) inches per foot.

3.02 INSTALLATION

A. Placement of Precast Concrete Base and Riser Sections:

1. Sections: Set the base and each manhole riser section such that the manhole will be plumb. Use sections of various heights to bring the ring and cover to the proper grade. The last riser section prior to placement of an eccentric cone or flat top shall be the shortest available but in no case greater than twenty four (24) inches in height.

2. Joints: Sections shall be clean and dry. Mortar joints shall not be used when temperature of the air or section will be below thirty five degrees Fahrenheit (35°F) when placing and curing, unless supplemental heat is used to keep the sections warm and mortar from freezing.

a. Using Joint Sealer: The mating surfaces of the two sections to be joined shall be thoroughly cleaned. Apply the joint sealer to the seat of the base or riser section that is already in place. Only one joint is permitted in the sealer. Carefully lower the second precast concrete section onto the first section so that the joint sealer compresses forming a uniform seal. Each succeeding precast section shall be jointed in a similar manner.

b. Using Mortar: The mating surfaces of the two (2) sections to be joined shall be thoroughly cleaned. Apply a one-inch (1") minimum bed of freshly mixed mortar to the joint of the section already in place. The mortar shall be uniform in thickness and cover the entire perimeter of the section. Carefully lower the second precast concrete section onto the first section so that the mortar compresses forming a uniform seal. Tool the mortar for a uniform appearing joint. Each succeeding precast section shall be jointed in a similar manner.

3. Lifting Holes: Fill all lifting holes with mortar.

B. Adjusting Rings, Ring, and Cover Installation:

1. Install ring and cover on one or maximum of two precast concrete adjusting rings.

2. Each adjusting ring shall be a maximum of eight (8) inches high.

3. Adjusting rings shall be placed similar to the precast concrete manhole rings (thoroughly cleaned and placed with mortar or joint sealer).

4. The total allowable height of adjusting rings, ring, and cover shall be one (1) inch less than the manufacturer's shortest precast concrete riser section.

5. Unless otherwise indicated in the DRAWINGS, set the top of the adjusting rings such that no part of the cast iron ring and cover will project above a point one-quarter inch (1/4") below the finish surface of pavement.

C. Pipe Connections:

1. The manhole shall be thoroughly bonded to the barrel of the pipe and all connections with pipe shall be made without projections or voids.

2. All pipes shall have a Hamilton Kent or approved equal waterstop gasket applied around the pipe.

3. The joint between the PVC pipe and manhole wall shall be sealed with a non-shrink grout.

3.03 FIELD QUALITY CONTROL

A. Each manhole shall be watertight from infiltration and exfiltration of water.

B. CONTRACTOR shall inspect and repair all visible leaks and damp spots.

C. When required by ENGINEER, manholes shall be pressure tested by filling with water to the level of the top of the top riser to determine watertightness. There shall be no measurable loss of water in a one-hour (1 hr.) time period.

3.04 ABANDONMENT

A. Manholes to be abandoned in place shall have all pipes entering or exiting the structure plugged with lean concrete or controlled low strength material backfill (Flo-

Fill). For manholes with existing pipes too large to plug with fill, CONTRACTOR shall construct a bulkhead on the inside of the manhole to prevent the fill from entering the pipes.

B. Manhole tops or cone section shall be removed to the top of the full barrel diameter section or to a point not less than eighteen (18) inches below final grade. The structure shall then be backfilled with lean concrete or Flo-Fill. Surface restoration shall be completed to match the surrounding areas.

C. Manhole rings and covers, inlet grates and frames, precast flat top or cone sections, or any other salvageable items shall be salvaged, stored, and delivered to such location as prescribed by ENGINEER.

END OF SECTION

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SECTION 33 41 00

REINFORCED CONCRETE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes construction of reinforced concrete pipe for storm drainage, culverts, and sanitary sewer, including appurtenances normally installed as a part of these systems. Construction may include surface preparation; trench excavation; shoring; dewatering; lay, align and join pipe installation of appurtenances; bedding and backfilling; surface restoration; and other related work.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 REFERENCES

A. The following is a list of standards, which may be referenced in this section:

1. ASTM International (ASTM):
    a. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
    b. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
    c. C150, Standard Specification for Portland cement.
    d. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
    e. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
    f. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.

g. C506, Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.

h. C507, Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe.

i. C655, Standard Specification of Reinforced D-Load Culvert, Storm Drain and Sewer Pipe.

j. C827, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.

k. C990, Standard Specifications for Joints in Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

l. C1417, Standard Specification for Reinforced Concrete Sewer, Storm Drain and Culvert Pipe for Direct Design.

m. C1479, Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installation.

n. C1619, Standard Specifications for Elastomeric Seals for Joining Concrete Pipe.

o. C1628, Standard Specifications for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets.

2. U.S. Bureau of Reclamation (USBR): M-1, Standard Specifications for Reinforced Concrete Pressure Pipe.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type and locations of gasket materials. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

D. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

2. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by ASTM C76 for non-pressurized pipe ,ASTM C361 for low head pipe or ASTM C507 for Elliptical Pipe, concrete pipe, which has any of the following visual defects, will not be accepted.

   a. Porous spots on either the inside or the outside surface of a pipe having an area of more than ten (10) square inches and a depth of more than one-half (1/2) inch.

   b. Pipe, which has been patched to repair porous spots, cracks, or other defects, when such patching was not approved by ENGINEER.

   c. Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.

   d. Pipe that has been damaged during shipment or handling even previously approved before shipment.

   e. Concrete pipe, at delivery to the job site, shall have cured and reach the design strength as required by ASTM C76 for non-pressurized pipe, ASTM C316 for low head pipe or ASTM C507 for Elliptical Pipe and be at least five (3) days (seventy-two [72] hours) old.

2. Acceptance of the pipe at point of delivery shall not relieve CONTRACTOR of full responsibility for any defects in materials due to workmanship.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled in a manner intended to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to ENGINEER. Physical damage to the pipe or accessory shall be repaired by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Precast concrete pipe, which does not conform to ASTM C76 for non-pressurized pipe, ASTM C361 for low head pipe or ASTM C507 for Elliptical Pipe or to any other requirement specified herein, shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of concrete pipe shall conform to the requirements of ASTM C76 for non-pressurized pipe, ASTM C361 for low-head pipes or ASTM C507 Elliptical Pipe, latest revision thereof, listed in Article References.

C. Marking:

1. The following shall be clearly marked on both the interior and exterior surface of the pipe:

    a. Appropriate ASTM Specification: ASTM 76, ASTM C361 or ASTM C507

    b. Class and size.

    c. Date of manufacture.

    d. Name or trademark of manufacturer.

D. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

E. Wall Thickness and Class of Pipe: The wall thickness and reinforcing steel, if any, shall comply with ASTM C76 for non-pressurized pipe, ASTM C361 for low head pipe or ASTM C507 for Elliptical Pipe and the class of pipe designated on the DRAWINGS. No elliptical reinforcing shall be allowed in any circular pipe. All jacking pipe shall be specifically designed by the pipe manufacturer to withstand all forces that the pipe may be subjected to during the jacking operations.

F. Fittings and Specials: Fittings and specials shall be made up of pipe segments having the same structural qualities as the adjoining pipe and shall have the interior treated the same as the pipe.

G. Lifting Holes: Lifting holes will be allowed for storm sewer pipe provided, however, only two lifting holes per pipe length will be allowed.

H. Cement: Unless otherwise required by ENGINEER, or specified otherwise on the DRAWINGS, Type II Modified Portland Cement complying with the

requirements of ASTM C150 will normally be acceptable in the manufacture of concrete pipe.

I. Joints:

1. The joint design for concrete pipe shall be bell and spigot or tongue and groove. Where rubber gaskets are required or specified, the bell or tongue shall be of confined gasket or single offset spigot configuration to properly contain and seat the rubber gasket. The joint assemblies shall be accurately formed so that when each pipe section is forced together in the trench the assembled pipe shall form a continuous watertight conduit with smooth and uniform interior surface, and shall provide for slight movement of any piece of the pipeline due to expansion, contraction, settlement or lateral displacement. If a gasketed joint is used, the gasket shall be the sole element of the joint providing water tightness. The ends of the pipe shall be in planes at right angles to the longitudinal centerline of the pipe, except where bevel-end pipe is required. The ends shall be furnished to regular smooth surfaces.

2. The jointing material used for concrete pipe storm sewer installations thirty six-inch (36") diameter and greater shall be a rubber gasketed joint. For storm sewers less than thirty six-inch (36") diameter the jointing material may be either a rubber gasket or a flexible plastic sealing compound, unless otherwise specified on the DRAWINGS. Only rubber gasketed joints will be acceptable for concrete pipe sanitary sewer installations. All joints and jointing material shall conform to the following minimum requirements.

a. Rubber Gasketed Joints:

1) Rubber gasket joints for tongue and groove or bell and spigot pipe using a confined gasket joint shall consist of an O-ring rubber gasket or other approved gasket configuration and shall conform to the requirements of ASTM 361, ASTM C443, ASTM C1619, or ASTM C1628 for the pipe designated. Unless otherwise approved by ENGINEER, the standard joint configuration shall be as noted in Subsection 3.04.F.
2) Rubber gasket joints for tongue and groove or bell and spigot pipe using a single offset joint shall consist of a non-circular rubber gasket or other approved gasket configuration and shall conform to the requirements of ASTM C76 or ASTM 361 for the pipe designated. Unless otherwise approved by ENGINEER, the standard joint configuration shall be as noted in Subsection 3.04.F.
3) Gaskets may be natural rubber, isoprene or neoprene conforming to ASTM C1619.

b. Flexible Plastic Joint Sealing Compound: Preformed plastic gaskets conforming to the minimum and application requirements set forth in PART 3 may be used as a joint sealant for storm sewer installations in lieu of rubber gaskets.

1) The flexible plastic gasket shall be in conformance with ASTM C990.
2) The plastic sealing compound shall be packaged in extruded preformed rope-like shape of proper size to completely fill the joint when fully compressed. The material shall be protected in a suitable,

removable, two-piece wrapper so that no wrapper may be removed as the compound is applied to the joint surface without disturbing the other wrapper, which remains attached to the compound for protection. The sealing compound shall be impermeable to water, have immediate bonding strength to the primed concrete surface and shall maintain permanent plasticity, and resistance to water, acids, and alkalis.

c. Mortared Joints: Mortared joints shall only be used in special circumstances and only where specifically authorized by ENGINEER. It is the intent of these SPECIFICATIONS to limit the use of mortared joints to the minimum extent possible except where unusual field conditions require deviation from the jointing material specified.

J. Protective Coatings: Normally, no additional exterior or interior protective coatings shall be required for concrete pipe. However, whenever adverse corrosive conditions warrant additional interior protection, those pipe segments will be noted on the DRAWINGS.

K. Concrete Cutoff Collars: Concrete shall meet the requirements of Section 03 31 00, Structural Concrete.

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipes that do not meet the requirements of PART 2 of this section will be rejected and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish and other unsuitable material within the area of excavation and trench side storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Storm sewer pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS.

2. Pipe lines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return

to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids.

3. Pipe with lifting holes shall be installed such that the lifting holes are in the crown of the pipe. All lifting holes shall be properly grouted with cement mortar immediately after the pipe is installed and prior to commencement of backfilling.

4. Pipe with lifting anchors shall be installed such that the lifting anchors are in the crown of the pipe. All lifting anchor recesses in the wall of the pipe at the lifting anchors need not be grouted.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flow line. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

E. Flexible Plastic Joint Sealing Compound:

1. All surfaces of the tongue and groove or bell and spigot shall be primed with an approved priming compound prior to the installation of the sealing compound. The installation of the priming compound and the sealing compound shall be accomplished in strict accordance with the manufacturer's instructions, as to the method of application, quantity of material, the grade of the materials, and the application temperatures.

2. Gaskets installed on both male and female joint surfaces (double gasketing) shall be required for all deflected pipe joints, as well as arch or elliptical pipe joints.

F. Acceptable Joint for Concrete Storm and Sanitary Sewer Installations: Except where a specified type of pipe joint or jointing material is noted on the DRAWINGS, joints and jointing material for concrete sewer installations shall be in conformance with the following table.

Allowable Type of Joints				
Application	**Tongue and Groove with Flexible Plastic Sealing Compound**	**Bell and Spigot (Single Offset) (ASTM 1628 or ASTM C443)**	**Bell and Spigot with USBR M-1 Type R-4 Joint (Confined Gasket) (ASTM C361)**	**Bell and Spigot with USBR M-1 Type R-2 Joint**
1. Non-Pressurized Storm Sewers				
a. Open Cut 36" & larger		X	X	
b. Open Cut 15" to 33"	X	X	X	X
c. Jack or Bored/ Cased			X	X
2. Pressurized Storm Sewers				
a. Open Cut			X	X
b. Jack or Bored/ Cased			X	X
3. Pressurized and Non-Pressurized Sanitary Sewers				
a. Open Cut			X	X
b. Jack or Bored/ Cased			X	X

NOTES:

1) Where more than one type of joint is acceptable, CONTRACTOR may use either type subject to the physical characteristics and manufacturing method of the pipe and approval of ENGINEER.

2) All elliptical pipe or arch pipe shall be double gasketed, or per ASTM C443

3) In addition to the gasket requirements, if the average joint gap in 36-inch diameter pipe or larger pipe exceeds 3/4-inch, the void shall be filled and troweled smooth with an approved non-metallic, non-shrink grout conforming to ASTM C827 or a flexible plastic sealant conforming to ASTM C990 so to provide a smooth interior surface at the joint.

4) For pipe sizes 18-, 24-, 30-, and 36-inch in diameter, the reinforcement in the bell and spigot shall conform to ASTM C76 for the class of pipe specified or to ASTM C361 for a minimum pressure head of 25 feet.

G. Obstructions not shown on the DRAWINGS may be encountered during the progress of the WORK. Should such an obstruction require an alteration to the pipe alignment or grade, ENGINEER will have authority to order a deviation from the DRAWINGS, or ENGINEER may arrange for the removal, relocation, or reconstruction of any structure, which obstructs the pipeline.

H. Joints of precast concrete boxes and precast concrete pipe shall be grouted in accordance with the manufacturer's recommendations or as designated on the DRAWINGS.

3.05 BEDDING AND BACKFILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete cutoff collars shall be placed around pipes as shown on the DRAWINGS or as directed by the ENGINEER.

3.07 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.08 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

SECTION 33 41 01

HIGH-DENSITY POLYETHYLENE PIPE (HDPE)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes construction of high-density polyethylene pipe for storm drainage culverts including appurtenances normally installed as a part of these systems. Construction may include surface preparation, trench excavation, shoring, dewatering, lay, align, and join pipe, installation of appurtenances, bedding and backfilling, surface restoration, and other related work.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 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. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
    b. M294, Standard Specification for Corrugated Polyethylene Pipe.
    c. Section 18, Soil Thermoplastic Pipe Interaction Systems.
2. ASTM International (ASTM):
    a. D638, Standard Test Method for Tensile Properties of Plastic.
    b. D1056, Specification for Flexible Cellular Materials - Sponge and Expanded Rubber.
    c. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

d. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

e. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material.

f. D4976, Specification for Polyethylene Plastics Molding and Extrusion Materials.

g. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

h. F667, Standard Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.

i. F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

j. F2306, Standard Specification for 12 to 60 in. Annular Corrugated Profile-Wall Polyethylene Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.

k. F2562, Specifications for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage.

l. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and fittings.

3. Plastic Pipe Institute (PPI):

a. Handbook of Polyethylene Pipe.

b. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type and locations of gasket materials. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

D. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. Experienced in the design, manufacture, and commercial supplying of the specific material for a minimum period of five (5) years.

2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a period of one (1) year.

3. Certify to above minimum experience requirements.

B. All HDPE pipe and fittings shall be from a single manufacturer. All HDPE pipe to be installed may be inspected at the factory for compliance with these SPECIFICATIONS by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of these plant inspections of all pipe approved, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

C. Inspection of the pipe shall also be made by the ENGINEER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the SPECIFICATION requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. Shipping: Material shall be shipped so to not cut, kink, or otherwise damage pipe during transport.

2. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

3. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

c. Keep pipe shaded from direct sunlight prior to installation in the trench.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by the applicable ASTM Specifications, pipe, which has any of the following visual defects, will not be accepted.

a. Cracks, bubbles, pinholes, inclusions or occlusions, which, because of their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired or replaced by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to Engineer. Physical damage to the pipe or accessory shall be repaired or replaced by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: HDPE pipe, which does not conform to ASTM D3350, ASTM D 4976, ASTM F667, ASTM F894, ASTM F2306, or ASTM F2562 or to any other requirement specified herein, shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable Pipe diameters for this specification shall be between eighteen (18) inches to thirty-six (36) inches unless approved by ENGINEER and OWNER.

C. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of HDPE pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed in Article References.

D. Marking:

1. The following shall be clearly marked on both the interior and exterior surface of the pipe:

a. Class and size.

b. Date of manufacture.

c. Name or trademark of manufacturer.

d. Deflection angle for bends.

E. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

F. Wall Thickness and Class of Pipe:

1. The wall thickness shall comply with the appropriate ASTM Specification and the class of pipe designated on the DRAWINGS.

2. HDPE pipe and fittings shall have a smooth interior and corrugated exterior. 18-inch through 36-inch pipe shall meet the requirements of AASHTO M294 Type S. The pipe shall have a full circular cross-section with annular corrugations. Pipe shall be produced to constant internal diameters.

3. Pipe and fittings shall be made of high-density, high-molecular weight polyethylene material meeting the requirements of cell classification 324420C or higher in accordance with ASTM D3350. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this SPECIFICATION.

G. Fittings and Specials:

1. Elbows and fittings shall be mitered from pipe sections welded together on the interior and exterior at all junctions.

2. The pipe sections forming the miters shall be cut to fit with no gap.

3. Tolerances on the angle of all elbows shall be plus or minus 1 degree.

4. The standard turning radius of elbows shall be 1.5 times the inside diameter. Special turning radii shall be used for special applications.

5. Elbows shall conform to the following requirements:

Angle of Elbow (Degrees)	**Number of Miters**
0 to 45	1
45 to 90	2

6. Elbows shall be designed to prevent joint rupture resulting from dynamic forces or application of a test pressure of 25 psi.

H. Joints:

1. Watertight joints shall be accomplished by rubber gasket, in accordance with ASTM D3212.

2. Gaskets shall be closed-cell synthetic, expanded rubber meeting the requirements of ASTM D1056, Grade 2A2 or made of polyisoprene meeting ASTM F477. Gaskets shall be installed on the connection by the pipe manufacturer.

3. Lubricant shall have no detrimental effect on the gasket of on the pipe.

4. Integral bell and spigot gasketed joints shall be designed so that when assembled, the elastomeric gasket, contained in a machined groove on the pipe spigot, is compressed radially in the pipe bell to form a positive seal. The joint shall be designed to avoid displacement of the gasket when installed in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipes, which do not meet the requirements of PART 2 of this section, will be rejected and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness, and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools, and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish and other unsuitable material within the area of excavation and trench side storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS.

2. Pipelines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids. Any pipe which is not in true alignment or which shows undue settlement after laying shall be taken up and re-laid at CONTRACTOR'S expense.

3. Lift or roll pipe to protect coating. Do not drag over gravel or rock. Avoid striking rocks or hard objects when lowering into trench.

    a. Pipe on which coatings have been damaged may be rejected at the site of the Work regardless of previous approvals.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flowline. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

E. Obstructions not shown on the DRAWINGS may be encountered during the progress of the WORK. Should such an obstruction require an alteration to the pipe alignment or grade, ENGINEER will have authority to order a deviation from the DRAWINGS, or ENGINEER may arrange for the removal, relocation, or reconstruction of any structure which obstructs the pipeline.

3.05 BEDDING AND BACKFILL FILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete shall meet the requirements of Section 03 31 00, Structural Concrete.

3.07 FIELD TESTING

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:

1. Alignment:

    a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.

    b. Contractor shall clean pipe of joint sealant, other dirt, and debris prior to inspection.

    c. Determine from Illumination or Physical Inspection:

        1) Presence of any misaligned, displaced, or broken pipe.
        2) Presence of visible infiltration or other defects.

B. Deflection Testing:

1. Maximum installed deflections of flexible pipe shall be five percent (5%) of mean internal diameter.

2. At the ENGINEER's discretion, CONTRACTOR shall test flexible pipe after backfill has been in place 30 days. Deflection is defined per ASTM D2321.

    a. CONTRACTOR shall provide rigid ball or mandrel deflection testing equipment and labor.

    b. Obtain approval of equipment and acceptance of method proposed for use in testing deflection of the pipe. Test shall be performed without mechanical pulling devices.

    c. Pipe exceeding deflection limits, as defined in ASTM D2321, shall be replaced or re-compacted at CONTRACTOR's expense.

3.08 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs, or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.09 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

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SECTION 33 41 02

SPIRAL RIBBED ALUMINIZED STEEL PIPE (ASP)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes construction of spiral-ribbed, aluminized steel pipe (ASP), and flared end sections intended for use in storm drainage systems and culverts, including appurtenances normally installed as part of these systems. Construction may include surface preparation, trench excavation, shoring, dewatering, lay, align, and join pipe, installation of appurtenances, bedding, and backfilling, surface restoration, and other related work.

1.02 RELATED SECTIONS

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 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. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
    b. M274, Steel Sheet, Aluminum Coated (Type 2) for Corrugated Steel Pipe.
2. ASTM International (ASTM):
    a. A760, Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
    b. A796, Structural Design of Corrugated Steel Pipe, Pipe-Arches, Arches for Storm and Sanitary Sewers, and Other Buried Applications.
    c. A798, Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications.
    d. A929, Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.
3. Standard Specification for Highway Bridges:
    a. Section 12 - Soil-Corrugated Metal Structure Interaction Systems.

b. Section 26 - Metal Culverts.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type, and locations of gasket materials and a schedule of pipe lengths (including length of individual pipes by diameter) for the entire project. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall submit to ENGINEER, the name of the pipe and fitting suppliers and a list of materials to be furnished including complete manufacturers specifications and data covering the materials to be furnished and detailed drawings covering the installation.

D. CONTRACTOR shall submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM and AASHTO Standards specified herein.

E. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. Experienced in the design, manufacture, and commercial supplying of the specific material for a minimum period of five (5) years.

2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a period of one (1) year.

3. Certify to above minimum experience requirements.

B. All ASP pipe and fittings shall be from a single manufacturer. All ASP pipe to be installed may be inspected at the factory for compliance with these SPECIFICATIONS by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of these plant inspections of all pipe approved, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

C. Inspection of the pipe shall also be made by the ENGINEER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the SPECIFICATION requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. Shipping: Material shall be shipped so to not bend, dent, or otherwise damage pipe during transport.

2. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

3. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

   a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes.

   b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by the applicable ASTM Specifications, pipe which has any of the visual defects will not be accepted.

   a. Dents, punctures, or damage to the coating which, because of the nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe fittings, specials, valves, and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled so as to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to ENGINEER. Physical damage to the pipe or accessory shall be repaired or replaced by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIAL

A. General: ASP pipe, which does not conform to the applicable ASTM Standard Specifications, listed in Article References or to any other requirement specified herein shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of ASP pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed in Article References.

C. Marking:

1. The following shall be clearly marked on both the interior and exterior surface of the pipe:

a. Pipe gauge and size.

b. Date of manufacture.

c. Name or trademark of manufacturer.

d. Deflection angle for bends.

D. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

E. Wall Thickness and Class of Pipe:

1. Spiral-ribbed aluminized steel pipe shall be manufactured conforming to AASHTO M36.

2. Pipe shall be aluminized Type 2, steel.

3. Metal Sheet for Spiral-ribbed Aluminized Pipe: All metal sheet for pipe fabricated under this SPECIFICATION shall be formed from aluminum-coated sheet conforming to AASHTO M274.

4. Metal Sheet Thickness for Spiral-ribbed aluminized Pipe: Thickness (gauge) specified by AASHTO M36, Section 8, Table 12.

5. Pipe Seam and Ends: Pipe shall be fabricated with helical corrugations having a continuous lock seam extending from end to end of each length of pipe. Each end of each length of pipe shall be re-rolled to an annular corrugation. The re-rolling shall be a minimum of three corrugations.

6. Classification shall be as follows for this SPECIFICATION of spiral-ribbed aluminized pipe:

a. Type IR: This pipe shall have a full circular cross section with a single thickness of smooth sheet, fabricated with helical ribs projecting outward.

b. Type IIR: This pipe shall be a Type IR pipe that has been reformed into a pipe-arch having an approximately flat bottom.

F. Joints:

1. Coupling Bands:

a. Coupling bands shall conform to AASHTO M36 as directed herein and shall allow the use of O-ring gaskets.

b. All coupling bands shall be no less than ten and one-half (10-1/2) inches wide with the minimum width conforming to the appropriate AASHTO designation for the spiral-ribbed aluminized pipe.

c. Steel Sheeting for Coupling Bands: The sheet used in fabricating coupling bands shall conform to the same SPECIFICATION listed herein. The sheet thickness of the coupling bands shall conform to the appropriate AASHTO designation for the corrugated steel pipe.

d. Hardware for Coupling Bands: Bolts and nuts shall conform to AASHTO M36. Coupling bands shall have bar, bolt, and strap connector assemblies per lap.

e. O-Ring Gaskets: Gaskets shall meet or exceed the requirements of AASHTO M198 and be used in conjunction with coupling bands. The use of TC-40 type mastic will be required at the lap joint with O-ring gaskets. The requirement for the use of O-ring gaskets will be noted on the DRAWINGS.

G. Fittings and Specials:

1. Fittings shall be for horizontal and vertical deflections, as specified in the DRAWINGS.

2. Fittings may also be for any accessory such as inlets, manhole structures, and manhole risers, as specified in the DRAWINGS.

3. Fittings shall be at a minimum, manufactured from the same material, thickness, and coating as the pipeline to which they are joined.

H. Concrete Cutoff Collars:

1. Concrete shall meet the requirements of section 03 31 00, Structural Concrete

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipe, which does not meet the requirements of PART 2 of this section, will be rejected and replaced at CONTRACTOR’s expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness, and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools, and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish, and other unsuitable material within the area of excavation and trench side storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall

contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing, or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS. Pipelines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids. Any pipe which is not in true alignment or which shows undue settlement after laying shall be taken up and re-laid at CONTRACTOR's expense.

2. Lift or roll pipe to protect coating. Do not drag over gravel or rock. Avoid striking rocks or hard objects when lowering into trench.

   a. Pipe on which coatings have been damaged may be rejected at the site of the WORK regardless of previous approvals.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flow line. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Join pipe sections with bolted coupling bands of the same material as the pipe in accordance with the manufacturer's recommendations.

3. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit (60°F) for a period of thirty (30) minutes before being placed on the pipe.

3.05 BEDDING AND BACKFILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete cutoff collars shall be placed around pipes as shown on the DRAWINGS or as directed by the ENGINEER.

3.07 FIELD TESTING

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:

1. Alignment:

a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.

b. CONTRACTOR shall clean pipe of excess mortar, joint sealant, and other dirt and debris prior to inspection.

c. Determine from Illumination or Physical Inspection:

1) Presence of any misaligned, displaced, or broken pipe.
2) Presence of visible infiltration or other defects.

B. Deflection Testing:

1. Maximum installed deflections of flexible pipe shall be five percent (5%) of mean internal diameter.

2. At the ENGINEER’s discretion, CONTRACTOR shall test flexible pipe after backfill has been in place 30 days. Deflection is defined per ASTM D2321.

a. CONTRACTOR shall provide rigid ball or mandrel deflection testing equipment and labor.

b. Obtain approval of equipment and acceptance of method proposed for use in testing deflection of the pipe. Test shall be performed without mechanical pulling devices.

c. Pipe exceeding deflection limits, as defined in ASTM D2321, shall be replaced or re-compacted at CONTRACTOR's expense.

3.08 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs, or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.09 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

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SECTION 33 41 03

POLYVINYL CHLORIDE (PVC) PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section includes all labor, materials, equipment, and incidentals required and installation of Polyvinyl Chloride (PVC) pipe and fittings, 18-inch diameter to 60-inch diameter intended for use in storm drainage systems including appurtenances normally installed as part of these systems. Construction may include surface preparation, trench excavation shoring, dewatering, lay align and join pipe, installation of appurtenances, bedding and backfilling, surface restoration, and other related work.

1.02 RELATED SECTIONS

1. Section 31 11 00, Clearing and Grubbing.
2. Section 31 14 13, Topsoil Stripping and Stockpiling.
3. Section 31 23 00, Excavation and Fill.
4. Section 31 23 19, Dewatering.
5. Section 31 23 33, Trenching and Backfilling.

1.03 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. M278, Standard Specification for Class PS46 Poly (Vinyl Chloride) (PVC) Pipe
   b. M304, Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
2. ASTM International (ASTM):
   a. D1784, Standard Specification for Rigid Polyvinyl Chloride (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds.
   b. D2321, Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications.
   c. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

d. D3212, Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

e. F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

f. F679, Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

g. F794, Polyvinyl Chloride (PVC) Ribbed Gravity Sewer Pipe and Fittings Based On Controlled Inside Diameter.

h. F949, Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.

i. F1803, Standard Specifications for Poly (Vinyl Chloride) (PVC) Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter.

1.04 SUBMITTALS

A. Details of fittings and specials shall be furnished for approval by ENGINEER.

B. Unless otherwise specified, CONTRACTOR shall submit to ENGINEER for approval SHOP DRAWINGS showing the exact dimension of the joints including the permissible tolerances for each size of pipe being furnished and the size, type and locations of gasket materials and a schedule of pipe lengths (including length of individual pipes by diameter) for the entire project. Approval of the joint detail DRAWINGS shall not relieve CONTRACTOR of any responsibilities to meet all of the requirements of these SPECIFICATIONS, or of the responsibility for correctness of CONTRACTOR's details.

C. CONTRACTOR shall submit to ENGINEER, the name of the pipe and fitting suppliers and a list of materials to be furnished including complete manufacturers specifications and data covering the materials to be furnished and detailed drawings covering the installation.

D. CONTRACTOR shall submit certified test reports that the pipe was manufactured and tested in accordance with the ASTM and AASHTO Standards specified herein.

E. CONTRACTOR shall cooperate with ENGINEER in obtaining and providing samples of all specified materials.

1.05 QUALITY ASSURANCE

A. Manufacturer:

1. Experienced in the design, manufacture, and commercial supplying of the specific material for a minimum period of five (5) years.

2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a period of one (1) year.

3. Certify to above minimum experience requirements.

B. All PVC pipe and fittings shall be from a single manufacturer. All PVC pipe to be installed may be inspected at the factory for compliance with these SPECIFICATIONS by an independent testing laboratory provided by the OWNER. The CONTRACTOR shall require the manufacturer's cooperation in these inspections. The cost of these plant inspections of all pipe approved, plus the cost of inspection of a reasonable amount of disapproved pipe, will be borne by the OWNER.

C. Inspection of the pipe shall also be made by the ENGINEER or other representatives of the OWNER after delivery. The pipe shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though pipes may have been accepted as satisfactory at the place of manufacture. Pipe rejected after delivery shall be marked for identification and shall immediately be removed from the job.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Responsibility for Material:

1. Shipping: Material shall be shipped so to not bend, dent or otherwise damage pipe during transport.

2. CONTRACTOR shall be responsible for all materials intended for the WORK that are delivered to the construction site and accepted by CONTRACTOR. Payment shall not be made for materials found to be defective or damaged in handling after delivery and acceptance. Defective or damaged materials shall be removed and replaced with acceptable materials at CONTRACTOR's expense.

3. CONTRACTOR shall be responsible for the safe and proper storage of such materials.

a. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.

b. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.

c. Keep Pipe shaded from direct sunlight prior to installation in the trench.

B. Pipe Acceptance:

1. In addition to any deficiencies not covered by the applicable ASTM Specifications, any pipe or fitting which has any of the visual defects will not be accepted.

a. Delaminations, cracks, bubbles, pinholes, inclusions or occlusions, which, because of their nature, degree, or extent, detrimentally affect the strength and serviceability of the pipe.

C. Pipe Handling:

1. Pipe and accessories furnished by CONTRACTOR shall be delivered to, unloaded, and distributed at the site by CONTRACTOR. Each pipe shall be unloaded adjacent to or near the intended laying location.

2. Pipe, fittings, specials, valves and appurtenances shall be unloaded and stored in a manner that precludes shock or damage. Such materials shall not be dropped.

3. Pipe shall be handled so as to prevent damage to the pipe ends or to any coating or lining. Pipe shall not be skidded or rolled against adjacent pipe. Damaged coatings or lining shall be repaired or replaced by CONTRACTOR, at CONTRACTOR's expense in accordance with the recommendations of the manufacturer and in a manner satisfactory to ENGINEER. Physical damage to the pipe or accessory shall be repaired or replaced by CONTRACTOR at CONTRACTOR's expense, and in a manner satisfactory to ENGINEER.

D. Gasket Storage: All gaskets shall be stored in a cool place, preferably at a temperature of less than seventy degrees Fahrenheit (70°F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: PVC pipe, which does not conform to the applicable ASTM Standard Specifications, listed in Article References or to any other requirement specified herein shall not be approved for storm sewer, culvert, or sanitary sewer installations.

B. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of PVC pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed in Article References.

C. Marking:

1. Class and size.

2. Date of manufacture.

3. Name or trademark of manufacturer.

4. Deflection angle for bends.

D. Diameter of Pipe: The diameter indicated on the DRAWINGS shall mean the inside diameter of the pipe.

E. Wall Thickness and Class of Pipe:

1. PVC large-diameter plastic gravity sewer pipe and fitting shall conform to ASTM F679 or ASTM F794, with minimum pipe stiffness of 46 psi.

2. The wall thickness shall comply with the appropriate ASTM Specification and the class of pipe designated on the DRAWINGS.

3. PVC pipe and fittings shall have a smooth interior and corrugated exterior. 18-inch through 36-inch pipe shall meet the requirements of AASHTO M294 Type S. The pipe shall have a full circular cross-section with annular corrugations. Pipe shall be produced to constant internal diameters.

4. Pipe and fittings shall be made of high-density, high molecular weight polyethylene material meeting the requirements of cell classification 324420C or higher in accordance with ASTM D3350. Clean rework material generated by the manufacturer's own production may be used so long as the pipe or fittings produced meet all the requirements of this SPECIFICATION.

F. Fittings and Specials:

1. Fittings and specials shall conform to ASTM F679 or ASTM F794, with minimum pipe stiffness of 46 psi.

2. Fittings or specials shall have permanently and plainly marked on the interior of the pipe wall the pipe class and size, date of manufacture, manufacturer's name or trademark, and deflection angle for bends.

G. Joints:

1. Pipe joints shall be airtight and of the bell spigot type with elastomeric gaskets conforming to the requirements of ASTM D3212.

2. Gaskets shall comply in all aspects with physical requirements specified in ASTM F477.

3. Gaskets shall be neoprene or synthetic elastomer. Natural rubber is not acceptable:

4. The gasket shall be the only element depended upon to make the joint flexible and watertight.

5. Lubricant used for assembly shall have no detrimental effect on the gasket or the pipe.

6. Integral bell and spigot gasketed joints shall be designed so that when assembled, the elastomeric gasket, contained in a machined groove on the pipe spigot, is compressed radially in the pipe bell to form a positive seal. The joint shall be designed to avoid displacement of the gasket when installed in accordance with the manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

A. The pipe and pipe coatings shall be inspected by ENGINEER for damage or defects before being placed in the trench. Damaged or defective pipe shall not be installed.

B. All pipes which do not meet the requirements of PART 2 of this section will be rejected and replaced at CONTRACTOR's expense.

C. CONTRACTOR shall install storm sewer pipe of the type, diameter, load class, wall thickness and protective coating that is shown on the DRAWINGS.

D. Proper equipment, implements, tools and facilities shall be provided and used by CONTRACTOR for safe and convenient installation of the type of pipe being installed.

3.02 SURFACE PREPARATION

A. Within Easement, Cultivated, Landscaped, or Agricultural Area:

1. All vegetation, such as brush, sod, heavy growth of grass or weeds, decayed vegetable matter, rubbish and other unsuitable material within the area of excavation and trenchside storage shall be stripped and disposed of in accordance with the requirements of Section 31 11 00, Clearing and Grubbing.

2. Topsoil shall be removed to a depth of eight (8) inches or the full depth of the topsoil, whichever is less. Topsoil shall be removed from the area to be excavated and stockpiled, or, CONTRACTOR may elect to import topsoil to replace that lost during excavation.

B. Within Unpaved Roadway Areas: CONTRACTOR shall strip the cover material from graveled roadways or other developed, but unpaved traffic surfaces to the full depth of the existing surfacing. The surfacing shall be stockpiled to the extent that it is acceptable and useable for restoration purposes.

C. Within Paved Areas:

1. The removal of pavement, sidewalks, driveways, or curb and gutter shall be performed in a neat and workmanlike manner. Concrete pavement, asphalt, sidewalks, driveways, or curb and gutter shall be cut with a power saw to a depth of two (2) inches prior to breaking. The concrete shall be cut vertically in straight lines and avoiding acute angles.

2. Bituminous pavement, sidewalks, driveways, or curb and gutter shall be cut with a power saw, pavement breaker, or other approved method of scoring the mat prior to breaking or excavation. The bituminous mat shall be cut vertically, in straight lines and avoiding acute angles.

3. Any overbreak, separation, or other damage to the existing bituminous or concrete outside the designated cut lines shall be replaced at CONTRACTOR's expense.

4. Excavated paving materials shall be removed from the job site and shall not be used as fill or backfill.

3.03 DEWATERING

A. All pipe trenches and excavation for structures and appurtenances shall be kept free of water during pipe laying and other related work. The method of dewatering shall provide for a dry foundation at the final grades of excavation in accordance with Section 31 23 19, Dewatering. Water shall be disposed of in a manner that does not inconvenience the public or result in a menace to public health. Pipe trenches shall

contain enough backfill to prevent pipe flotation before dewatering is discontinued. Dewatering shall continue until such time as it is safe to allow the water to rise in the excavation.

3.04 INSTALLATION

A. General: Precautions shall be taken to prevent foreign material from entering the pipe before or while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. The open ends of pipe shall be closed with a watertight plug, or with other devices approved by ENGINEER, at times when pipe laying is not in progress.

B. Pipe:

1. Pipe shall be installed in accordance with the manufacturer's recommendations for installing the type of pipe used, unless otherwise shown on the DRAWINGS.

2. Pipe lines shall be laid to the grades and alignment shown on the DRAWINGS or staked by ENGINEER. Variation from the prescribed grade and alignment shall not exceed one-tenth (0.10) foot, and the rate of departure from, or return to, the established grade or alignment shall be not more than one (1) inch in ten (10) feet, unless approved by ENGINEER. No deviation from grade shall cause a depression in the sewer invert that could retain fluids or solids. Any pipe which is not in true alignment or which shows undue settlement after laying shall be taken up and re-laid at Contractor's expense.

3. Lift or roll pipe to protect coating. Do not drag over gravel or rock. Avoid striking rocks or hard objects when lowering into trench.

a. Pipe on which coatings have been damaged may be rejected at the site of the WORK regardless of previous approvals.

C. Pipe Fittings:

1. Pipe fittings shall be laid so as to form a close concentric joint with the adjoining pipe to avoid sudden offsets of the flowline. Pipe sections shall be joined together in accordance with the manufacturer's recommendations.

2. Pipe fittings and appurtenances shall be carefully lowered into the trench with suitable tools or equipment to prevent damage to the pipe and protective coatings and linings; pipe and accessory materials shall not be dropped or dumped into the trench.

D. Gaskets: No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used, when the air temperature is ten degrees Fahrenheit (10°F) or lower shall be warmed to temperature of sixty degrees Fahrenheit) for a period of thirty (30) minutes before being placed on the pipe.

E. Obstructions not shown on the DRAWINGS may be encountered during the progress of the WORK. Should such an obstruction require an alteration to the pipe alignment or grade, ENGINEER will have authority to order a deviation from the DRAWINGS,

or ENGINEER may arrange for the removal, relocation, or reconstruction of any structure which obstructs the pipeline.

3.05 BEDDING AND BACKFILL FILLING

A. Select bedding and backfill material may be required and shall be so shown on the DRAWINGS. Select bedding materials shall conform to the designated gradation requirements in Section 31 23 33, Trenching and Backfilling.

B. Bedding material shall be placed under and around all pipes as shown on the DRAWINGS. Bedding shall be placed in a manner that will minimize separation or change in its uniform gradation. Bedding shall be distributed in six-inch (6") maximum layers over the full width of the trench and simultaneously on both sides of the pipe. Special care shall be taken to ensure full compaction under the haunches and joints of the pipe.

C. Backfill compaction shall not be attained by inundation or jetting, unless approved in writing by ENGINEER. Backfill material shall be uniformly compacted the full depth of the trench.

3.06 CONCRETE CUTOFF COLLARS

A. Concrete shall meet the requirements of Section 03 31 00, Structural Concrete.

3.07 FIELD TESTING

A. Acceptance Tests for Gravity and Low-Pressure Pipelines:

1. Alignment:

a. Sewer shall be inspected by flashing a light between manholes or by physical passage where space permits.

b. Contractor shall clean pipe of, joint sealant, and other dirt and debris prior to inspection.

c. Determine from Illumination or Physical Inspection:

1) Presence of any misaligned, displaced, or broken pipe.
2) Presence of visible infiltration or other defects.

B. Deflection Testing:

1. Maximum installed deflections of flexible pipe shall be five percent (5%) of mean internal diameter.

2. At the ENGINEER’s discretion, CONTRACTOR shall test flexible pipe after backfill has been in place 30 days. Deflection is defined per ASTM D2321.

a. CONTRACTOR shall provide rigid ball or mandrel deflection testing equipment and labor.

b. Obtain approval of equipment and acceptance of method proposed for use in testing deflection of the pipe. Test shall be performed without mechanical pulling devices.

c. Pipe exceeding deflection limits, as defined in ASTM D2321, shall be replaced or re-compacted at CONTRACTOR's expense.

3.08 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs or other surfaces broken, cut or damaged by CONTRACTOR shall be replaced in kind or as shown on the DRAWINGS.

3.09 CLEAN UP

A. All rubbish, unused materials, and other non-native materials shall be removed from the job site. All excess excavation shall be disposed of as specified, and the right-of-way shall be left in a state of order and cleanliness.

END OF SECTION

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SECTION 33 46 00

SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. CONTRACTOR shall furnish all labor, tools, and equipment and perform all Work necessary for, or incidental to, the supply and installation of pipe underdrains as shown in the DRAWINGS and specified herein. This WORK includes trenching, placement of a geotextile fabric, rock, HDPE pipe, PVC pipe, and clean-outs to drain water from structure foundations. The WORK shall be coordinated with the work of all other trades and activities on the PROJECT.

B. CONTRACTOR shall furnish and install all supplementary and miscellaneous items, appurtenances and devices incidental to or necessary for a complete installation.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS which may be related to this section:

1. Section 31 23 19, Dewatering.

2. Section 31 23 33, Trenching and Backfilling.

1.03 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. M252, Standard Specification for Corrugated Polyethylene Drainage Pipe.

b. M294, Standard Specification for Corrugated Polyethylene Pipe, 300-mm to 1500-mm Diameter.

2. ASTM International (ASTM):

a. C33, Standard Specification for Concrete Aggregates.

b. D737, Standard Test Method for Air Permeability of Textile Fabrics.

c. D1784, Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

d. D3034, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

e. D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

f. D3776, Standard Test Method for Mass per Unit Area (Weight) of Fabric.

g. D3786, Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method.

h. D3887, Standard Specification for Tolerances for Knitted Fabrics

i. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

j. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

k. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

l. D4751, Standard Test Method for Determining the Apparent Opening Size of a Geotextile.

m. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

n. D6241, Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products using a 50-mm Probe

o. D6707, Standard Specification for Circular-Knit Geotextile for Use in Subsurface Drainage Applications

p. F405, Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.

q. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.04 SUBMITTALS

A. Submittals shall include as a minimum the following:

1. Geotextile fabric.

2. Rock gradation results.

3. Polyethylene pipe and fittings (including slot perforation pattern).

4. PVC pipe and fittings (including perforation pattern).

5. Meter vault sections and lid (where required for clean-outs).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Geotextile: During shipment and storage, the rolls of fabric shall be protected against deterioration from the sun, mud, dirt, dust, and other deleterious conditions at all times.

B. Keep Pipe shaded from direct sunlight prior to installation in the trench.

PART 2 PRODUCTS

2.01 GEOTEXTILE FABRIC

A. The fabric shall have complete resistance to deterioration from ambient temperatures, acid, and alkaline conditions, and shall be indestructible to microorganisms and insects. The material shall be resistant to short-term (until placement) deterioration by ultraviolet light or protected until placement, as recommended by the manufacturer, such that no deterioration occurs.

B. Fibers used in the manufacture of geotextiles, and the threads used in joining geotextiles by sewing, shall consist of long chain synthetic polymers composed of at least eighty five percent (85%) by weight polyolefins, polyesters, or polyamides. They shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including selvedges.

C. The property values shown below are not design values, but represent the minimum accepted physical characteristics of the geotextile required. The number represents a value to be confirmed by the manufacturer. These values represent minimum average roll values (for example, any roll tested shall meet or exceed the minimum values in the table).

Property	Value	Test Method
Grab Strength	120 lbs.	ASTM D4632
Grab Tensile Elongation	55%	ASTM D4632
Burst Strength	225 psi	ASTM D3786
Puncture Resistance	65 lbs.	ASTM D4833
Trapezoid Tear Strength	50 lbs.	ASTM D4533
Apparent Opening Size	70, U.S. Standard Sieve	ASTM D4751
Permittivity	1.7 $sec.^{-1}$	ASTM D4491
Water Flow Rate	140 $gal./min./ft.^2$	ASTM D4491

D. Geotextile fabric for pipe underdrains shall be Mirafi 140N or equivalent.

2.02 DRAIN SLEEVE

Property	Value	Test Method
Weight	3.5 – 3.9 $oz./yd^2$.	ASTM D3776
Thickness	0.040 in.	
Burst Strength (min)	120 psi	ASTM D3887
Puncture Resistance (min)	180 lbs.	ASTM D6241
Air Permeability	700 $ft.^3/ft.^2/min.$	ASTM D737
Apparent Opening Size	30, U.S. Standard Sieve	ASTM D4751

Property	Value	Test Method
Permittivity (min)	2.4 $sec.^{-1}$	ASTM D4491
Water Flow Rate	300 $gal/min/ft.^2$ (2" Constant Head)	ASTM D4491

2.03 ROCK BEDDING

A. Unless otherwise shown in the DRAWINGS, rock shall consist of dense, clean, uniformly graded material with a maximum size of two (2) inches and less than five percent (5%) passing the three-eighths inch (3/8") sieve. Coarse concrete aggregate meeting the requirements of ASTM C33 No. 4 may be used.

2.04 HDPE PIPE AND FITTINGS

A. ADS Heavy Duty Pipe meeting ASTM F405 with slotted or circular perforations providing a minimum inlet area as required by AASHTO M252 or AASTO M294 Class 2 perforations.. The slotted perforation pattern shall be in accordance with AASHTO M252 or AASHTO M294 Class 2 perforations providing a flow rate for six-inch (6") diameter pipe of ninety four hundredths (0.94) GPM at a one-foot (1') pressure head. The pipe is available in ten-foot (10') joints, one hundred (100), and one thousand five hundred (1,500) linear foot rolls. The pipe shall include a factory-installed drain sleeve that meets the requirements of ASTM D6707 (ADS Drain-Sleeve or approved equal).

B. HDPE pipe and fittings shall be made in accordance with ASTM F405.

C. HDPE pipe shall be Type S or approved equal.

2.05 PVC PIPE AND FITTINGS

A. Specifications and Dimensions:

1. PVC pipe and fittings shall be made in accordance with ASTM D1784.

2. The pipe shall be designed, manufactured, tested, inspected and marked in accordance with the provisions of this SPECIFICATION and ASTM D3034. The minimum wall thickness shall be SDR 35.

3. Nominal pipe lengths of pipe shall be twenty (20) feet, with shorter lengths provided as required by DRAWINGS, alignment, and grade.

B. Joint Type:

1. Pipe joints shall be made using an integral bell with an elastomeric gasket push-on type joint. The joint shall comply with the requirements of ASTM D3212.

2. Gaskets shall meet the requirements of ASTM F477.

3. Solvent-cement joints are strictly prohibited.

C. Perforations:

1. PVC piping shown on the DRAWINGS to be perforated shall be perforated to the pattern shown on the DRAWINGS. If no pattern is shown on the DRAWINGS, four (4) one-quarter inch (1/4") diameter holes shall be provided at six-inch (6") centers at the quarter points of the pipe. No perforation shall be made within six (6) inches from either end of the pipe.

2. Laterals, drain lines away from the structure, and the top ten (10) feet of cleanout risers shall have a solid wall.

2.06 METER VAULT

A. The precast concrete meter vault sections and lid shall be to the dimensions shown on the DRAWINGS. The vault shall be furnished by Amcor or equivalent. The lid shall be blank and not be labeled “water.”

PART 3 EXECUTION

3.01 TRENCHING

A. The underdrain shall be trenched into the native soil a maximum of six (6) inches if so shown on the DRAWINGS to the grades shown on the DRAWINGS. The trenches shall slope uniformly at the grade shown on the DRAWINGS.

3.02 GEOTEXTILE FABRIC

A. All perforated pipe shall be wrapped with geotextile fabric.

B. Perforated pipe in cleanout risers shall be wrapped in geotextile fabric. Suitable means shall be found to seal the seam and maintain the position of the fabric during backfilling.

C. Care shall be taken not to tear any geotextile fabric during backfilling.

3.03 ROCK

A. Rock shall be placed on the geotextile fabric to the depth shown prior to placement of the underdrain pipe. After the pipe is in place, rock shall be placed along and over the top of the pipe in a manner that shall not damage the pipe.

3.04 HDPE PIPE AND FITTINGS

A. The pipe shall be installed in accordance with the manufacturer’s written instructions, a copy of which shall be maintained on site during pipe installation.

3.05 PVC PIPE AND FITTINGS

A. General: When laying PVC pipe out on a curve, the joints may be deflected up to seventy five percent (75%) of the maximum value permitted by the manufacturer of the pipe. Tighter curves shall be made by either using shorter lengths of pipe or by using manufactured bends.

B. Perforated Pipe: Perforated pipe shall be placed in the rock bedding as shown on the DRAWINGS.

C. Solid Pipe: Solid PVC pipe shall be placed on six (6) inches of sand bedding, unless the native soil is capable of providing uniform support as approved by ENGINEER or shown on the DRAWINGS.

3.06 CLEAN-OUTS

A. The clean-out risers shall be protected from damage during the backfilling operations.

B. The ring and cap shall be secured in place with a reinforced concrete collar as shown on the DRAWINGS.

END OF SECTION