

SECTION 028400

IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The General Provisions of the Contract, including all General and Supplementary Conditions and Supplements and Amendments to the General Conditions of the Contract apply to work specified in this section.

1.02 DESCRIPTION OF WORK

A. The work covered by this section includes, but is not limited to:

1. Coordination of new water meter installation
2. Installation and testing of backflow preventer
3. Installation of backflow preventer security enclosure
4. Excavation, backfill, and compaction of trenches
5. Installation and pressure testing of mainline pipe
6. Installation of lateral line pipe
7. Installation of sleeves for pipe and wire under pavements
8. Installation of mainline isolation valves
9. Installation of master control valve
10. Installation of flow sensor
11. Installation of remote-control valve assemblies
12. Installation of quick-coupling valves
13. Installation of automatic controller
14. Installation of two-wire type control wiring, and related equipment
15. Installation of sprinkler heads and swing-joint risers
16. Installation of drip emitters
17. Installation of drip zone filters and pressure regulators
18. Operational testing of the irrigation system
19. Initial maintenance of the irrigation system

B. The extent of the irrigation work is shown on the drawings and details.

1.03 RELATED WORK

A. Related work includes, but is not limited to, the:

1. Earthwork and grading operations
2. Installation / planting of trees, shrubs, and turf areas
3. Construction hardscape and other site improvement

1.04 COORDINATION

A. The Contractor shall coordinate all irrigation system work with the Owner's Representative. Work that is completed or in-progress shall be protected during the installation of the irrigation system. The Contractor shall notify the Owner's Representative immediately of field conditions which prevent installation of the irrigation system as shown.

1.05 REQUIRED LICENSURE

A. All work shall be performed by a Contractor licensed by the State of Arizona Registrar of Contractors. The license classification held by the Contractor shall be appropriate for the work to be performed.

1.06 QUALIFICATIONS OF IRRIGATION SYSTEM INSTALLERS

A. The irrigation system shall be installed by, and under the direct supervision of, individuals who have

appropriate experience with the installation of irrigation systems like the system being installed. A supervisor, with not less than three-years of irrigation system installation experience shall be always on-site when the project irrigation system is being installed.

1.07 COMPLIANCE WITH APPLICABLE REGULATIONS

A. The Contractor shall comply with all local, state, and federal regulations regarding materials, methods of work, and disposal of excess and waste materials. The Contractor shall provide notices required by governmental authorities, request required inspections, obtain required permits, and pay for all associated fees.

1.08 REFERENCE SPECIFICATIONS

A. American Society for Testing and Materials:

1. ASTM-D-1784 Specification for Rigid Polyvinylchloride Compounds
2. ASTM-D-1785-34 Specification for PVC Pipe, Schedules 40, 80, and 120
3. ASTM-D-2241-34 Specification for PVC Pipe (SDR-PR)
4. ASTM-D2564 Specification for Solvent Cements for PVC Pipe and Fittings
5. ASTM-D-2672 Specification for bell-end PVC Pipe
6. ASTM-F-656 Specifications for Primers to be used for Solvent Weld Joints of PVC Pipe

1.09 SUBMITTAL REQUIREMENTS

A. Material and Equipment Information: The Contractor shall submit to the Owner's Representative, three (3) sets of catalog cuts for all irrigation system materials and equipment proposed for use on the project. The information submitted shall clearly indicate the type, model, and size of the equipment proposed and shall be sufficient for the Owner's Representative to determine if the proposed equipment meets the project specifications. No materials or equipment shall be ordered or incorporated into the Work until the material or equipment has been approved for use on the project. The submittal shall include information related to the following items, if required for the project.

1. Backflow Preventers
2. Backflow Preventer Security Enclosures
3. Mainline Pipe (Reclaimed)
4. Lateral Line Pipe (Reclaimed)
5. Sleeving Pipe under paving
6. Fittings for Mainline Pipe
7. Fittings for Lateral Line Pipe
8. Solvent Weld Primer for PVC Pipe
9. Solvent Weld Cement for PVC Pipe
10. Isolation Valves
11. Master Valves
12. Flow Sensors
13. Remote Control Valves
14. Quick Coupling Valves
15. Pressure Regulating Valves
16. Access Boxes for Master Valves
17. Access Boxes for Flow Sensors
18. Access Boxes for Remote Control Valves
19. Access Boxes for Isolation Valves
20. Access Boxes for Quick-Coupling Valves
21. Controllers
22. Controller Security Enclosure (and/or pedestal)
23. Communication Cable
24. Conduit for Communication Cable
25. Pull Boxes for Communication Cable
26. Low Voltage Control Wire

27. Waterproof Wire Splices
28. Sprinkler Heads (Large Radius)
29. Swing Joints for Large Radius Sprinklers
30. Swing Joints for Medium Radius Sprinklers
31. Drip Emitters (Multi-outlet, all types)
32. Drip Emitters (Single Outlet)
33. In-Line Screen Filters
34. Emitter Distribution Tubing
35. Access Boxes for Emitters
36. Access Boxes for Flush Caps
37. Mainline Marking Tape

B. As-Built Record Drawings: The Contractor shall submit to the Owner's Representative prior to Substantial Completion of the work, As-Built Record drawings for the irrigation system installed. The drawings shall indicate the location of all; mainlines, master valves, flow sensors, mainline isolation valves, remote control valves, quick coupling valves, and sleeves and pipelines under roadways or other paved surfaces.

1. Preliminary As-Built Drawings: Preliminary As-Built Drawings shall be prepared for the irrigation mainline and mainline isolation valves prior to the backfilling of mainline trenches. The Preliminary As-Built Drawings shall be presented to the Owner's Representative when the mainline is pressure tested. Approval of the pressure test and authorization to backfill the mainline trenches will be contingent upon submittal of acceptable Preliminary As-Built Drawings.
2. Procedures to be Used to Document As-Built Locations: The location of all mainlines shall be identified by two or more dimensions from fixed objects such as curbs or structures. The location of all valves shall be identified by Global Positioning System (GPS) coordinates using the State Plane Coordinate System. The GPS equipment used to locate irrigation system valves shall be accurate to within +/-3 meters and shall be as approved by the Owner's Representative. A table listing all system valves and their corresponding coordinates shall be included on the As-Built Drawings. As-Built requirement recommendations to be provided by Lake Havasu City.
3. Format for Final As-Built Drawings: The Final As-Built Drawings shall be prepared with ink on mylar. The preparation of mylar reproductions of the drawings and the preparation of the drawings shall be at the Contractor's expense.

1.10 IRRIGATION SYSTEM DRAWINGS

A. The irrigation drawings are diagrammatic and are intended to show the approximate location of outlets, equipment and piping. Certain runs of piping may be shown distorted for clarity. Minor adjustment to the layout of the system will be necessary. Significant adjustments to the layout, including all changes that effect the configuration of the system or length of piping runs, shall be approved by the Owner's Representative prior to installation.

1.11 ACQUISITION AND INSTALLATION OF NEW METER(S) AND WATER SERVICE(S)

A. Requests for and Installation of New Water Meters: The Contractor shall be responsible for contacting Lake Havasu City Water or the appropriate water company and requesting the installation of new water meters as shown on the Project Plans. If required, the Contractor shall obtain an "address" for each meter from Lake Havasu City. The Contractor shall pay for all fees and charges associated with the supply and installation of the new meter(s) and water service(s).

1.12 PAYMENT FOR WATER DURING CONSTRUCTION

A. Payment for Irrigation Water Prior to Final Acceptance: The Contractor shall be responsible for paying all charges for water used for irrigation or for other purposes during construction, during the initial maintenance period, and up to the date of Final Acceptance of the landscape and irrigation improvements.

B. Transfer of Water Meters to the Lake Havasu City: At the time of Final Acceptance of the landscape and irrigation work, the Contractor shall submit a letter to the Owner's Representative requesting that the party billed for water service at the project site be changed from the Contractor to the Lake Havasu City Parks

and Recreation Department. The request shall note the date of Final Acceptance. Upon receipt of this request, the Owner will initiate a formal request to change the name of the party to be billed for water.

1.13 CONTRACTOR PROVIDED SPARE PARTS

A. Contractor Provided Spare Parts: Prior to Substantial Completion of the Work, the Contractor shall turn-over the following spare parts to the Owner's Representative.

1. Sprinkler Heads: Three (3) sprinklers of each type installed on the project
2. Sprinkler Nozzles: Three (3) sets for each sprinkler type installed on the project
3. Drip Emitters: Twenty (20) for each type installed on the project
4. Remote Control Valves: One (1) of each size valve installed on the project
5. Emitter Access Boxes: Ten (10) of each type installed on the project

PART 2 - MATERIALS

2.01 PIPE AND FITTINGS

A. Color Coding of Pipe Conveying Reclaimed Water: All mainline and lateral line pipe used to convey irrigation water shall be integrally color-coded purple pipe.

B. PVC Mainline and Lateral Line Pipe: Mainline and lateral line pipe shall be PVC plastic pipe extruded from virgin parent materials. Pipe shall comply with ASTM standards D-1785-34 or D-2241-34 as applicable and shall be free from defects.

1. Mainline Pipe - 3" and 4" Size: Mainline pipe, pipe subject to constant pressure that is 3" size to 4" size (inclusive) shall be C900 Class 200 PVC pipe with gasketed bell-ends. Color shall be purple. Pipe shall be furnished with elastomeric gaskets that conform to ASTM F477 providing a water-tight seal when tested in accordance with ASTM D3139
2. Mainline Pipe - 2-1/2" Size and Smaller: Mainline pipe, pipe subject to constant pressure that is 2-1/2" size or smaller shall be Schedule 40 PVC pipe. Joints shall be of the solvent weld type. Color shall be purple
3. Lateral Line Pipe: Lateral line pipe not subject to constant pressure shall be Schedule 40 PVC pipe. Joints shall be of the solvent weld type. Color shall be purple
4. Sleeves for Pipe and Control Wire: Sleeves for irrigation pipe and control wire under roadways, parking lots, and walkways shall be Schedule 40 PVC pipe for sizes 3" and larger and Schedule 40 PVC pipe for all sleeves 2-1/2" size and smaller. Color shall be purple.

C. PVC Pipe Fittings: PVC fittings shall be made from Type I, Grade I, PVC compounds conforming to ASTM D-1784, D-2672, and D-2241 as applicable.

1. Fittings for Mainlines 3" and 4" Size: Fittings for mainlines 3" and 4" size shall be Spears Ever Tuff CI 315 fittings.
2. PVC Fittings for Mainlines 2-1/2" and Smaller: PVC fittings for mainlines 2-1/2" and smaller shall be Spears Ever Tuff CI 315 fittings.
3. PVC Fittings for Lateral Lines: PVC fittings for lateral lines shall be Schedule 40 PVC.
4. PVC Fittings for Remote Control Valve Assemblies: PVC fittings for remote control valve assemblies, and as detailed for other locations, shall be Schedule 80 PVC.
5. Threaded PVC Pipe and Nipples: All threaded PVC pipe and nipples shall be Schedule 80 PVC.
6. Swing Joints: Swing joints shall PVC and shall be of the factory assembled, double-swing type with "O" ring connections. Swing joints shall have a rated operating pressure of not less than 80 psi.

D. PVC Solvent Cement and Primer: Solvent cement and primer for joining PVC pipe and fittings shall be as approved by the pipe and fitting manufacturers and shall comply with ASTM Standards D-2564 and F-656.

1. Primer: Primer shall be manufactured for use on all Classes and Schedules of rigid PVC pipe and fittings, including Schedule 80. Color shall be purple.
2. Solvent Weld Cement: Solvent weld cement shall be manufactured for use on all Classes and Schedules of rigid PVC pipe and fittings, including Schedule 80. It shall have a medium fast set-up time. Color shall be grey. Fast-set or "hot-glue" solvent weld cement shall not be utilized without

written approval by the Owner's Representative.

- E. Steel Pipe and Fittings: Steel pipe and fittings shall be Schedule 40 galvanized steel pipe. Unless otherwise detailed on the Project Plans, steel pipe shall be used for backflow preventer risers only if called for on the plans.
- F. Copper Pipe and Fittings: Copper pipe shall be Type K rigid pipe. Fittings shall be wrought copper or cast bronze fittings. Unless otherwise detailed on the Project Plans, copper pipe shall be used for backflow preventer risers only if called for on the plans.
- G. Corrosion Protection Pipe Wrap: Pipe wrap for steel and copper pipe installed below grade shall be adhesive backed polyethylene tape specifically designed for the protection of buried metallic pipe.

2.02 BACKFLOW PREVENTERS

- A. Backflow Preventers: Backflow preventers shall be of the reduced pressure principle type with bronze body and stainless steel springs. The device shall be equipped with ball valves on the upstream and downstream ends. The backflow preventer manufacturer and model shall be as previously approved by Lake Havasu City Water Department. Size shall be as noted on the drawings.
- B. Backflow Preventer Security Enclosure: The backflow preventer security enclosure shall be fabricated from bent 1-1/4" diameter Schedule 40 steel pipe, 1" x 1" steel angle, and 13 gauge expanded metal panels. The enclosure shall be equipped with hinges and U-bolt hasp for padlocking. The enclosure shall have a powder coated finish. Color shall be "Desert Tan." The security enclosure manufacturer and model shall be as noted on the Project Plans.

2.03 AUTOMATED CONTROL VALVES

- A. Master Valves shall be of the globe type with brass body and bonnet. The valve shall be of the normally-closed design and shall be equipped with a heavy-duty 24 VAC solenoid. The master valve manufacturer and model shall be as noted on the Project Plans.
- B. Remote Control Valves: Remote control valves shall be of the globe type with heavy duty glass filled nylon body and bonnet, nylon reinforced rubber diaphragm, stainless steel flow control stem, and 24 volt heavy-duty solenoid. The remote control manufacturer, model, and size shall be as noted on the Project Plans.

2.04 MANUAL VALVES

- A. Gate Valves - 3" Size and Smaller: Gate valves (3" size and smaller) shall be 200 psi rated WOG brass gate valves with female NPT threaded ends. Valves shall have a clear waterway equal to the full nominal diameter of the valve and shall be equipped with a hand wheel and non-rising stem.
- B. Ball Valves: Ball valves shall be 400 psi rated WOG, full-port brass ball valves with threaded ends. Ball valves shall be equipped with resilient TFE seats and blow-out proof stems. Valve handle shall provide 1/4 turn on / off control.
- C. Quick Coupling Valves: Quick coupling valves shall be constructed of brass with a two piece design. Internal valve spring shall be of stainless steel. Valve shall be equipped with a self-closing thermoplastic rubber cover. The quick-coupling valve manufacturer and model shall be as noted on the Project Plans.
 - 1. Quick-Coupling Valve Key: Quick coupling valve keys shall be constructed of brass with galvanized steel handle. Key shall be furnished with brass hose swivel ell. Key shall be of the same manufacturer as the quick-coupling valve.
- D. In-line Pressure Regulating Valves: In-line pressure regulating valves shall be of the permanently assembled type with heavy-duty plastic body and FPT ends. The regulator shall have a pre-set outlet pressure as noted on the drawings. The pressure regulating valve manufacturer and model shall be as noted on the Project Plans.

2.05 CONTROLLERS

- A. Controller: Controller(s) shall be a microprocessor based electronic irrigation controller. The controller shall

have water management capabilities that include the ability to adjust operating times based on evapotranspiration (ET), the ability to receive and process flow-sensing data, the ability to provide reports to an off-site location, and the ability to provide an alert when system failures occur. The controller(s) shall be as manufactured by Motorola and shall be fully compatible with the Lake Havasu City's central control system. The controller model number shall be as noted on the Project Plans.

2.06 FLOW SENSORS AND ACCESSORIES

- A. Flow Sensors / Meters: Flow meters shall integrate both a vertical turbine Woltman-type water meter and a pilot operated, diaphragm actuated control valve, with a built-in auxiliary shut-off pilot for batch applications. Flow meters shall be as manufactured by Bermad. Model number shall be as noted on the Project Plans.
- B. Communication Cable: Communication cable shall be as manufactured by Paige Cable, Model P-7354-D, or approved equal.
 1. Conduit and Fittings for Communication Cable: Conduit and fittings for communication cable shall be Schedule 40 PVC conduit. Size shall be 3/4", minimum, or as required for the Work
 2. Pull Boxes for Communication Cable Conduit: Pull boxes shall be constructed of HDPE plastic materials. Pull boxes shall be of the manufacturer and model as noted on the Project Plans. Box size and configuration shall be as follows:
 3. Pull Boxes: 19-3/4" x 13-1/8" Clear Opening x 12" Height

2.07 LOW VOLTAGE CONTROL WIRING

- A. Low Voltage Irrigation Control Wire: Control wire shall be Type UF and shall be of the size and type recommended by the valve manufacturer. Wire size for control wires shall be minimum #14 AWG solid copper, jacketed or approved equal or as noted on the drawings. Wire shall be Underwriters Laboratory (UL) approved for direct burial. Insulation color shall be as follows:
- B. Waterproof Wire Splices: Wire splices shall be of the two piece, sealant filled type which permit connection of 2 or 3 wires of 18 through 10 gauge size. Wire splices shall be Underwriter Laboratory (UL) listed. Wire splices shall be #M Scotchcast Connector Sealing Pack 3570G-N or as approved by manufacturer and Owner's Representative.

2.08 SPRINKLER HEADS

- A. Large Radius Gear Drive Sprinkler Heads (For Turf Areas): Large-radius, gear-drive sprinkler head shall have a body, nozzle, and screen constructed of UV resistant heavy duty plastic. Riser stem and retract spring shall be constructed of stainless steel. Sprinkler cover shall be rubber. Inlet shall be 1 inch FPT and pop-up height shall be four inches (4"). Sprinklers shall be full circle or part circle. Part circle heads shall be adjustable from 40 to 360 degrees. Radius of spray on both full and part circle heads shall be adjustable. Nozzles shall be color coded, removable, and capable of providing matched precipitation rates. Sprinkler manufacturer, model number, and nozzle size shall be as noted on the Project Plans.
- B. Medium/Small Radius Pop up Sprinkler Heads: Medium-radius, pop up sprinkler head shall have a body, nozzle, and screen constructed of UV resistant heavy duty plastic. The sprinkler shall be of the viscous fluid brake rotary type and be a multi-stream, multi-trajectory rotating stream sprinkler. Riser stem and retract spring shall be constructed of stainless steel. The sprinkler shall have a pressure-activated, multi-function, UV stable wiper seal that will clean debris from the pop-up stem while it retracts. The sprinkler shall have a standard pressure-regulating device as an integral part of the pop-up riser. Sprinkler cover shall be rubber. Inlet shall be 1/2 inch FPT and pop-up height shall be four inches (4"). Sprinklers shall be full circle or part circle. Part circle heads shall be adjustable from 40 to 360 degrees. Radius of spray on both full and part circle heads shall be adjustable. Nozzles shall be color coded, removable, and capable of providing matched precipitation rates. Sprinkler manufacturer, model number, and nozzle size shall be as noted on the Project Plans.

2.09 DRIP EMITTERS

- A. Eight-Outlet Drip Emitters: Emitters shall be of the type with eight independent / removable emitter ports. The pressure compensating ports available having flow rates of 0.5 to 24 gph. Emitter shall have a 1/2"

FPT inlet. The eight-outlet emitter manufacturer and model shall be as noted on the Project Plans.

1. Eight outlet drip emitters shall be used to irrigate specific plants of the species and sizes as noted on the Project Plans
- B. Six-Outlet Drip Emitters: Emitters shall be of the permanently assembled, pressure compensating, six-outlet type with $\frac{1}{2}$ " FPT inlets. The flow rate per outlet shall be nearly the same at inlet pressures of 15 to 50 psi. The six-outlet emitter manufacturer and model shall be as noted on the Project Plans.
 1. Six outlet emitters shall be used to irrigate specific plants of the species and sizes as noted on the Project Plans.
- C. Root Zone Watering System Bubbler Emitters: Bubbler Emitters shall be permanently assembled, pressure compensating, one outlet type with $\frac{1}{2}$ " FPT inlet. The flow rate per outlet shall be nearly the same at inlet pressures of 15 to 50 psi. The bubbler outlet emitter manufacturer and model shall be as noted on the Project Plans. Bubbler shall be a part of a root zone watering system consisting of perforated polyethylene cylinder with length – 36". The factory-assembled system comes preconfigured with swing assemblies and/or spiral barbed fittings, with an integrated bubbler and optional check valve. System shall have a locking grate cover to help deter vandalism, also a sock option in order to prevent small particles from penetrating the cylinder
- D. Emitter Distribution Tubing: Emitter distribution tubing shall be fabricated from polyvinyl materials with a 0.16" I.D. and a 0.22" O.D. The tubing manufacturer and model shall be as noted on the Project Plans.
- E. Emitter Lateral Line Flush Caps: Flush caps shall consist of a Schedule 40 PVC pipe riser, a Schedule 40 PVC male adapter fitting, and a Schedule 40 PVC threaded cap. Flush caps shall be assembled as detailed.

2.10 ACCESS BOXES

- A. Valve Access Boxes: Valve access boxes for gate valves, ball valves, master valves, flow sensors, remote control valve assemblies, and quick-coupling valves shall be constructed of HDPE plastic materials. Valve box covers shall be permanently marked with the words "control valve" or "irrigation". Valve access box shall be of the manufacturer and model as noted on the Project Plans. All boxes, exclusive of emitter access boxes and emitter line flush cap access boxes, shall be equipped with bolt-down lids. Box sizes and configurations shall be as follows:

1. Master Valves:	19-3/4" x 13-1/8" Clear Opening x 12" Height
2. Flow Sensors:	15-3/8" x 10-1/8" Clear Opening x 12" Height
3. Drip Zone Remote	
(a) Control Valve Assemblies:	19-3/4" x 13-1/8" Clear Opening x 12" Height
4. Turf Zone Remote	
(a) Control Valve Assemblies:	19-3/4" x 13-1/8" Clear Opening x 12" Height
5. Isolation Valves:	15-3/8" x 10-1/8" Clear Opening x 12" Height
6. Quick-Coupling Valves:	9-1/4" Diameter Clear x 10-1/8" Height
7. Emitter Line Flush Cap	6-7/8" Diameter Clear Opening x 9-5/16" Height
8. Access Boxes:	6-7/8" Diameter Clear Opening x 9-5/16" Height
9. Emitter Boxes	6-7/8" Diameter Clear Opening x 9-5/16" Height

2.11 MISCELLANEOUS IRRIGATION SYSTEM EQUIPMENT

- A. In-Line Filter: In-line filters shall have a glass-filled nylon body with removable, 200 mesh, stainless steel screen, and manual flush port. The filter manufacturer and model shall be as noted on the Project Plans.
- B. Detectable Marking Tape: Detectable marking tape to be installed above all mainlines shall be a five mil thick, five-ply composition, polyethylene tape. The tape shall have a 20 gauge solid aluminum foil core that is encapsulated within the polyethylene material. The tape shall be three inches (3") wide.
 1. Tape for Irrigation Systems: Tape shall have the words "CAUTION, IRRIGATION LINE BELOW" printed at regular intervals. Tape color shall be green.

PART 3 - EXECUTION

3.01 BLUE STAKING

A. Blue Staking: The Contractor shall request that the project site be Blue Staked prior to the start of any excavation or trenching work. Blue Staking shall be kept current during the course of the project. All utilities damaged by the Contractor shall be repaired or replaced by the Contractor, as required by the Owner or appropriate utility company, at the Contractor's expense.

3.02 LAYOUT

A. Layout of Irrigation System: Prior to the start of trenching and excavation work, the Contractor shall layout the irrigation system, staking out the location of mainlines, master valves, flow sensors, remote control valves, sprinkler heads and other equipment as shown on the drawings. All deviations from the layout shown on the drawings impacting the length of piping runs or the configuration of the system shall be approved by the Owner's Representative.

3.03 WATER METER INSTALLATION

A. Water Meter Installation: The Contractor shall coordinate the installation of new water meter(s) as specified herein. The location of the water meter shall be as approved by the water provider and the Owner's Representative.

3.04 BACKFLOW PREVENTER INSTALLATION

A. Backflow Preventer: Backflow preventers shall be installed as detailed in all locations shown on the Project Plans. All backflow preventers shall be tested by an individual certified by Lake Havasu City Water or the appropriate water provider. Test certificates, signed by the tester, shall be filed with the water provider in accordance with the water utility's requirements.

B. Backflow Preventer Security Enclosure: The backflow preventer security enclosure shall be installed as detailed and per manufacturer's specifications. The device shall be positioned so as to allow for the opening and closing of the security enclosure without interfering with the backflow preventer.

3.05 TRENCHING FOR PIPE AND CONTROL WIRING

A. Trenching: Trench excavations shall be straight and true with uniform bottom for bearing of pipe. Minimum depth of cover on pipe, sleeves, and wire shall be as follows:

1. PVC Sleeves under Roadways and Parking Areas	24 inches
2. PVC Sleeves for Mainlines under Walkways	24 inches
3. PVC Sleeves for Lateral Lines under Walkways	18 inches
4. PVC Mainline	24 inches
5. Detectable Marking Tape over Mainline	8 inches
6. PVC Lateral Lines	18 inches
7. Control and Common Wires	24 inches
8. Communication Cable / Conduit:	24 inches

B. Barriers to Prevent Public Access to Open Trenches: The Contractor shall provide barriers as required to restrict public access to open irrigation trenches. Barriers shall be in compliance with applicable construction site safety regulations.

3.06 PLACEMENT OF SLEEVES AND (MAINLINE / LATERAL LINE) PIPE

A. Sleeves: Sleeves shall be installed as detailed. Separate sleeve shall be provided for pipe and control wire. Sleeve size shall be as noted. If not noted, the sleeve shall be a minimum of two standard pipe sizes larger than the pipe enclosed. The minimum sleeve size shall be three inches (3").

B. Mainline and Lateral Line Pipe: PVC pipe shall be placed in trenching with identification markings located on top of the pipe so they are readable. Place select backfill material in bottom of trench as detailed before laying pipe. Do not install pipe in trench that is wet or when conditions are otherwise unsuitable for the

Work. Keep inside of pipe clean during installation. Snake pipe from side to side of trench to allow for expansion and contraction. Provide 2 inch minimum vertical and horizontal clearance between irrigation pipes. Provide 12 inch minimum clearance between irrigation pipes and pipe, conduit, or cable of other trades.

3.07 CONSTRUCTION OF PIPE JOINTS

- A. PVC Pipe - Solvent Weld Joints: Make all solvent weld joints using only procedures recommended by the pipe, fitting, and solvent weld cement manufacturers. Make all threaded connections using teflon tape on male threads with a maximum 3 wraps around pipe.

3.08 FLUSHING AND PRESSURE TESTING OF MAINLINE

- A. Notification: The Contractor shall notify the Owner's Representative of his intent to perform pressure testing 72 hours prior to the scheduled test time. Except as otherwise approved, all tests shall be performed in the presence of the Owner's Representative. The entire mainline shall be tested at one time except for instances where project phasing requires testing of individual segments of the mainline system.
- B. Tools and Equipment: The Contractor shall furnish all tools, materials, fittings, and equipment required for testing and shall make all temporary connections.
- C. Trench and Backfill Conditions for Testing: The trench(es) shall not be backfilled until pressure testing of mainline has been successfully completed. Center loading of mainline pipe during testing is acceptable. All joints shall be exposed during testing operations.
- D. Flushing: After all mainline piping and risers are connected in place and all related work is complete, open each control valve(s) use a full head of water to flush the mainline system.
- E. Testing: The mainline shall be tested at a pressure of 150 psi for a period of two (2) hours. For acceptance, the original test pressure shall be maintained for the duration of the test.
- F. Repairs: All leaks or defects which develop under pressure testing shall be promptly repaired and the test repeated until satisfactory results have been achieved. Repairs shall be made using only materials and procedures specified herein.

3.09 CONTROL WIRE AND COMMUNICATION CABLE INSTALLATION

- A. Control Wiring: Wherever possible, mainline trenches shall be used for installation of wire.
- B. Wire Splices: Each end of the two-wire control wire shall be brought to the remote control valve and a 3' long coil of wire shall be neatly looped in the access box as detailed. Splices shall be made using manufacturer recommended waterproof wire splices. Wire shall be spliced at remote control valve locations only.
- C. Communication Cable: Communication cable shall be installed in conduit as detailed. Pull boxes shall be installed at intervals not exceeding 200 feet. Cable shall not be spliced between connections at the project controllers.

3.10 BACKFILLING OF TRENCHES

- A. Placement of Bedding Material: Place select backfill material around pipe to provide minimum cover shown on the details. Carefully tamp or water-in bedding material around pipe.
- B. Placement of Backfill: Place excavated material as backfill in lifts of six inches, maximum. Carefully compact each lift as work progresses. Grade top of trenches to be level with adjacent finished grade. All trenches improperly backfilled or where settlement occurs shall be re-excavated and compacted as specified.
- C. Removal of Excess Material: Excavated material that is removed from trenches and not used as backfill shall be carefully removed from the site and disposed of in an approved location at the Contractor's expense.

3.11 INSTALLATION OF VALVES AND VALVE ACCESS BOXES

- A. Valves: Gate valves, ball valves, master valves, remote control valves, and quick coupling valves shall be installed as detailed. Use teflon tape on all threaded connections.
- B. Valve Access Boxes: Install valve access boxes such that top of box is parallel to and flush with the surrounding finished grade, or as detailed. Provide gravel sumps and brick footings as detailed. Where more than one access box is to be installed in a given location, group boxes together and keep boxes within a uniform alignment. Provide adequate clearance around enclosed valves to allow for valve operation and/or removal.

3.12 CONTROL SYSTEM INSTALLATION

- A. Controller(s): The controller(s) shall be installed as detailed, in the location(s) approved by the Owner's Representative. Extend electrical power and communication connections to the new controller(s) as shown on the electrical plans and make connections. All work shall be in accordance with applicable code requirements.
- B. Programming of Controllers: The Contractor shall be responsible for the initial programming of all controllers. Programming work shall be performed by a technician certified by the control system manufacturer. Controllers shall be programmed to operate as stand-alone controller during construction and during the initial Contractor Maintenance Period.
 1. Verification of Central Control System Operation: Prior to Final Acceptance of the Work, the Contractor shall coordinate the programming of the on-site controller(s) with the Lake Havasu City Parks and Recreation Department staff. Testing shall be performed to ensure that the system installed in the field properly communicates with the Department's off-site workstation. Deficiencies associated with equipment installed by the Contractor shall be repaired by the Contractor prior to Final Acceptance of the Work.
- C. Grounding Equipment: Grounding equipment shall be installed at each controller in accordance with the controller manufacturer's written recommendations and applicable codes.

3.13 FLOW SENSORS

- A. Flow Sensors: Flow sensors shall be installed as detailed and in accordance with the manufacturer's written instructions.

3.14 SPRINKLER HEADS

- A. Large-Radius and Medium-Radius, Gear-Drive Sprinkler Heads: Install gear drive sprinkler heads on double swing joints so that top of head matches finished grade as detailed. Use teflon tape on all threaded connections, exclusive of "O" ring connections. Flush lateral line and clean inlet screen prior to installation of nozzle. Adjust radius of spray and orientation of head and nozzle so that spray pattern matches the area to be irrigated and minimizes over-spray on to adjacent surfaces.
 1. Nozzle Adjustment: Sprinkler heads shall be installed with the nozzles noted on the drawings. If necessary to provide complete and uniform coverage, the Contractor shall remove and replace the specified nozzles and supply and install nozzles that are one size larger or one size smaller than that specified. Nozzle replacement work, if required, shall be performed by the Contractor at no cost to the Owner.

3.15 DRIP EMITTERS

- A. Drip Emitters: Install drip emitters in access boxes and extend distribution tubing to locations around the irrigated plant as detailed.

3.16 MISCELLANEOUS IRRIGATION EQUIPMENT

- A. In-Line Filters: Install in-line filters as detailed. Position filter in access box so that the unit can be disassembled and the filter removed and/or replaced, without removal of the access box.
- B. Detectable Marking Tape: Install detectable marking tape above all mainline pipe as detailed.

3.17 OPERATIONAL TESTING

- A. Operational Test: An operational test shall be performed by the Contractor after the irrigation system installation is complete. The test shall demonstrate that all controller and control valves perform properly and that all sprinkler heads and emitters are operating correctly and are providing adequate irrigation water to landscape plantings. All tests shall be performed in the presence of the Owner's Representative. Irrigation system components found to be operating incorrectly or to be defective shall be replaced or repaired by the Contractor at no cost to the Owner.
- B. Schedule for Performance of Operational Test: The operational test shall be performed at the date and time of the Substantial Completion inspection. The operational test may be performed in advance of the Substantial Completion inspection, if requested by the Contractor. The request for an operational test inspection shall be submitted to the Owner's Representative not-less-than seven (7) days prior to the requested inspection date.

3.18 REPAIR OF DAMAGE BY LEAKS

- A. Repair of Damage: The Contractor shall be responsible for damages to slabs, curbs, roadways, walkways, piping systems, electrical systems, buildings and associated equipment and contents caused by leaks in the irrigation piping systems being installed or having been installed by him. The Contractor shall repair all damage so caused. All repair work shall be performed in a manner that is satisfactory to the Owner's Representative, and at no cost to the Owner.

3.19 CLEAN-UP

- A. Clean up: Perform cleaning operations during the installation of the Work and upon completion of the project. Remove from the site all excess materials, debris, and equipment. Legally dispose of all excess and waste materials. Repair all damage resulting from irrigation system installation.

3.20 TURF IRRIGATION SYSTEM AUDIT

- A. Applicability: An audit of the installed turf irrigation system shall be performed as noted on the Project Plans.
- B. Scope of Audit: The scope of the irrigation audit shall include an evaluation of the Distribution Uniformity (DU) of the installed irrigation system within designated turf areas as noted on the Project Plans.
- C. Reference Standards and Procedures: The evaluation of the Distribution Uniformity (DU) shall be in accordance with definitions, standards, and procedures as published by the Center for Irrigation Technology at the University of California, Fresno.
- D. Schedule for Performance of Audit: The irrigation audit shall be performed and remedial actions implemented, as-needed, prior to Substantial Completion of the Work.
- E. Qualifications of the Individual Performing Audit: The individual performing the audit shall be a Certified Irrigation Auditor as certified by the Irrigation Association (IA).
- F. Payment for Audit Fees: Except as may be noted in the project documents, the Lake Havasu City Parks and Recreation Department will hire the Irrigation Auditor directly and pay the fee for the initial audit and one (1) follow-up inspection, if needed. If additional inspections are required, the cost of the additional inspections shall be borne by the Contractor.
- G. Performance Standards: The audited Distribution Uniformity (DU) for the turf irrigation system(s) installed shall be as follows:
 1. For Rotor Type Sprinkler Heads: 65% Minimum
- H. Remedial Work: If the turf irrigation system installed does not meet the minimum Distribution Uniformity (DU) standards noted above, the Contractor shall be responsible for making required corrections and/or adjustments. Remedial work may include, but is not be limited to, correction of head spacing, replacement of incorrect nozzles, and repair of damaged or contaminated sprinklers. Remedial work shall be performed at the Contractor's expense.

- I. Re-inspection of the Work: Installed systems that do not meet the specified Distribution Uniformity (DU) standards, as determined by audit, shall be re-inspected by the Certified Irrigation Auditor after remedial work has been performed by the Contractor. Additional remedial work and re-inspections will be required until the specified Distribution Uniformity (DU) has been achieved.

3.21 MAINTENANCE AND GUARANTEE

- A. Maintenance during Construction: The Contractor shall operate and maintain the irrigation system during project construction. Operation and maintenance procedures shall include, but not be limited to: programming of the controller(s), repair / adjustment of sprinklers, repair / replacement of emitters, and replacement of defective installations. Maintenance during construction shall continue until the issuance of a Certificate of Substantial Completion.
- B. Inspection of Completed Irrigation Work: Upon substantial completion of the irrigation work, the Contractor shall notify the Owner's Representative who will schedule an inspection of the irrigation system improvements. During the inspection, items which are incomplete or which must be repaired or replaced will be identified. The issuance of a Certificate of Substantial Completion will be contingent on the completion or correction of noted items.
- C. Maintenance after Substantial Completion: After issuance of a Certificate of Substantial Completion, the Contractor shall continue to operate and maintain the irrigation system for a period of 60 consecutive calendar days. Operation and maintenance procedures shall include, but not be limited to: programming of the controller(s), repair / adjustment of sprinklers, repair / replacement of emitters, and replacement of defective installations. Upon satisfactory completion of the initial Contractor maintenance period, the Owner will assume responsibility for irrigation system operation and maintenance.
 1. Irrigation Maintenance Requirements: Activities and tasks associated with the 60-day maintenance period shall include, but not be limited to:
 - (a) Daily inspection of the project to check on-site conditions and to perform activities required to correct safety deficiencies and/or to address field conditions impacting the proper operation of the irrigation system
 - (b) Daily observation of the turf grass irrigation system operation to verify that sprinklers are performing correctly and that all turf areas are receiving adequate and appropriate irrigation water
 - (c) Weekly checking and adjustment of the irrigation controller program(s) as needed to provide appropriate application of water to the project plantings
 - (d) Weekly inspection of the operation of each sprinkler to check for proper pop-up and retraction, arc adjustment, radius adjustment, nozzle performance, rubber cover installation, height adjustment.
 - (e) Weekly inspection of the operation of each drip emitter to check for proper water flow from each of the emitter distribution tubing outlets
 - (f) Weekly flushing of the in-line filter at each drip zone remote control valve assembly
 - (g) As-needed repair of leaks and other system deficiencies
 - (h) As-needed replacement of defective irrigation system equipment
 2. Suspension of Initial Contractor Maintenance Period for Non-Compliance: Failure to properly operate and maintain the irrigation system as specified herein, as determined by the Owner's Representative, will result in the suspension of the number of days being credited towards the initial 60 day Contractor maintenance period. The suspension will remain in effect until such time as the remedial actions required by the Owner's Representative have been implemented by the Contractor.

3.22 STANDARDS FOR FINAL ACCEPTANCE OF THE LANDSCAPE IMPROVEMENTS

- A. Standards for Acceptance of the Irrigation System: Standards for acceptance of the irrigation system include, but are not limited to, the following:
 1. On-site controller(s) and remote-control valves) have been tested and are operating correctly.
 2. Communication between the on-site control system and the Lake Havasu City Parks and Recreation Department's off-site central control workstation has been established and is working properly.
 3. All sprinkler heads are popping up correctly and sealing in the up position during operation to

eliminate flows from the perimeter of the riser stem.

4. All sprinkler heads are retracting properly to the fully closed or down position.
5. All sprinkler heads are set plumb so that riser stem extends vertically when in the up position.
6. The arc of all part-circle sprinkler heads has been adjusted to avoid overspray on adjacent surfaces.
7. The inlet screens and nozzles of all sprinkler heads have been cleaned and are set in the proper, sealed position.
8. The radius of spray for all sprinklers has been adjusted to provide uniform coverage of the turf area with minimal overspray on to adjacent surfaces.
9. The top of all sprinkler heads have been adjusted to finished grade as detailed on the Project Plans.
10. The cover and/or top of all sprinkler heads are undamaged and correctly attached to the sprinkler.
11. All drip emitter lateral lines have been flushed to remove contamination.
12. All drip emitters are operating correctly and providing uniform flow to the irrigated plants.
13. All emitter distribution tubing has been extended to the locations detailed on the Project Plans and covered with soil or surfacing material as detailed.
14. All irrigation system components are in place and operating as detailed on the Project Plans, as specified herein, as required by the irrigation equipment manufacturer, and as required for proper operation of the irrigation system.

3.23 GUARANTEE

- A. **Guarantee:** The Contractor shall guarantee the irrigation system to be free of defects in materials and workmanship for a period of two (2) years from the date of Final Acceptance. All material and equipment that proves to be defective within that period shall be promptly repaired or replaced by the Contractor at no additional cost to the Owner. The guarantee period for any part so repaired or replaced shall be extended for a period of two (2) years from the date of repair or replacement.

END OF SECTION

SECTION 029005

GENERAL LANDSCAPE

PART 1 - GENERAL

1.01 SUMMARY

- A. This section covers work necessary for installing the landscape and plant materials as indicated on the Construction Documents and details in accordance with the Contract Documents.

1.02 DESCRIPTION OF WORK

- A. The work shall include, but is not limited to, supply all trees, shrub, cacti and all plant materials (nursery stock), labor, material procurement, equipment, tools, transportation protection, and services required for complete installation of landscape and plant materials as indicated or reasonably implied on the Construction Documents and/or specified herein.
- B. Contractor shall retain a copy of the Construction Documents on the project site until final project acceptance.
- C. If any discrepancies exist between the plans and the specifications, the specifications will prevail.
- D. Contractor shall be responsible for obtaining all necessary permits required for installation of landscape. .

1.03 RELATED SECTIONS

- A. Examine all sections related to the project work.

1.04 REFERENCES

- A. American Nursery and Landscape Association (ANLA) American Standard for Nursery Stock ANSI Z60.1-2004 May 12, 2004 (Approved by American National Standards Institute, ANSI).
- B. Arizona Nursery Association Grower's Committee Recommended Average Tree Specifications, August 2005.
- C. U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and equal in quality to standards for Certified Seed.
- D. Federal Specifications (FS): FS O-F-241 (Rev D) Fertilizers, Mixed, Commercial.
- E. American Joint Committee on Horticulture Nomenclature.

1.05 DEFINITIONS

- A. Subgrade: The final elevation of material supporting additional material above it.
- B. Finished Grade: The final elevation of the uppermost surface material (sod shall be top of thatch layer.)

1.06 SUBMITTALS

A. Product Data

1. Submit product data sheets for each of the following items. Submittals must be made prior to commencing any activities. Make all submittals at one time. No submittals will be reviewed until the entire package has been provided for review. Finished work shall match approved samples.
 - (a) Plant Material Availability
 - (b) Plant substitutions
 - (c) Plant material delivery schedule
 - (d) Construction schedule
 - (e) Supplier List
 - (f) Soil Amendments
 - (g) Soil mix

- (h) Imported Topsoil
- (i) Fertilizers
- (j) Gravel or Rock
- (k) Decomposed Granite
- (l) Seed mixes
- (m) Tree ties and guys
- (n) Other

B. Samples

1. Submit physical samples of each of the aforementioned materials for approval. Applicable samples shall be submitted in a one quart, clear, plastic bag (Ziploc type) or appropriate container. Submittals must be made prior to commencing any activities. All samples shall be clearly labeled with the following information.
 - (a) Project Name
 - (b) Material name as shown on Construction Documents and Specifications
 - (c) Supplier or distributor's name
 - (d) Supplier or distributor's product name and/or order number

C. Substitutions

1. Substitutions must have written approval of Owner's Representative and equal the standard of products specified herein and in the Construction Documents.
2. Installation of approved substitution is Contractor's responsibility. Changes required for installation of approved substitution must be made to the satisfaction of Owner's Representative and without additional cost to Owner.
3. Approval by Owner's Representative of substituted equipment does not waive these requirements.

D. Supplier list

1. The Contractor shall provide the Owner's Representative with a single list of all material suppliers for plant material, and all related landscape and irrigation materials to complete the work in this section and related sections. List must be submitted prior to commencing any activities.

E. Construction Schedule

1. Prior to beginning installation of the landscape, the Contractor is to submit a project construction schedule to the Owner's Representative for approval. The schedule should include the areas and types of construction to be undertaken and the sequence which will be used to accomplish the completion of the project. The construction schedule shall be submitted prior to commencing any activities.

F. Soils Testing

1. The cost of testing shall be the responsibility of the Contractor.
2. Results of the testing shall be submitted to the Owner's Representative.
3. Soil Test Reports
 - (a) Submit soils report for all horticultural soil testing as specified herein to the Owner's Representative.
 - (b) Soil report must include the following: complete fertility analysis (major nutrients and micronutrients copper, zinc, manganese and iron), pH, reverse lime analysis, calcium, magnesium, boron, sodium, potassium, exchangeable (plus soluble) sodium percentage, free lime, nitrate, nitrogen, phosphate, phosphorous, organic content, salts, salinity level by electroconductivity, plasticity index and particle size gradation, and texture.
4. Soils Testing Agency
 - (a) Soil tests and analyses shall be performed by an approved independent certified agricultural soil testing laboratory.
 - (b) The laboratory shall be responsible for determining the number, location, and collection of the soil samples for testing.
 - (c) The test results shall determine the acceptability of the soils.

(d) The testing laboratory shall suggest ways to amend soil to make it suitable to grow plants.

G. Certificates for Inspections of Materials

1. All plant material shall be inspected and accepted by the owner at the nursery prior to delivery. Notify the Owner's Representative 48 hours in advance of any Inspections or Approvals of Landscape Materials. Furnish a certificate with each delivery of material to the site in containers, or in bulk. Certificates shall state source, quantity, or weight, type and analysis, and date of delivery. Deliver all certificates to the Owner's Representative.
2. All State, Federal, or other inspection certificates shall be submitted to the Owner's Representative prior to acceptance of the plant material along with other information showing the source or origin.
3. Current grower or nursery certifications indicating that all contractor supplied plant material is healthy, vigorous, and free from insect pests, plant diseases, and injuries

H. Contract Closeout Submittals

1. Refer to Section 029100 – Landscape Establishment and Maintenance.
2. Operation and Maintenance Manuals
 - (a) At the completion of the work, furnish three (3) copies of written maintenance instructions to the Owner's Representative for maintenance and care of the landscaping. Instructions shall include directions for irrigation, weeding, pruning, fertilization, and spraying, as required for continuous and proper maintenance through a full growing season and dormant period. Contractor shall also furnish three (3) copies of operation manuals for all equipment, provided by the Contractor.
3. Warranty
 - (a) At completion of work, furnish written warranty to the Owner's Representative based on the requirements of this section.

1.07 QUALITY ASSURANCES

A. Landscape Subcontractor's Qualifications: The work covered under this Section is considered specialty work and the Subcontractor shall have a valid Arizona Business License or he shall employ as a Subcontractor a person or persons holding such a license. Additionally, a minimum of three (3) years' experience performing landscape work of comparable size and scope is required.

B. Field Conditions

1. The Contractor shall conduct a site visit to become familiar the existing site conditions.
2. The Contractor is responsible to inform the Owner's Representative of any discrepancies between the existing site conditions and those on the Construction Documents prior to the start of construction.
3. The Contractor shall determine the requirements for preparation and construction methods appropriate for the soil type and existing site conditions.

C. Advanced Notices

1. The Contractor shall provide the Owner's Representative with the following advanced notices:
 - (a) Notice of product delivery schedules forty eight (48) hours in advance
 - (b) Notice for observation of landscaping layout, plant materials installation and fine grading forty eight (48) hours in advance.
 - (c) Substantial Completion acceptance walk through and the start of the Maintenance Period one (1) week in advance.
 - (d) Final Acceptance observation one (1) week in advance.
 - (e) Notice of Warranty Period expirations, each phase one (1) week in advance.
 - (f) Notice of Final Completion and Owner assumes maintenance of project two (2) weeks in advance.

D. Obtaining and Analyzing Samples

1. The Owner's Representative reserve the right to obtain and analyze samples of any materials for conformity to the requirements specified at any time during the work.
2. The Contractor shall furnish samples upon request by the Owner's Representative.
3. Rejected materials shall be immediately removed from the site at the expense of the Contractor

E. Observation, Sale and Shipment

1. The Contractor shall comply with all local, state and federal laws pertaining to the observation, sale and shipment of the plant materials.
2. The Owner's Representative may impose additional requirements.

F. Specifications of Materials

1. Contractor shall furnish specifications of any item to be used on-site upon request by the Owner's Representative.

G. Soils Testing

1. The cost of testing shall be the responsibility of the Contractor.
2. Results of the testing shall be submitted to the Owner's Representative.
3. Soil Test Reports
 - (a) Submit soils report for all horticultural soil testing as specified herein to the Owner's Representative.
 - (b) Soil report must include the following: complete fertility analysis (major nutrients and micronutrients copper, zinc, manganese and iron), pH, reverse lime analysis, calcium, magnesium, boron, sodium, potassium, exchangeable (plus soluble) sodium percentage, free lime, nitrate, nitrogen, phosphate, phosphorous, organic content, salts, salinity level by electroconductivity, plasticity index and particle size gradation, and texture.
4. Soils Testing Agency
 - (a) Soil tests and analyses shall be performed by an approved independent certified agricultural soils testing laboratory.
 - (b) The laboratory shall be responsible for determining the number, location and collection of the soil samples for testing.
 - (c) The test results shall determine the acceptability of the soils.
 - (d) The testing laboratory shall suggest ways to amend soil to make it suitable to grow plants.
5. Imported Soils
 - (a) If imported soils are needed, the following tests shall be performed on the on-site and imported soils to ensure both soils have similar characteristics.
 - (b) Soils tests and analysis shall include tests for complete fertility analysis (major nutrients and micronutrients copper, zinc, manganese and iron), pH, reverse lime analysis, calcium, magnesium, boron, sodium, potassium, exchangeable (plus soluble) sodium percentage, free lime, nitrate, nitrogen, phosphate, phosphorous, organic content, salts, salinity level by electroconductivity, plasticity index and particle size gradation, and texture.
 - (c) Contractor may be directed by the Owner's Representative to provide the amendments at no additional cost to the Owner.

H. Soil Percolation Testing

1. A test for percolation shall be done to determine positive drainage of plant pits and beds.
2. The Owner's Representative will be notified, in writing, of all soil and drainage conditions detrimental to growth of plant material and shall submit a proposal for correcting the condition.

I. Soil Amendments

1. Refer to Section 029140 – Fine Grading and Soil Preparation

J. Fertilizers

1. Refer to Section 029140 – Fine Grading and Soil Preparation

K. Plant Material Availability

1. The Contractor is responsible for the documentation and verification of the availability of plant material specified on the Construction Documents within thirty (30) days of the date on the Notice to Proceed. Approved documentation from a wholesale nursery will specify the following:
 - (a) Nursery name
 - (b) Nursery location
 - (c) Nursery contact information
 - (d) Plant botanical and common name

(e) Plant quantities and sizes

L. Plant Material Quantities

1. Plant quantities shown on the drawing are for reference only. It is the responsibility of the Contractor to furnish the plant quantities and materials necessary to complete the work as indicated on the Construction Documents and shall be of species, kinds, sizes, etc., specified.

M. Plant Substitutions

1. Plant substitutions shall be requested by the Contractor within thirty (30) days of the date on the Notice to Proceed. No request for substitutions will be accepted after the submittal package has been approved. Refer to Section 013300 – Submittals

N. Plant Delivery Coordination

1. The Contractor will coordinate all deliveries of plants and other materials covered by this specification.

O. General Plant Health and Condition

1. Plants shall equal or exceed the measurements specified in the plant list, which are minimum acceptable sizes. Plants shall be measured before pruning with branches in normal position. Any necessary pruning shall be done at the time of planting.
2. Plants shall be free from pests, eggs, diseases. Plants shall not be root bound, damaged or substandard in any way. All materials to bear original labels.
3. Plant material shall not exhibit signs of accelerated growth.
4. Trees
 - (a) Trees shall be well branched, with grafts at ground level and with normal trunks throughout their full height.
 - (b) Trees with weak, thin trunks not capable of supporting themselves when planted will not be approved.
5. Container stock
 - (a) Container stock will be grown for four (4) months to one (1) year before delivery.
 - (b) The container stock shall not be root bound and have sufficient roots to hold the root ball intact after removal from the container.
6. The health and vigor of the plant material shall be the sole responsibility of the Contractor.

P. Plant Acclimation

1. Plant materials shall be acclimated to Arizona environs for not less than eight (8) months prior to planting.
2. Contractor is responsible for any off-site storage arrangements to meet the acclimation requirement.
3. Materials stored for acclimation will be available for periodic review by the Owner's Representative.

Q. Review of Plant Material/Inspection

1. All Plant material shall be subject to review and approval of the Owner's Representative at place of growth and/or upon delivery to the site for conformance with requirements specified. The Owner's Representative reserves the right to reject at any time or place, prior to acceptance, the work and all materials which in the Owner's Representative's opinion fails to meet these specification requirements.
2. The review/inspection of the plant material is primarily for quality; however, other requirements are not waived even though visual inspection results in approval. Materials may be inspected where growing but inspection at the place of growth shall not preclude the right of rejection at the site.
3. The review/inspection may be made periodically during installation of materials, at completion, and at the end of warranty periods by the Owner's Representative. Plants shall have a habit of growth that is normal for the species. They shall be healthy, vigorous, and free from insect pests, plant diseases, and injuries. All plant material shall be inspected stock conforming to all State and Federal Regulations.
4. Such approval will not limit the right of observation and rejection during progress of the work.
5. Observation and tagging of plant material by the Owner's Representative for design intent purposes does not necessarily constitute Owner's Representative's approval of the plant material in regards to their health and vigor as specified herein.
6. Tagged material shall be clearly designated to ensure that the proper plants will be delivered to the

project site.

R. On-Site Review of Root Ball

1. The Owner's Representative shall randomly select two plants of each species on-site for review of the root ball. Plants of the same species from different growers shall be considered as separate shipments.
2. If the Owner's Representative determines the roots do not sufficiently fill the container, or have become overgrown or "rootbound", restricted or are deformed in the containers, all the plants of that species from the same shipment and grower shall be rejected and removed from the site immediately.
3. The Contractor and or the Contractor's project superintendent will attend all plant inspections. The Contractor shall replace any plants damaged during any inspection at no additional cost to the Owner. The Contractor shall replace all plants rejected by the Owner's Representative at no additional cost to the Owner.

S. Defective Materials

1. Any plant not conforming to the requirement herein shall be considered defective. All defective plants whether in place or still in the container will be tagged as rejected and immediately removed from the site and replaced with new plants at no additional expense to the Owner.

T. On-Site Plant Care

1. Upon acceptance of plant delivery, the Contractor will assume full responsibility for the condition, care and protection of the plant material.
2. The Contractor will provide replacements for plants damaged under his care.

U. Replacement Plants

1. Replacement plants will be provided in accordance with these Specifications including the warranty provision.

V. Vandalism

1. The Contractor will not be responsible for malicious destruction of plantings after Final Acceptance of the project. The Contractor will, however, be responsible for replacement of vandalized materials stored but not yet installed, and material vandalized prior to Final Acceptance. All cases of vandalism shall be promptly reported to the Owner's Representative. The Contractor shall inform the Owner's Representative in writing if additional protection must be installed to protect the landscaping from damage after installation.

1.08 DELIVERY, STORAGE, AND HANDLING

A. General Requirements

1. The delivery, storage, handling and transporting of any materials for the project will be following all Federal, State and Local laws and requirements.

B. Pesticides And Herbicides

1. It is the responsibility of the Contractor to verify status and delivery, storage, handling and transporting requirements of the materials utilized.
2. The Contractor shall notify the Owner's Representative and obtain prior approval for the use of any chemicals for insect eradication or control and weed eradication or control.
3. The types of insecticides or herbicides to be used and the methods of application will conform to Environmental Protection Agency, and all state and local requirements and labeling instructions.
4. Insecticides and herbicides shall be approved by the Owner's Representative prior to use on the Project.

C. Fertilizer and Amendments

1. Deliver fertilizer to site in original unopened containers bearing the manufacturer's guaranteed chemical analysis, name, trade name, trademark, and conformance to Federal and State laws. Notify Owner's Representative forty eight (48) hours in advance of delivery so that material may be inspected upon arrival at the job site.
2. Deliver packaged manufactured materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at the site. Provide

copies of delivery receipts for materials to be incorporated into the construction to the Owner's Representative as the deliveries are made. Materials to be accounted for shall include (but are not limited to) the following: fertilizers, soil amendments, manure, grass seed, plant tabs, etc.

D. Plant Material

1. The Contractor shall be responsible for obtaining all necessary permits and tags for transporting plant materials on public roads.
2. Plants shall be containerized, properly wrapped and prepared for shipping in accordance with recognized standard practice. The root system shall be kept moist and plants shall be protected from adverse conditions due to climate and transportation at all times including when they are planted.
3. Each plant shall be identified by means of a grower's label affixed to the plant. The grower's label shall give the data necessary to indicate conformance to Construction Documents. Durable waterproof labels with water resistant ink which will remain legible for a minimum of sixty (60) days shall be used.
4. Owner's Representative shall be notified a minimum of forty eight (48) hours prior to delivery of plant materials to the site so plant material may be inspected upon arrival at job site.
5. Care shall be taken when working with plants. Plants shall not be dropped, nor shall plants be lifted by the trunk, stems, or foliage. The root ball of the plant shall be natural and intact, and the plant shall be always handled by the container. All plants shall be always protected from drying out or other injury. Minor broken and damaged roots shall be pruned before planting.
6. Storage and Protection
 - (a) Deliver trees and shrubs after preparations for planting have been completed and plant immediately. If planting is delayed more than four (4) hours after delivery, set trees and shrubs in shade, protect from weather and mechanical damage.
 - (b) Always keep root balls moist. Do not allow root balls to dry out.
 - (c) Protect all existing and newly planted trees, shrubs, and groundcover within the areas of construction and related excavation as herein specified. Provide suitable barricades and/or fences as required.
7. The Contractor shall be responsible for repair or replacement of any damaged structures, plants, etc. in which the damage was caused by the planting operations.

E. Acceptance at Site

1. Major damage to any part of the plant or root ball shall be cause for rejection.
2. No container plant shall be accepted if the root ball is broken, or the trunk is loose in the root ball or the container.
3. The Contractor shall be responsible for the removal of all unacceptable or rejected plant material immediately from job site. Removal shall be done in a legal manner.

1.09 PROJECT/SITE CONDITIONS

- A. The Contractor must examine the sub-grade upon which work is to be performed, verify sub-grade elevations, observe the conditions under which work is to be performed, verify suitability of the soil and notify the Owner's Representative in writing of unsatisfactory conditions. Work shall not proceed until unsatisfactory conditions have been corrected in a manner acceptable to the Owner's Representative. Commencement of work shall mean acceptance of the site conditions.
- B. Existing Conditions
 1. Any discrepancy between the existing site conditions and the contract documents shall be reported to the Owner's Representative and resolved prior to the start of construction operations.
 2. The site shall be provided to the Contractor within ± 0.2 foot of finish grades.
 3. Determine location of all existing and proposed underground utilities and perform work in a manner which will avoid possible damage. Do not permit heavy equipment such as trucks, rollers, or bulldozers to damage utilities. Hand excavate where called for, or as necessary, to minimize the possibility of damage to underground utilities. Maintain grade stakes set by others until removal is mutually agreed upon by all parties concerned. Any damage to existing or proposed utilities that may result in spite of

protective measures must be completely corrected and repaired by the Contractor at no additional cost to the Owner.

4. All scaled dimensions are approximate. Before proceeding with work carefully check and verify all dimensions and quantities; immediately inform the Owner's Representative of any discrepancy between the drawings and/or the specifications and the actual dimensions. No work shall be done in any area where there is such a discrepancy until review and approval for the same has been given by Owner's Representative.
5. Planting areas shall be kept clean, free of any waste or debris.

1.10 SEQUENCING & SCHEDULING

- A. Coordinate the landscape construction with all other trades to ensure that construction is not delayed.
- B. Schedule each type of landscape work required during the normal season for such work in the area of the site. Establish dates for each type of work and establish a completion date. Correlate work with specified maintenance periods to provide maintenance until accepted by the Owner. Do not depart from the accepted schedule, except with written authorization from the Owner's Representative. Submit request to the Owner's Representative for changes in the planting schedule. When delays in the planting schedule are unavoidable, include documentation of the reason for delay.

1.11 ORDER OF COMPLETION

- A. Pre-Substantial Completion Walk-through
 1. A Pre-Substantial Completion Walk-through shall be performed upon acceptance of Substantial Completion of all landscape and irrigation work under this Contract.
 2. A punch list shall be generated by the Owner's Representative in the presence of the Contractor requiring incomplete or unacceptable work to be successfully installed per the work under this Contract.
 3. A final walk through with the Owner's Representative and the Contractor shall occur to review the punch list items to ensure they all have been completed successfully as required per the work under this contract.
 4. At this time the Contractor shall submit Irrigation Record Drawings (As-Builts) for approval by the Owner's Representative per Section 028000 – Irrigation of these specifications.
- B. Substantial Completion
 1. Substantial Completion shall be granted only when one hundred (100) percent of the irrigation system is fully operational and functioning properly and all plantings and landscape materials are installed per the Construction Documents successfully.
 2. Conditional Acceptance shall be provided at the time the Owner's Representative deems the project Substantially Complete.
- C. Plant Establishment/Maintenance Period
 1. The start of the Landscape Establishment/Maintenance Period shall begin after the work recorded on the punch list at the Substantial Completion walk-through and all work in the Construction Documents and under this contract is successfully completed. At this time if it is established that all work under this Contract has been successfully complete acceptance will be provided by the Owner's Representative to the Contractor and the Plant Establishment/Maintenance Period shall begin.
 2. A second Substantial Completion walk-through in the presence of the Contractor shall be conducted to establish compliance with the punch list items generated at the first Substantial Completion walk-through and that all work has been successfully completed as per the work under this Contract.
 3. The length of the Landscape Establishment/Maintenance Period shall be forty-two (42) calendar days (six weeks).
 4. The schedule of Operations for the Landscape Establishment/Maintenance Period shall include but not limited to the following.
 - (a) Each week the Contractor shall submit a work schedule of operations for approval by the Owner's Representative.

- (b) Failure to maintain an approved work schedule will result in the extension of the maintenance period for one (1) workday each day until the schedule of operations is submitted and approved by the Owner's Representative.
- 5. Maintenance Observations by the Owner's Representative shall occur biweekly during the Landscape Establishment/Maintenance Period.
 - (a) The Contractor shall be present for all observations.
 - (b) The Contractor shall maintain a weekly landscape maintenance log, indicating services performed. Submit copies of the log with each month's pay request.
 - (c) If it is determined that the landscape areas are being improperly maintained, plant replacement shall be required, or other corrective measures shall become necessary. The Contractor shall correct all items in a timely manner at no additional cost to the Owner.
 - (d) Any remedial work shall be completed prior to the next maintenance observation.
 - (e) If the remedial work is not completed in the time, the Landscape Establishment/Maintenance Period shall be extended one (1) month, or at the discretion of The Owner's Representative.
 - (f) Monthly payments shall be held until the remedial work is completed.
- D. Final Acceptance Observation
 - 1. The Owner's Representative shall be notified seven (7) days prior to the end of the Landscape Establishment/Maintenance Period that Final Acceptance Observation is requested.
 - 2. The Owner's Representative shall set the date with Contractor present for Final Acceptance Observation.
 - 3. A punch list shall be prepared of any plantings or other work in this Specification Section or as a part of this contract that is not acceptable and requires correction.
 - 4. Contractor will immediately make such corrections.
- E. Notice of Final Acceptance
 - 1. After the Final Acceptance Observation, if the Owner's Representative agrees that all planting areas are weed free and plant materials are in satisfactory growing condition, written Notice of Final Acceptance will be given to the Contractor for landscape installation.
 - 2. Final written Notice of Acceptance will be granted only after one hundred (100) percent of the items on the Final Acceptance Observation punch list are corrected and accepted by the Owner's Representative.
 - 3. Owner maintenance shall begin only after the Notice of Final Acceptance for all landscape items is issued.
- F. Additional Observations
 - 1. If additional observations are required to gain Final Acceptance, the Contractor shall be required to pay all consultants and staff fees.
 - 2. Fees will be deducted from final payment.
- G. Corrective Work
 - 1. Deficiencies in workmanship and installation shall be written up in a corrective work report. Perform work requiring corrective action within fifteen (15) days after the observation.
 - 2. Corrective work shall be done in accordance with the Contract Documents and at no extra cost to the Owner.
 - 3. Contractor shall submit, in writing, notice of completion of corrective work

1.12 WARRANTY

- A. The Warranty Period shall begin after:
 - 1. The Irrigation Record As-built Drawings have been received and approved by the Owner's Representative.
 - 2. The Final Acceptance punch list items have been completed and approved by the Owner's Representative.
- B. The Contractor shall guarantee all trees, shrubs, groundcovers, and all plant material for a period of one (1) year from the date of Final Acceptance against defects not resulting from neglect of Owner, or abuse and

damage by others. The Contractor shall replace any plants that are dead, unhealthy, unsightly, or that have lost their natural shape due to dead branches or excessive pruning. Inadequate maintenance by the Owner shall not be cause for replacement. All replacement planting is to be done no later than the succeeding season.

- C. Replacement plants shall be of the same variety and size or larger as originally specified in the plant list. Plants shall be planted as originally specified. All areas damaged by planting or replacement operations shall be fully restored to their original condition as specified. Remove all dead or defective plant material from the site immediately.
- D. A one (1) year warranty shall also apply to the plants replaced at the first warranty walk-through.
- E. Salvaged Plants that were transplanted from their original location and placed in a temporary nursery whether boxed or transplanted directly in the native soil shall be guaranteed. Salvaged plants that die during the landscape construction or Plant Establishment/Maintenance Period shall be replaced with plant material of like kind, size and economic value at no additional expense to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Fertilizer
 - 1. Refer to Fine Grading & Soil Preparation Section 029140.
 - 2. If it is determined by the soil test that the plant material does not need additional fertilization and based on the sole discretion of the Owner's Representative the Agriform Tablets may be eliminated from the contract.
- B. Plant Material
 - 1. General Requirements
 - (a) All plants grown in a nursery will conform to the applicable requirements specified in the current edition of "American Standard for Nursery Stock" ANSI Z60.1 as approved by the American National Standards Institute, Inc., and sponsored by the American Association of Nurserymen, Inc.
 - (b) Botanical plant names will be in accordance with the current edition of "Standard Plant Names" prepared by the American Joint Committee on Horticultural Nomenclature.
 - (c) Plants shall be in accordance with Arizona State Department of Agriculture regulations for nursery observations, rules and ratings.
 - (d) Label each tree and shrub with a securely attached waterproof tag bearing legible designation of botanical and common name and size.
 - (e) The Owner's Representative will be sole judge as to acceptability.
 - 2. Species, Sizes, Grades, and Condition
 - (a) Requirements for measurements, branching, and quality of plants in the plant list generally follow the code of standards currently recommended by the American Association of Nurserymen, Inc., in the American Standard for Nursery Stock ANSI Z60.1.
 - (b) The size of all plants will correspond to that normally expected for species and variety of commercially available nursery stock as specified in the Construction Documents.
 - (c) Plants shall be equal to or exceed the measurements specified in the plant list, which are minimum acceptable sizes.
 - (d) Plants shall be nursery grown under climatic conditions like those in Pima County, Arizona. Grower's certificates may be required when doubt exists as to the origin of the plant material.
 - (e) Plants shall be container grown or established "boxed out" field grown plant material unless otherwise specified.
 - (f) Established container stock is defined as a tree, shrub or groundcover grown from seed or transplanted into a container for a length of time sufficient to develop new fibrous roots so that the root mass will retain its shape and hold together when removed from the container.

- (g) Container stock shall be grown in containers for at least four (4) months and shall not be root bound. No bare root or recently containerized stock will be accepted.
- (h) Container plants with cracked or broken balls or earth when taken from the containers may only be planted with specific approval of the Owner's Representative.
- (i) Plant material containers shall be sufficiently rigid to retain the root ball shape and protect the root mass during shipping.
- (j) Protect all plant material in transit and after delivery to the project site. Plants in broken containers and plants with broken branches or injured trunks will be rejected. Remove rejected material from the site immediately.
- (k) Plants, including their containers, will be free of noxious weeds including Bermuda grass and Bufflegrass.
- (l) Flat grown plant material shall be rooted full and compact and shall not be leggy.
- (m) All plants shall have a normal growth habit for each respective species and will be sound, healthy, vigorous, and free from plant disease, insect pests or their eggs, fresh bark abrasions, excessive abrasions, or other objectionable disfigurements.
- (n) Where formal arrangements or consecutive order of plants are shown, select stock for uniform height and spread, and label with numbers (if necessary) to ensure symmetry in planting.
- (o) At no time will tree or plant materials be pruned, trimmed, or topped prior to delivery and any alteration of their shape will be conducted only with the approval of and as directed by the Owner's Representative.

3. Plant Material Substitutions

- (a) Plants larger than specified in the plant list may be used if approved by the Owner's Representative but use of such plants will not increase the contract price.
- (b) If use of larger plants is approved, the root ball will be increased in proportion to the size of the plant.
- (c) Under no conditions will there be any substitutions of plants or sizes listed on the drawings, except with written approval from the Owner's Representative.
- (d) The Owner's Representative shall consider plants of other kinds than those indicated on the plant list only upon submission of proof that the specified plant is not reasonably procurable in the local region.
- (e) Replacement plants shall be approved on the grounds that it resembles the plant specified regarding appearance, ultimate height, shape, habit of growth, general soil and other requirements.
- (f) In no case shall the average cost and value of the substituted plants be less than the cost and value of plants indicated.
- (g) All proposed plant substitutions due to unavailability shall be requested in writing for approval by the Owner's Representative prior to the confirmation of ordering.
- (h) Should the Contractor not secure plant materials and materials become unavailable at time of installation, the Contractor shall install larger container size of equal plant variety at no additional cost to the Owner.

4. Trees

- (a) Height of branching should bear a relationship to size and variety of tree specified and with the crown in good balance with the trunk and trunk caliper as recommended by ANSI Z60.1.
- (b) Trees shall not be "poled" or have the leader removed.
- (c) Single trunk plants shall be reasonably straight and symmetrical with crown according to species and have a persistent main leader.
- (d) Boxed trees shall be harvested and boxed at least ninety (90) days prior to planting.
- (e) Trees in groves shall match in caliper, height, spread and overall form.

5. Shrubs and Groundcovers

- (a) Provide deciduous shrubs with not less than the minimum number of canes required by ANSI Z60.1 for the type and height of shrub specified.
- (b) Plants furnished in containers shall have been grown in pots, cans, or baskets long enough to

have sufficient roots to hold earth together intact after removal from container, without being root bound.

C. Tree Stakes and Guys

1. Stakes and guys shall only be installed for plant material larger than 24" box container size for a minimum period of one year.
2. Tree stakes shall be two (2) inches dia. x eight (8) feet in length, be sound and knot-free pressure treated Redwood or Lodgepole Pine, uniformly sized, pointed six (6) inches from the end and capable of at least two (2) years ground burial.
3. Guy wire shall be twisted double strand twelve (12) gauge galvanized steel wire. Trunk protective covering shall be three quarter (3/4) inch dia. vinyl two-ply fabric-bearing hose with a six (6) inch to eight (8) inch inside diameter around the tree trunk to allow for natural sway of tree. Install hose and guy to not constrict tree trunk and per Construction Documents.

D. Weed Control

1. Pre-Emergent Herbicide: Elanco Mfg. Co. "Surflan 75W" or approved equal. Do not apply on areas that receive native seed mix or turf.
2. Herbicide: Monsanto "Round-Up" or approved equal.

E. Water

1. The water shall be free of oil, acid, salts, or other toxic elements.
2. The Owner's Representative shall approve the water source prior to use.

F. Fencing

1. The Contractor shall provide temporary security fencing for adequate protection of workers, the public, preserve-in-place vegetation and existing features and structures from construction activities.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall inspect the site with the Owner's Representative prior to beginning any activities on site. The Contractor shall provide a written report of any discrepancies that would interfere with their scope of work or would delay progress on the project.

B. The Contractor shall verify the location of underground utilities and facilities.

C. Any damage to any such underground items resulting from work of this Specification Section or under this contract shall be repaired at the Contractor's expense.

D. Weed Control

1. If live perennial weeds exist on the site at the beginning of the landscaping operation, spray with herbicide according to the manufacturer's instructions and applied by an Arizona licensed herbicide applicator.
2. After allowance of adequate time for systemic kill, clear and remove all dead vegetation and maintain entire site weed-free until Final Acceptance by Owner's Representative using mechanical, manual, and/or chemical treatment.
3. Remove all weeds including Bermuda Grass, Buffalo grass, Johnson Grass and Nut Grass and dispose of off-site in a legal manner.

3.02 PROTECTIVE FENCING

A. Existing Landscape

1. Provide protective fencing for existing landscaped plants from construction activities per the direction of the Owner's Representative.

B. Prior to Construction

1. The Contractor shall, prior to the start of construction activities on the site, define the limit boundaries of all areas designated as off-limits to the Contractor.

3.03 REMOVAL OF EXISTING MATERIALS

- A. General
 - 1. Items such as abandoned irrigation lines, sleeving, wiring or other used materials shall be disposed of appropriately and in a legal manner off-site.
 - 2. Care shall be taken not to damage existing irrigation system.
 - 3. Damage shall be repaired immediately
 - 4. Damaged and/or modified lines shall be flushed and pressure tested.
- B. Tree and Shrub Removal
 - 1. Remove existing trees and shrubs as necessary to execute all aspects of these contract documents and as directed by the Owner's Representative.
 - 2. Prior to construction, remove the entire trunk and root system below grade of the indicated trees and shrubs.
 - 3. Dispose of off-site in a legal manner.
 - 4. Fill the removed tree and shrub plant holes with approved imported soil suitable for plant growth.

3.04 INSTALLATION/APPLICATION

- A. Proceed with and complete the landscape work as rapidly as portions of the site become available, working within the seasonal limitations for each kind of landscape work required.
- B. Coordinate and cooperate with any other Contractors and trades which may be working in and adjacent to the landscape work areas. Examine drawings which show the development of the entire site and become familiar with the scope of all work required. Refer to Section 02800 – Irrigation.
- C. Refer to section 029140 – Fine Grading and Soil Preparation
- D. Refer to section 029220 – Turf Installation by Sodding
- E. Refer to section 029230 – Hydroseeding with Native Seed
- F. Existing Plant Materials
 - 1. Any existing plants outside the construction limits that are removed, damaged, or destroyed during construction shall be replaced with plants of the same species, size and variety at the Contractor's expense.
 - 2. The Contractor shall be responsible for maintaining all "preserve in place" plants as designated by the Owner's Representative.
 - 3. The Contractor shall provide an adequate water supply to any "preserve in place" plants affected by construction activities.
 - 4. Any plants designated as "preserve in place" that are removed, damaged or destroyed during construction will be replaced with trees and shrubs of the same species, size and variety at the Contractor's expense.
- G. Native Plants
 - 1. Protected native plants within the project that have been identified by the Owner's Representative.
 - 2. Plastic tape to correspond to the determinations made in the Native Plant Inventory
 - (a) White tape - Plants to remain in place.
 - (b) Red tape - Plants to be moved to another location.
 - (c) Blue tape - Plants to be destroyed.
 - 3. The Contractor is responsible for properly marking and protecting preserve-in-place native vegetation.
- H. Removal and Storage of Salvageable Vegetation
 - 1. Salvageable vegetation shall be removed or relocated to an area near the present location as directed by the Owner's Representative.
- I. Pruning of Existing Plant Materials
 - 1. International Society of Arboriculture Certified Tree Worker or Arborist supervising pruning of existing trees and plant material.

2. Existing plant materials adjacent to walkways or within sightlines shall be pruned as part of landscape restoration to provide a minimum seven foot (7') height canopy/branch clearance above walkway surfaces for trees and maximum three foot (3') height for shrubs.
3. All existing shrubs as hedges which exceed the three foot (3') maximum height shall be removed to provide a four foot (4') clearance from the back of all walkways.
4. All plant removal and pruning shall be reviewed and approved with the Owner's Representative prior to beginning any work.
5. Failure to get prior approval may require the Contractor to replace the pruned plant material at no additional cost to the Owner.

J. Irrigation System

1. No planting shall be done until installation and acceptance by the Owner's Representative of the irrigation system in total or in increments is provided.
2. The initial watering and all subsequent watering of the planting shall be done using the newly constructed irrigation system.
3. Boxed Trees
 - (a) Boxed trees may be placed before irrigation system installation.
 - (b) The Contractor shall transport adequate water to these trees to maintain them in prime condition until the irrigation system is automated.
4. Refer to Section 028000 – Irrigation for additional information.

K. Layout of Planting Areas

1. The Contractor shall paint or stake the layout of all planting areas and berm locations for approval of the Owner's Representative prior to grading.
2. All planting areas shall be shaped as indicated on the Construction Documents or as directed by Owner's Representative.

L. Layout of Plant Material

1. Stake location of individual trees, for approval by Owner's Representative, prior to planting or excavating.
2. If a new tree or shrub relocation is necessary due to interference with underground piping or wiring, the Contractor shall notify the Owner's Representative and receive approval of a new plant location prior to installation.
3. The Owner's Representative must approve the precise location of all plants prior to pit excavation and installation.
4. Make minor adjustments as requested by the Owner's Representative, or as necessary to avoid conflicts with sprinkler line locations.

M. Work Under or Near Existing Vegetation

1. Where landscape operations are to be completed below the canopy spread of existing trees, all work shall be performed by hand or other methods necessary to complete the work and prevent damage to any limbs, branches, trunks or roots.
2. Excavation or trenching below existing trees shown to remain shall be completed providing the greatest allowable distance from the trunk and limited to one side of the tree.
3. Field verify the location or route which shall provide the least disturbance of the root structure.
4. Roots encountered which are two (2) inches or larger in diameter shall be tunneled or excavated under or around and protected from any damage.
5. Roots that are less than two (2) inches in diameter shall be cleanly pruned and painted with two coats of standard tree paint or compound prior to backfilling.
6. No roots shall be left unprotected from damage caused by exposure or loss of moisture.
7. Notify Owner's Representative for direction if conditions are encountered which may affect trees or landscape installation methods.

N. Excavation For Planting

1. If rock, underground construction work, or other obstructions are encountered in excavation for planting

of trees or shrubs, notify the Owner's Representative. If necessary, new locations may be selected by the Owner's Representative.

2. Any subsurface obstructions, materials or substances which conflict with or impact the installation of plants or may be detrimental to plant health shall be excavated and removed to a minimum of two times the root ball container depth and four times the root ball container width.
3. Remove any rock or other underground obstruction, if possible, to the depth necessary to permit proper planting according to the Construction Documents and as specified.

O. Planting Operations

1. General
 - (a) Do not install plant materials until all construction work has been completed and irrigation system has been installed and tested. Planting areas shall have been graded and prepared as herein specified and shall have been approved by the Owner's Representative.
 - (b) Do not plant during unfavorable weather.
 - (c) Soil shall be at optimum moisture content for planting.
 - (d) Do not lift or handle container plants by tops, stems or trunks at any time.
 - (e) All plants shall be set so that, when settled, natural grade of the container plant shall be as detailed in the Construction Documents.
 - (f) All plants shall be planted immediately after the containers are cut and containers shall be regularly removed from the site so as not to present a hazard to persons using the area.
 - (g) Set plants upright, plumb and faced to give best appearance or relationship to each other or adjacent structure.
 - (h) Set vines as close as possible to the structure and tie to structure. Two (2) ties per vine.
 - (i) Place backfill in six (6) inch lifts, water settle if possible.
 - (j) After planting remove all nursery stakes and tags after inspection and Acceptance of Substantial Completion.
 - (k) Thoroughly water in all planting.

P. Planting Pits

1. Boxed Trees
 - (a) Boxed material shall be observed by Owner's Representative and approved prior to planting in a new location as shown on the Construction Documents.
 - (b) Width of pit shall be a minimum of two (2) to three (3) times the width of the box size and the depth will be the same as depth of box size or as large as necessary for placement in pit without damage to tree or adjacent structures or existing landscaping.
 - (c) At the Owner's Representative's option, tree pits will be filled with water and must drain completely within twenty-four hours (24) to be acceptable. Pits that do not drain shall receive a drainage chimney. A drainage chimney is twelve inch (12") diameter x twenty four inch (24") deep auger holes (two per tree pit) to be filled with one and one half (1-1/2) inch gravel.
2. Container Stock
 - (a) Planting pits shall be approximately circular with diameter two (2) to three (3) times the width and depth at least the height of the plant ball or container.
 - (b) If pits are dug with an auger the surface shall be scarified.
 - (c) Pits must be large enough to permit handling and planting without injury or breakage of the root ball or root system.
 - (d) If soil is added to level or stabilize the plant, the soil shall be compacted to avoid settlement after planting.
 - (e) Plants shall not be allowed to stand in these pits without watering.

Q. Moving Boxed Plants

1. Check plant box containers before moving.
2. Any box damage that may cause harm to the root ball will be repaired at the Contractor's expense prior to relocation.
3. This includes but is not limited to provide new bottoms, side reinforcement, re-banding, box repair or

replacement.

R. Placing Plants

1. General
 - (a) Place shrubs no closer than twenty (20) inches from foundations, fences, walls and walks or as far as character of growth demands, whichever is greater, unless directed otherwise by the Owner's Representative.
 - (b) Place trees no closer than six (6) feet to foundations, fences, walls and walks unless directed otherwise by the Owner's Representative.
 - (c) All plants which settle deeper than the surrounding grade shall be rejected and must be raised to correct level.
 - (d) Backfill plants with clean site soil that will be thoroughly settled by watering and tamping to fill all voids. Refer to Section 029140 – Fine Grading and Soil Preparation.
 - (e) Set trees plumb and rigidly brace in position until the soil has been tamped solidly around the ball.
2. Boxed Trees
 - (a) Notify Owner's Representative at least two (2) days in advance to secure approval of the equipment to be used for planting.
 - (b) Owner's Representative shall be present at the time the trees are set and positioned in the planting pit.
 - (c) Fill the excavated planting pits halfway with water and drain before placing tree in pit. Any drainage problem must be rectified prior to planting the tree.
 - (d) Boxed trees will be carefully lowered into their pits using approved equipment and at no time will be pushed or dropped into pit.
 - (e) Boxed trees thirty (30) inches or greater shall be positioned by crane.
 - (f) Branches and root balls shall not be damaged.
 - (g) Top of root ball at finish grade shall be in accordance with details in the Construction Documents.
 - (h) Add soil backfill under the tree if needed to bring root ball to proper height.
 - (i) Planting pit will be backfilled with clean site soil as box sides are progressively removed to minimize damage to the root ball and to prevent it from collapsing. Refer to Section 029140 Fine Grading and Soil Preparation.
 - (j) Backfill in bottom of planting pit to prevent undue settling.
3. Container Stock
 - (a) Unless otherwise specified, place all plants in the center of planting pits, plant upright and face to give the best appearance and relationship to the adjacent plants or structures.
 - (b) Plants will be set in relation to surrounding grade in accordance with the details in the Construction Documents.
 - (c) After removing plant from container, scarify side of root ball to eliminate root bound condition.
 - (d) Do not plant stock if root ball is cracked or broken.
4. Watering and Filling
 - (a) Water compact topsoil to the extent approved by the Owner's Representative.
 - (b) After settlement, supply additional topsoil as required to make a constant finished in accordance with details in the Construction Documents.
5. Staking of Plants
 - (a) Tree stakes shall be two (2) inches in diameter x eight (8) feet in length sound and knot-free pressure treated Redwood or Lodgepole Pine, uniformly sized, pointed six (6) inches from the end and capable of at least two (2) years ground burial.
 - (b) Trees stakes shall be placed on opposite sides of the tree in accordance with details in the Construction Documents.
 - (c) Tree stakes will be driven vertically into firm ground and will not injure the root ball.
 - (d) Provide extra guys if they are needed in the opinion of the Owner's Representative.
 - (e) In accordance with details in the Construction Documents, avoid rigid restraint of tree and allow for trunk movement.
 - (f) All stakes and guys are to be removed from all trees after a period of one year from Project

Completion.

6. Pruning
 - (a) After planting, prune the plants of superfluous growth as directed by the Owner's Representative.
 - (b) Dead or broken tip growth shall be removed.
 - (c) Typical growth habit of individual plants shall be retained with clean cuts made at the natural growth collar at the base of the branch where it emerges from the parent trunk.
 - (d) "Headback" cuts at right angles to line of growth shall not be permitted.
 - (e) All cuts larger than 3/4-inch diameter will be trimmed back to healthy tissues, smoothed so as not to retain water.
 - (f) Trees shall not be poled or the leader removed, nor shall the leader be pruned or "topped off".
 - (g) Improper cuts, stubs, dead and broken branches shall be removed.
 - (h) All pruned material shall be removed from project site.
 - (i) Pruning tools will be new and of proper size for the cut and maintained with sharp cutting surfaces.
 - (j) Remove and replace excessively pruned or deformed stock resulting from improper pruning.

3.05 FIELD QUALITY CONTROL

- A. When the landscape work is completed, the Owner's Representative shall, upon seven (7) calendar days advance notice, inspect the landscape work to determine if the work is complete and acceptable. The Owner's Representative shall prepare a punch list of items improperly installed, inadequately sized or otherwise deficient based on the findings of his inspection. The punch list shall be completed not more than seven (7) working days after the field inspection. When the Contractor has remedied all deficiencies and completed all items on the punch list, the Contractor shall request another inspection by the Owner's Representative to determine whether the deficiencies have been adequately corrected. Once the punch list items have been corrected and re-inspected, the Owner's Representative shall issue a written certificate to the Owner who will then respond to the Contractor in writing formally accepting the work and beginning the Warranty Period.
- B. Additional landscape inspections shall be conducted upon request by the Owner's Representative, to determine the condition of the work at the completion of the Warranty Period.

3.06 ADJUSTING AND CLEANING

- A. During landscape work, store materials and equipment where directed.
- B. Keep pavements clean and work areas in an orderly condition.
- C. Protect landscape work from loss, damage, and deterioration during storage, installation, and maintenance periods.
- D. Protect from unauthorized persons (trespassers), as well as from operations by other Contractors and tradesmen and landscape operations.
- E. At the time of the final inspection of the work and before the issuance of Final Acceptance, all paved areas shall be thoroughly cleaned by the Contractor by sweeping and washing. All construction equipment and excess materials shall have been removed and any debris or rubbish shall have been removed from the site.

END OF SECTION

SECTION 029100

LANDSCAPE ESTABLISHMENT & MAINTENANCE

PART 1 - GENERAL

1.01 SUMMARY

- A. This section covers work necessary for maintaining the landscape amenities as indicated on the Construction Documents and details in accordance with the Contract Documents.

1.02 DESCRIPTION OF WORK

- A. Furnish all supervision, labor, material, equipment, transportation, permits and fees, and perform all operations in connection with and reasonably incidental to maintaining all plantings, hydroseed, hydrostolon and turf, included within the area as delineated on the plan and as called for under this Contract for a forty two (42) calendar days (six weeks) Contractor shall retain a copy of the Construction Documents on the project site until final project acceptance.
- B. These specifications are intended as a guideline for contractors to develop their maintenance schedules for the duration of the Landscape Establishment Maintenance Period. Work will be inspected on the overall performance, rather than strict conformance with the Specifications. The Owner's Representative will monitor work at biweekly intervals to ensure that the landscape is well manicured, free of weeds, properly watered, dead material is removed or replaced, and the overall appearance of the site is acceptable to the owner. The Contractor shall be present for all of the Owner's Representative maintenance observations.
- C. These guidelines are minimum expectations of the Contractor. Maintenance obligations during the Landscape Establishment Maintenance Period are anticipated to be more involved on the part of the Contractor.
- D. The Contractor is responsible for all elements that may be included in maintaining the property. These elements will include but are not limited to aeration, fertilizing, mowing, trimming, blowing sidewalks and street curbs, keeping log books, replacements of trees and shrubs, clean up, weeding, insect and disease control, etc. It is the responsibility of the Contractor to utilize all measures to maintain this property at a high level.
- E. The following areas shall have an appearance as described below, immediately after each plant or turf area is installed, at all times during the Landscape Establishment Maintenance Period. Some of the elements listed may not occur within this project.
 - 1. Planting Areas
 - (a) Continuous operations of watering, weeding, cultivating, trimming, mowing, edging, rolling, fertilizing, spraying, insect, pest, fungus and rodent control, and any other operations to ensure good normal growth.
 - (b) All planting areas shall be weed free. Decomposed granite and or screened rock should be raked, redistributed, or replenished to maintain a depth outlined in Construction Documents.
 - (c) Dead plant material should be removed or replaced, as indicated by Owner's Representative.
 - (d) All perennials and annuals should be dead headed on a regular basis to promote further flowering, and have a neat, well kept appearance.
 - 2. Sod and Hydrostolon turf areas
 - (a) Refer to Section 029220 – Refer to Turf by Sodding
 - 3. Hydroseeded areas (native seed mix)
 - (a) This includes all areas within the limits of work that are irrigated, non-irrigated, recently planted, or well established. Contractor should monitor these areas on a regular basis for the presence of weeds and percentage of germination/coverage.
 - (b) Areas will require individual attention and separate maintenance schedules, thus the Contractor is responsible for developing and sustaining a weed-free, lush stand of native plant material.

(c) Chemical, mechanical, or manual methods should be implemented to prevent the spread of weeds. Contractor will be expected to re-seed or over-seed areas as bare spots develop.

1.03 QUALITY ASSURANCE:

- A. The Contractor is responsible to protect all improvements installed as a part of the Contract against damage from pedestrian and vehicular traffic, vandalism or malicious destruction until Final Acceptance is provided in writing by the Owner's Representative (not including Warranty Period).
- B. Contractor shall maintain a weekly landscape maintenance log, indicating services performed. Submit copies of the log with each month's pay request.
- C. Contractor shall submit a sample of the form used to log work. Owner's Representative must approve the format for logging work. All maintenance logs will be entirely completed and in a uniform format. Contractor shall maintain originals of the maintenance logs in a bound format. The Owner's Representative will be sent a copy of the logs for the month prior to the Contractor submitting the pay request.
- D. Contractor shall use the pay request form approved by the Owner's Representative in preparing monthly pay submittals.
- E. Contractor shall assume all responsibility for plant material or turf which is damaged or stressed in any way as a result of poor maintenance. Contractor will assume all cost associated with replacement of damaged plant material.

PART 1 - PRODUCTS

- A. Materials used for maintenance shall be supplied by Contractor unless otherwise specified.
- B. Any replacement plant materials shall conform to the sizes identified in the supplemental unit prices.
- C. Any replacement non-organic landscape materials shall conform to the type, size and condition of the material being replaced.

PART 2 - EXECUTION

2.01 TREE MAINTENANCE

- A. Pruning
 1. Fall planted trees shall not be pruned until one year after planting, except to remove broken or weak branches.
 2. Prune trees to select and develop permanent scaffold branches that are smaller in diameter than the trunk or forty eight (48) inches and radial orientation so as not to overlay one another; to eliminate diseased or damaged growth; to eliminate narrow V-shaped branch forks that lack strength; to reduce toppling and wind damage by thinning out crowns; to maintain growth within space limitations; to maintain a natural appearance; to balance crown with roots.
 3. Stripping of lower branches ("raising up") of young trees shall be permitted unless directed by the Owner's Representative.

2.02 SHRUBS, GROUND COVERS, ORNAMENTAL GRASSES, AND FLOWERS

- A. Pruning
 1. Prune shrubs and ground covers by hand to maintain a natural appearance. There are no plantings in which shearing is intended.
 2. Prune all dead, diseased, and dying branches.
 3. Prune long uncharacteristic branches that detract from the shrub's overall form. Prune branches adjacent to bare spots to encourage full shrub growth.
 4. Prune flowering shrubs within two (2) weeks after flowering has ended (to prevent pruning of future flower buds).

5. Prune ground covers to maintain a neat, well kept appearance and to prevent ground covers from climbing shrubs.
6. Cut back taller growing herbaceous perennials when they become rangy in appearance.
7. Pinch back dead flower heads on a weekly basis to promote greater flowering.

B. Fertilization

1. In early May, fertilize all shrubs, ornamental grasses, and ground cover with 18-7-10 formulation, slow release fertilizer at the rate of 6 oz/1,000 sq. ft. Use a broadcast or liquid application method for fertilizer, or as directed by Owner's Representative.

2.03 TURF BY SODDING

- A. Refer to Section 029220 –Turf by Sodding

2.04 HYDROSEEDING WITH NATIVE SEED

- A. Refer to Section 029230 –Hydroseeding with Native Seed

2.05 WEED CONTROL

- A. Weeds represent the greatest threat to successful establishment of ground covers, shrub planting and hydroseeded areas. Therefore, a vigorous, high level of weed control is necessary to maintain an attractive, healthy landscape.
- B. Spot control weeds weekly using chemical and/or mechanical means. Do not spray in windy weather. Use extra caution in application of chemicals to prevent overspray onto ornamental plant material. If necessary, use mechanical means for removal of weeds.

2.06 REPLACEMENTS

- A. Notify Owner's Representative of any unhealthy or dead plant material. Submit proposed removal and replacement and receive written authorization prior to replacement. Cost of removal and replacement shall be determined by pre-approved price schedule, or unit pricing in bid form.
- B. If replacement plant material becomes necessary, conform to material and installation standards (including Warranty Period of one year) established in the original project specifications.
- C. Replace plant material with size equal to that of the plant material being replaced.
- D. All replacements shall be affixed with an inconspicuous tag, to be removed after the one year warranty has expired. This tag shall indicate the date the plant material was installed.
- E. All replacements shall carry a one year warranty against expiration of the plant material, assuming adequate maintenance is performed.

2.07 DISEASE/INSECT CONTROL

- A. Inspect all landscape areas weekly during growing season for signs of insect or disease infestation.
- B. Apply seasonal applications of insecticide, herbicide, or fertilizer as necessary to protect plant material.
- C. Spot treat areas as needed to maintain healthy growing plant material. Spot treatment is included in the scope of this contract.
- D. Do not apply airborne insecticides or pesticides when unprotected people or animals may be affected.
- E. Protect all trees, shrubs, and ground covers from over spray that is detrimental to the health of ornamental plant material.
- F. Notify Owner's Representative if extensive spraying is required. Submit proposed for additional application and receive written authorization prior to commencement.

2.08 CLEANUP

- A. Clean all areas weekly to provide a neat, well-groomed site. Pick up all trash and debris, sweep walks and

rake decomposed granite and or screened rock in planting areas, parking islands, etc.

- B. Adjust cleanup to match seasonal needs.
- C. Cleanup after severe rain or hailstorms is not included [notify Owner's Representative within twenty four (24) hours after damage occurs]. Obtain a written authorization from Owner's Representative prior to cleanup.
- D. Provide weekly, complete policing and litter pickup to remove paper, glass, trash, undesirable materials, animal and bird droppings, situation and other accumulated debris within the hard surfaces and landscape areas to be maintained, including but not limited to: walkways, between and around planted areas, drains, catch basins, and pond edges.
- E. Litter pickup shall be completed as early in the day as possible, but in no case later than 10:00 A.M.
- F. Contractor shall be responsible for weekly removal of all trash, litter and accumulated debris to an approved off-site disposal site.
- G. Rake and remove accumulation of leaves and grass clippings. Remove from all turf and landscaped areas, including planting beds, turf areas and under trees, play and sand areas, and removed from site. Rake as needed in fall and spring. Collect and remove grass clippings in non-playfield areas only when thatch build-up in irrigated turf areas becomes a problem. Notify Owner's Representative and obtain approval prior to removing clippings during mowing operations.

2.09 SWEEP/WASHING

- A. Check paved areas bi-weekly for cracks, crevices and deterioration. Report any problems to Owner's Representative immediately. Walkways, hard surface areas, play and sand areas shall be cleaned, including but not limited to: the removal of all foreign objects from surfaces, such as gum, grease, paint, graffiti, broken glass, etc. Methods of sweeping of designed areas can incorporate one or all of the following:
 - 1. Power pack blowers
 - 2. Vacuums
 - 3. Brooms
 - 4. Push power blowers
- B. In the event the Contractor elects to use power equipment to complete such operations, Contractor shall be subject to local and state ordinances regarding noise levels. Further, any schedule of such operations may be modified by the Owner's Representative in order to ensure that the public is not unduly impacted by the noise created by such equipment.
- C. Sweep all walkway and hard surface areas once per week.

2.10 GRAFFITI

- A. Graffiti abatement is not part of the base maintenance contract and will be paid for on an hourly basis as approved by the Owner's Representative at the agreed upon unit price.
- B. Eradication and control of graffiti shall include all surfaces throughout the site, including, but not limited to, the following:
 - 1. Walkways and hard surfaces
 - 2. Site furniture
 - 3. Boulders
 - 4. Retaining walls
 - 5. Monumentation and signage
 - 6. Lighting
- C. All materials and processes used in graffiti eradication shall be non-injurious to surfaces and adjacent property and approved by Owner's Representative.
- D. Appropriate surface preparation shall be made on painted surfaces. Paint applied shall be the exact shade

of color as existing paint, unless otherwise specifically approved by the Owner's Representative.

E. Contractor shall use special care and attention when removing graffiti from treated or sealed surfaces. Such surfaces shall not be painted. Contractor shall use materials, and methods of application approved by the Manufacturer and Owner's Representative.

F. Visually inspect all areas weekly. Remove graffiti the same day it is visually noted.

2.11 MAINTENANCE

A. The Contractor will perform maintenance operations to keep installed plants in a healthy growing condition at no additional cost to the Owner.

B. Beginning of Maintenance operations will begin immediately after each plant is installed and will continue as required until the start of the Maintenance Period. All maintenance activities shall be provided at the start of the maintenance period.

C. Duties include the Contract to observe the plants at least once per week and appropriate maintenance performed.

D. Replacing Unhealthy Plants

1. A plant will be considered unhealthy or dead when main leader has died back or twenty five (25%) percent of crown is dead.
2. The cause for an unhealthy plant will be determined and reported to the Owner's Representative.
3. Unhealthy or dead plants will be immediately removed from the site and disposed of in a legal manner.
4. The plant will be replaced as soon as seasonal conditions permit.

E. Irrigation

1. The Contractor will maintain the irrigation system and make any necessary repairs, regardless of cause, to ensure a complete and operational system during the course of the work, during Plant Maintenance/Warranty Period and until final written Notice of Acceptance.
2. Plants will be watered as necessary to maintain an adequate supply of moisture within the plant's root zone.
3. Run-off, puddling and wilting will be prevented.

F. Weeding

1. Plant beds and planting swales will be kept free of weeds, grass and other undesirable vegetation.
2. Weeds in planting swales and plant beds will be removed before reaching two inches in height.
3. Removal will include root growth.

G. Pruning

1. After planting, prune the plants of superfluous growth as directed by the Owner's Representative.
2. Dead or broken tip growth will be removed.
3. Typical growth habit of individual plants will be retained with clean cuts made at the natural growth collar at the base of the branch where it emerges from the parent trunk.
4. "Headback" cuts at right angles to line of growth will not be permitted.
5. All cuts larger than 3/4-inch diameter will be trimmed back to healthy tissues, smoothed so as not to retain water.
6. Trees will not be poled or the leader removed, nor will the leader be pruned or "topped off".
7. Improper cuts, stubs, dead and broken branches will be removed.
8. All pruned material will be removed from project site.
9. Pruning tools will be new and of proper size for the cut and maintained with sharp cutting surfaces.

H. Any plants that have been knocked out of true for any reason will be straightened.

I. All loose stakes and guying materials will be tightened. Staked plants will be checked for girdling and adjusted if necessary.

J. Settling

1. Plants will be checked for settlement and will be reset to proper grade as necessary.

2. Serious settlement of a plant will require re-planting to match original requirements as specified herein and in the Construction Documents.
- K. Edges of planting beds will be maintained to retain design intent.
- L. Planting areas will be protected from erosion. Eroded areas will be repaired to match original requirements.
- M. The Contractor will remove construction trash and debris daily.
- N. Condition of Planting at the End of the Maintenance Period.
 1. All plant materials shall be live, healthy, undamaged, and free from infestations.
 2. Ground cover, shrub areas, lawn, and other planting areas shall be free of all weeds (broadleaf and grass weeds).
 3. All lawn areas shall be completely covered at the time of Final Acceptance.
 4. Plantings that do not conform to specifications shall be replaced and brought to a satisfactory condition before Final Acceptance of the work can be made.
 5. Mow grass to one and one eighth (1-1/8) inches.
- O. The required maintenance instructions shall be forwarded to the Owner's Representative prior to the Final Acceptance to inform the Owner's Representative of any maintenance responsibilities that would be required for the project.
 1. The items addressed by the manual may include but is not limited to the following:
 - (a) Irrigation
 - (b) Fertilization
 - (c) Weeding
 - (d) Pesticide and herbicide application
 - (e) Pruning
 - (f) Resetting unstable plants
 - (g) Mowing
 - (h) Repairing, adjusting or replace stakes and guying
 - (i) Repair damage caused by weather, wildlife, and vandalism
 - (j) Precautions to prevent damage from cold, frost, sunburn, vandalism, or other hazards
 - (k) Perform other maintenance operations necessary to ensure healthy plant growth
 - (l) Wood Chip replacement
 - (m) Decomposed Granite or Screened Rock Replacement

END OF SECTION

SECTION 029140

FINE GRADING & SOIL PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This section covers work necessary for ripping, fertilizing, soil conditioning, and fine grading as indicated on the Construction Documents and details in accordance with the Contract Documents.

1.02 DESCRIPTION OF WORK

- A. The work shall include, but is not limited to, supplying fertilizer, soil conditioners and all labor, material procurement, equipment, tools, transportation protection, and services required for complete execution of the fine grading and soil preparation as indicated or reasonably implied on the Construction Documents and/or specified herein.
- B. Contractor shall retain a copy of the Construction Documents on the project site until final project acceptance.
- C. If any discrepancies exist between the plans and the specifications, the specifications will prevail.
- D. Contractor shall be responsible for obtaining all necessary permits required for installation of landscape. .

1.03 RELATED SECTIONS

- A. Examine all sections related to the project work.

1.04 SUBMITTALS

- A. Section 013300 – Submittals
- B. Section 029005 – General Landscape
- C. Section 029220 – Turf by Sodding
- D. Soil Test Reports
- E. Fertilizer Manufacturer's Specifications

1.05 QUALITY ASSURANCE

- A. Qualifications
 1. The Contractor shall provide, upon request of the Owner's Representative, past performance data indicating that equipment and procedure are suitable.
- B. Equipment and Procedure Approval
 1. The Owner's Representative has the final approval as to equipment and procedure to be utilized to complete the work under this contract.
- C. Rejection of Work
 1. Any method of installation or use of materials not in conformance with these specifications shall be reinstalled, repaired or removed as directed by the Owner's Representative at no additional cost to the Owner.
- D. Soils Testing
 1. The cost of testing shall be the responsibility of the Contractor.
 2. Results of the testing shall be submitted to the Owner's Representative.
 3. Soil Test Reports
 - (a) Submit soils report for all horticultural soil testing as specified herein to the Owner's Representative.

- (b) Soil report must include the following: complete fertility analysis (major nutrients and micronutrients copper, zinc, manganese and iron), pH, reverse lime analysis, calcium, magnesium, boron, sodium, potassium, exchangeable (plus soluble) sodium percentage, free lime, nitrate, nitrogen, phosphate, phosphorous, organic content, salts, salinity level by electroconductivity, plasticity index and particle size gradation, and texture.
- 4. Soils Testing Agency
 - (a) Soil tests and analyses shall be performed by an approved independent certified agricultural soil testing laboratory.
 - (b) The laboratory shall be responsible for determining the number, location, and collection of the soil samples for testing.
 - (c) The test results shall determine the acceptability of the soils.
 - (d) The testing laboratory shall suggest ways to amend soil to make it suitable to grow plants.
- 5. Imported Soils
 - (a) If imported soils are needed, the following tests shall be performed on the on-site and imported soils to ensure both soils have similar characteristics.
 - (b) Soils tests and analysis shall include tests for complete fertility analysis (major nutrients and micronutrients copper, zinc, manganese and iron), pH, reverse lime analysis, calcium, magnesium, boron, sodium, potassium, exchangeable (plus soluble) sodium percentage, free lime, nitrate, nitrogen, phosphate, phosphorous, organic content, salts, salinity level by electroconductivity, plasticity index and particle size gradation, and texture.
 - (c) Contractor may be directed by the Owner's Representative to provide the amendments at no additional cost to the Owner.
- 6. Soil Percolation Testing
 - (a) A test for percolation will be done to determine positive drainage of plant pits and beds.
 - (b) The Owner's Representative will be notified, in writing, of all soil and drainage conditions detrimental to growth of plant material and will submit a proposal for correcting the condition.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Comply with Sections 029005 – General Landscape

1.07 PROJECT/SITE CONDITIONS

- A. Do not perform work when climate and existing site conditions will not provide satisfactory results.
- B. Vehicular accessibility on-site shall be as directed by the Owner's Representative. Repair damage to prepared ground and surface caused by vehicular movement during work under this section to original condition at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Compost

- 1. A totally organic product that has been aerobically and naturally processed without the addition of coarse wood chips, in such a manner as to maintain a consistent temperature of 140 degrees Fahrenheit or greater for a period sufficient to create the following characteristics, measured by dry weight.
 - (a) Moisture content of 30%-35%
 - (b) Organic matter to nitrogen ratio: 25:1 to 30:1.
 - (c) pH: 6.0 to 8.0 pH.
 - (d) Salts: maximum of 10 mmhos/cm.
 - (e) Less than 1% soil, dirt or sand.
 - (f) Maximum particle size of 1/2 inch diameter.
 - (g) Eradication of all harmful weed seeds, pathogens and bacteria.
 - (h) A non-offensive, earth smell.

B. Topsoil

1. Topsoil will be a screened, fertile, friable soil from well-drained arable land, free of brush, litter, stumps, nut grass, roots, heavy clay, noxious weeds, or other material toxic to plant growth.
2. Soils containing rocks, clods or objects larger than 3/4 inches in any dimension shall also be rejected.
3. The topsoil textural composition will be:
 - (a) silt 20-45%
 - (b) clay 15-20%
 - (c) sand 30-60%
4. The topsoil content will be:
 - (a) Topsoil 90%
 - (b) Mulch 15%
 - (c) Compost 10% (total organic matter from composted source)
5. The pH shall be no lower than 6.5 nor over 8.0.
6. Soluble salts shall not exceed 1000 PPM.
7. Plasticity index shall be in the range of 5 to 20 inclusive.

C. On-Site Topsoil

1. Topsoil shall be the existing surface soil stripped and stockpiled on the project site at a location approved by the Owner's Representative.
2. For the purposes of the Bid, the Contractor shall assume that there is no available topsoil on site.
3. Soil shall be amended as required to meet topsoil quality and requirements, and as recommended by soils testing agency to meet local growing conditions for the type and variety of plants specified.
1. The source of topsoil shall be subject to observation by the Owner's Representative.

D. Imported Topsoil Source

1. For purposes of the Bid, the Contractor shall **estimate 4" depth topsoil** over all areas to be sodded.
2. The imported topsoil shall be furnished by the Contractor.
3. The source of topsoil shall be subject to approval by the Owner's Representative.
4. Imported topsoil shall be delivered and installed in sufficient quantity to complete the work under this Contract.

E. Fertilizer

1. Fertilizer applications shall be prescribed as specified herein and be based on soil testing as specified herein. The following guidelines will be used for soils testing and the resulting fertilizer applications.
 - (a) Formulated fertilizer analysis shall be submitted to Owner's Representative for review and shall be based upon recommendations made by soil lab. Contractor to submit soil sample to an Arizona based testing lab for analysis and fertilizer recommendations.
 - (b) See Soil Testing 1.04 Quality Assurances in this Section.
 - (c) If soil types are similar in structure, the Contractor may use a consistent formulated fertilizer for the entire site area. However, if soil structures are vastly different, a formulated fertilizer for each specific site area will be required.
2. General
 - (a) The following organic amendments, soil amendments and fertilizers are for bidding purposes only.
 - (b) Trees, shrubs and groundcovers shall have installed in their planting pits, Scotts Agriform Tablets per the manufacturer's recommended application rate based on container size.
 - (c) Ammonium Sulfate
 - (i) Chemical fertilizer will be standard commercial fertilizer, suitable for application with approved equipment, containing the minimum analysis and in physical form of 21-0-0 at an application rate of 2.5 pounds of product per 1,000 square feet.
 - (ii) Chemical fertilizer will be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked.

F. Soil Amendments

1. General

- (a) The following organic amendments, soil amendments and fertilizers are for bidding purposes only.
- 2. Sand will be washed masonry sand.
- 3. Peat Moss
 - (a) Peat moss shall be Canadian "sphagnum" peat moss consisting of partially decomposed plant residues containing a negligible amount of woody or mineral material.
 - (b) Peat shall be evenly moist at the time of mixing and will be delivered to the site in unopened original containers.
- 4. Gypsum
 - (a) Agricultural grade gypsum product, commercially packaged and free flowing, and containing a minimum of ninety five percent (95%) calcium sulfate by volume.
- G. Sodded Area Amendments
 - 1. Section 029220 – Turf by Sodding
- H. Seeded Area Amendments
 - 1. Section 029230 – Hydroseeding with Native Seed

2.02 SOURCE QUALITY CONTROL

A. Verification of Performance

- 1. Compost and other soil amendments are typically identified by a rate of cubic yards per 1000 s.f. In order to accurately determine if amendments are applied at the correct rate, the following chart is supplied. This chart is intended to verify the cubic yards by allowing a method for measuring the depth of the material spread uniformly across the surface of the planting area, with no exposed soil, prior to mixing the amendments with the existing soils. This method will be used during inspections to verify that adequate amendments are incorporated into the soil.

<u>c.y./1000 s.f.</u>	<u>Depth (inches)</u>
3 c.y./1000 s.f.	1"
3.5 c.y./1000 s.f.	1 $\frac{1}{8}$ "
4.0 c.y./1000 s.f.	1 $\frac{1}{4}$ "
4.5 c.y./1000 s.f.	1 $\frac{1}{2}$ "
5.0 c.y./1000 s.f.	1 $\frac{5}{8}$ "

- 2. An inspection of soil preparation will be performed by the Owner's Representative before areas will be released for planting. The inspection shall consist taking a soil sample to determine
 - (a) Proper tilling of the soil. Soil will be judged on how easily a soil probe can be inserted into the ground.
 - (b) Proper depth of tilling, and homogeneity of the soil. The soil sample will be judged on uniformity of the soil profile in the top six to eight inches.
 - (c) A visual inspection for adequate compost will be conducted. An area that has similar soil structures, that has not received compost will be used as the basis of comparison. Should a disagreement exist, multiple soil samples will be sent to an independent testing laboratory to determine the amount of organic matter present. The cost of this testing will be absorbed by the Owner's Representative.

PART 3 - EXECUTION

3.01 EXAMINATION

A. General

- 1. Verify that existing site conditions are as specified and indicated before beginning work under this Section.

B. Grades

1. Inspect to verify rough grading is within +0.2 foot of grades indicated and specified.
- C. Damaged Earth
 1. Inspect to verify that earth rendered unfit to receive planting due to concrete, water, mortar, limewater or any other contaminant dumped on it has been removed and replaced with clean earth from a source approved by the Owner's Representative.
- D. Cleanliness
 1. Inspect to verify that site is clean of all trash and debris.
- E. Equipment
 1. Inspect to verify other trades have removed all equipment and staging areas from areas of work.
- F. Unsatisfactory Conditions
 1. Report in writing to Contractor with copy to Owner's Representative.
- G. Acceptance
 1. Beginning of installation means acceptance of existing conditions by installer.

3.02 PREPARATION

- A. Protection
 1. Locate sewer, water, irrigation, gas, electric, phone and other pipelines or conduits and equipment prior to commencing work.
 2. Be responsible for proper repair to landscape, utilities, walls, pavements and other site improvements damaged by operations under this section.
- B. Weed Control
 1. Remove annual weeds by tilling. Remove perennial weeds by applying herbicide 1 week before soil preparation and as needed, but no sooner than three (3) months before beginning work.
 2. If the area to be developed is infested with noxious or invasive weeds, a chemical application will be required, at a rate recommended on the chemical's product label.
- C. Surface Grade
 1. Remove weeds, debris, clods and rocks larger than one half (1/2) inch. Dispose of accumulated debris at direction of Owner's Representative.
- D. Runoff
 1. Take measures and furnish equipment and labor necessary to control the flow, drainage, and accumulation of water. Ensure that all water will run off the grades.
- E. Erosion Control
 1. Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited material on the site throughout duration of work.

3.03 INSTALLATION

- A. Refer to Section 029220 – Turf by Sodding
- B. Refer to Section 029225 – Turf by Hydrostolon
- C. Refer to Section 029230 – Turf by Hydroseeding with Native Seed
- D. Soil Amendment
 1. Evenly distribute soil amendments, conditioners, and fertilizer, and first application of fertilizer in landscaped areas at the rates outlined in Part 2.01 of this Section.
- E. Mixing
 1. Thoroughly mix all materials to achieve a uniform, well pulverized soil mix free of clumps, stones, sticks and any other foreign debris. Distribute planting mix uniformly in planting pits per the Construction Documents and details and specified herein.

F. Fine Grading in all Landscape Areas:

1. Do fine grading for areas prior to planting.
2. For ground surface areas surrounding buildings to be landscaped, maintain required positive drainage away from buildings.
3. Establish finish grades to within 0.04 foot of grades indicated.
4. Fine grading must be inspected and approved by Owner's Representative.
5. Any damage caused by inclement weather, to finish grades before inspection, will be repaired by the Contractor, prior to acceptance by Owner's Representative.
6. Sodded areas - Allow one (1) inch for sod.

G. Noxious weeds or parts thereof shall not be present in the surface grade prior to landscaping.

H. Prior to acceptance of grades, hand rake to smooth, even surface free of debris, clods, rocks, and vegetative matter greater than one half (1/2) inch.

3.04 FIELD QUALITY CONTROL

A. Inspection

1. Provide notice to Owner's Representative requesting inspection at least seven (7) calendar days prior to anticipated date of completion.
2. The following required inspections will be conducted to ensure proper preparation of soil, prior to planting.
 - (a) During, or after, the first cultivation
 - (b) After the application of specified soil amendments.
 - (c) During, or after, the second cultivation
 - (d) After the final grades have been established

B. Deficiencies

Owner's Representative will specify deficiencies to Contractor who shall make satisfactory adjustments and shall again notify Owner's Representative for final inspection.

3.05 CLEANING

A. Remove debris and excess materials from site. Clean out drainage inlet structures. Clean paved and finished surfaces soiled as a result of work under this Section, in accordance with direction given by Owner's Representative.

3.06 PROTECTION

A. Provide and install barriers as required and as directed by Owner's Representative, or as needed, to protect fine graded areas against damage from pedestrian and vehicular traffic until acceptance by Owner's Representative. Contractor is responsible for malicious destruction of fine graded areas caused by others until Final Acceptance (not including Warranty Period)

B. Protection of Surfaces

1. Any materials spilled or sprayed will be cleaned up at the Contractor's expense to the satisfaction of the Owner's Representative.

C. Protection of Existing Features

1. Protect existing utilities, paving, irrigation systems, and other facilities from damage caused by grading and soil preparation operations.

END OF SECTION

SECTION 029220

TURF BY SODDING

PART 1 - GENERAL

1.01 SUMMARY

- A. This section covers work necessary for installing the turf areas using sod as indicated on the Construction Documents and details in accordance with the Contract Documents.

1.02 DESCRIPTION OF WORK

- A. The work shall include, but is not limited to, supply all sod, labor, material procurement, equipment, tools, transportation protection, and services required for complete installation of the turf areas as indicated or reasonably implied on the Construction Documents and/or specified herein.
- B. Contractor shall retain a copy of the Construction Documents on the project site until final project acceptance.
- C. If any discrepancies exist between the plans and the specifications, the specifications will prevail.
- D. Contractor shall be responsible for obtaining all necessary permits required for installation of landscape.

1.03 RELATED SECTIONS

- A. Section 013300 – Submittal Process
- B. Section 029005 - General Landscape
- C. Section 029100 - Landscape Establishment and Maintenance
- D. Section 029140 - Fine Grading and Soil Preparation

1.04 REFERENCES

- A. Reference Standards: U.S. Department of Agriculture Rules and Regulations under Federal Seed Act and equal in quality to standards for Certified Seed.

1.05 SUBMITTALS

- A. Section 013300 – Submittal Process
- B. Section 029005 - General Landscape
- C. Soil Test Reports
 1. Submit Certificate of Analysis for all horticultural soil testing as specified by the Owner's Representative and as specified herein.

1.06 QUALITY ASSURANCE

- A. Qualifications
 1. The Contractor shall provide, upon request of the Owner's Representative, past performance data indicating that equipment and procedure are suitable.
- B. Equipment and Procedure Approval
 1. The Owner's Representative has the final approval as to equipment and procedure.
- C. Rejection of Work
 1. Any turf area that fails to produce, in the opinion of the Owner's Representative, shall be rejected and reinstalled at no cost to the Owner.
 2. Any method of installation or use of materials not in conformance with these specifications shall be reinstalled, repaired or removed as directed by the Owner's Representative at no additional cost to the Owner.

D. Soils Testing

1. The cost of testing shall be the responsibility of the Contractor.
2. Results of the testing shall be submitted to the Owner's Representative.
3. Soil Test Reports
 - (a) Submit soils report for all horticultural soil testing as specified herein to the Owner's Representative.
 - (b) Soil report must include the following: complete fertility analysis (major nutrients and micronutrients copper, zinc, manganese and iron), pH, reverse lime analysis, calcium, magnesium, boron, sodium, potassium, exchangeable (plus soluble) sodium percentage, free lime, nitrate, nitrogen, phosphate, phosphorous, organic content, salts, salinity level by electro-conductivity, plasticity index and particle size gradation, and texture.
4. Soils Testing Agency
 - (a) Soil tests and analyses shall be performed by an approved independent certified agricultural soils testing laboratory.
 - (b) The laboratory shall be responsible for determining the number, location, and collection of the soil samples for testing.
 - (c) The test results shall determine the acceptability of the soils.
 - (d) The testing laboratory shall suggest ways to amend soil to make it suitable to grow plants.
5. Soil Percolation Testing
 - (a) A test for percolation will be done to determine positive drainage of plant pits and beds.
 - (b) The Owner's Representative will be notified, in writing, of all soil and drainage conditions detrimental to growth of plant material and will submit a proposal for correcting the condition.

E. Documentation of Sod Availability

1. Contractor is responsible for documenting and verification of the availability of the sod within thirty (30) days of the award of contract.
2. Submit written documentation to the Owner's Representative within 30 days after contract award for review and approval showing that the sod is available and secured in a wholesale nursery.
3. Documentation will specify the following:
 - (a) Plant quantities and sizes
 - (b) Nursery name
 - (c) Contact person
 - (d) Phone number
 - (e) Location of nursery
4. This verification will serve as proof of availability for the sod.

F. Sod Materials

1. Subject to inspection and acceptance. The Owner's Representative reserves the right to reject at any time or place prior to acceptance, any work and sod which in the Owner's Representative's opinion fails to meet these specification requirements. Rejected sod will be promptly removed from site.

G. Inspection

1. Primarily for quality, however, other requirements are not waived even though visual inspection results in acceptance. Notify the Owner's Representative of intended sod farm prior to cutting for inspection. Inspection at growth site shall not preclude the right of rejection at project site.
2. Inspection shall be made periodically during sodding, at completion and at end of Warranty Period by the Owner's Representative.
3. Inspection shall be scheduled prior to sodding. The Owner's Representative shall inspect finish grades on which sod will be laid. This inspection does not dismiss the Contractor's responsibility for creating positive drainage across the landscaped areas.

H. Sod Standards

1. General - Healthy, thick turf having undergone a program of regular fertilization, mowing and weed control; free of objectionable weeds; uniform in green color, leaf texture and density; healthy, vigorous root system; inspected and found free of disease, nematodes, pests and pest larvae by the

entomologist of the State Department of Agriculture.

2. Each piece of Sod - Sandy-loam soil base that will not break, crumble or tear during sod installation.
3. Thickness – one half (1/2) inch minimum root zone thickness.
4. Thatch - Not to exceed one half (1/2) inch uncompressed.
5. Size – Large rolls, forty two (42) inches wide x one hundred and five (105) feet long, approximately four hundred (400) square feet in size, shall be installed as often as possible, cut no more than twenty four (24) hours prior to delivery. Small size sixteen (16) inches x seventy two (72) inches may be used in areas where large rolls cannot be laid, cut in strips twenty four (24) inches wide no more than twenty four (24) hours prior to delivery.

1.07 DELIVERY, STORAGE AND HANDLING

- A. General
 1. Refer to Section 029005 - General Landscape
- B. Packing and Shipping
 1. Deliver on large sod on rolls small sod rolls on pallets, properly loaded on vehicles and with root system protected from exposure to sun, wind, and heat in accordance with standard practice and labeled with botanical and common name of each grass species in accordance with Federal Seed Act.
 2. Protect sod from dehydration, contamination and heating at all times. Keep stored sod moist and under shade or covered with moistened burlap.
 3. Do not drop sod rolls from carts, trucks or pallets.
- C. Acceptance at Site
 1. Material shall be inspected upon arrival at job site.
 2. Immediately remove unacceptable material from job site.
- D. Storage and Protection
 1. Do not stack sod more than two (2) feet deep.
 2. Do not deliver more sod than can be installed within twenty four (24) hours. Storage is not recommended.

1.08 PROJECT/SITE CONDITIONS

- A. Environmental Requirements:
 1. Do not install sod on saturated or frozen soil unless otherwise directed by the Owner's Representative.
 2. Comply with all local and state regulations for dust control.
- B. Existing Conditions
 1. Import and place any fill material required to adjust the fine grade to meet drainage requirements or to match hard surface fine grades, or as indicated on plans (e.g.: one and one half (1-1/2) inches lower than adjacent concrete paving).
 2. Vehicular accessibility on-site shall be as directed by the Owner's Representative. Repair damage to prepared grounds and surfaces caused by vehicular movement during work under this Section to original condition at no additional cost to Owner.

1.09 WARRANTY

- A. Warranty sod for a period of one year from date of Substantial Completion is in a healthy, vigorous growing condition.
- B. During the original Warranty Period, replace at once sod areas that die due to natural causes, etc., or which in the Owner's Representative's opinions are unhealthy.
- C. Replacement will not be required in any season definitely unfavorable for sodding.
- D. Install replacements as originally specified and warranted.

PART 2 - PRODUCTS

2.01 SOD

- A. See Plans for Sod Type

2.02 SOIL AMENDMENTS

- A. Compost

1. A totally organic product that has been aerobically and naturally processed without the addition of coarse wood chips, in such a manner as to maintain a consistent temperature of 140 degrees Fahrenheit or greater for a period of time sufficient to create the following characteristics, measured by dry weight.
 - (a) Moisture content of 30%-35%
 - (b) Organic matter to nitrogen ratio: 25:1 to 30:1.
 - (c) pH: 6.0 to 8.0 pH.
 - (d) Salts: maximum of 10 mmhos/cm.
 - (e) Less than 1% soil, dirt or sand.
 - (f) Maximum particle size of 1/2 inch diameter.
 - (g) Eradication of all harmful weed seeds, pathogens and bacteria.

- B. Sand

1. Sand will be washed masonry sand.

- C. Fertilizer

1. Ammonium Sulfate

- (a) Chemical fertilizer will be standard commercial fertilizer, suitable for application with approved equipment, containing the minimum analysis and in the physical form of 21-0-0 at an application rate of 5 pounds of product per 1000 square feet.
- (b) Chemical fertilizer will be furnished in standard containers with the name, weight, and guaranteed analysis of the contents clearly marked.

2. Gypsum

- (a) Agricultural grade gypsum product, commercially packaged and free flowing, and containing a minimum of ninety five percent (95%) calcium sulfate by volume.

2.03 EQUIPMENT

Equipment used shall be consistent with industry standards and approved by Owner's Representative prior to installation.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. General

1. Verify that existing site conditions are as specified and indicated before beginning work under this section.
2. The planting of turf grass shall not commence until the soil preparation has been completed.
3. The planting of turf grass shall not commence until the irrigation system in the area to be planted has been installed, made fully operational, and has been approved by the Owner's Representative.

- B. Layout

1. Verify layout of sodded areas as indicated on Construction Documents and Civil Engineering Plans prior to starting operations.

- C. Grades

1. The Contractor shall be responsible for the coordination and installation of all grade stakes for the layout and grading as shown on the Construction Documents including the Civil Engineering Plans. All grades and stakes shall be set by an Arizona Registered Land Surveyor including a 20' x 20' grid for multi-use turf area.
 - 1. The finish grade shall be uniform and set to the grades indicated on the grade stakes set in the topsoil

for the new sod areas and shall be approved by the Owner's Representative for approval prior to the installation of the sod.

2. Do not deliver sod to the site until the finish grade has been approved by the Owner's Representative.
3. Verify that grades are within 0.2 ft. of grades indicated and specified.

D. Unsatisfactory Conditions

1. Report in writing to Contractor with copy to the Owner's Representative.
2. Beginning of installation means acceptance of existing conditions by the Contractor.

3.02 SCHEDULE AND LOCATIONS

A. Scheduling

1. Perform sodding only after other work affecting the areas to receive sod is complete.
2. The Owner's Representative, in conjunction with the Contractor, will establish exact dates to begin sod installation.
3. The Owner's Representative, in conjunction with the Contractor, may adjust the schedule of sod installation, until conditions are suitable.

B. Locations

1. Install areas as shown on the Construction Documents and Civil Engineering Plans.
2. Sod installation shall not be performed outside the limits of the project or as shown on the Construction Documents and Civil Engineering Plans.

3.03 PREPARATION

A. Protection

1. Identify prepared sod areas requiring protection and erect barriers for proper protection and traffic control.
2. Any damage to sodded areas, either accidental or otherwise, by the Contractor or sub-contractors shall be repaired by the Contractor to the satisfaction of the Owner's Representative at no additional cost to the Owner.

B. Sod Installation

1. The responsibility for all preparation will be by the Contractor.

C. Subgrade Preparation

1. For areas to be sodded, at the time of planting, the top six (6) inches will be free of stones, stumps, or other deleterious matter three (3) inches in diameter or larger, and free from all wire, plaster, concrete, rubble, or similar objects which would hinder planting, maintenance, or sod growth.

2. Dispose of accumulated debris off-site in approved legal dump site, or in an on-site location pre-approved by the Owner's Representative.

3. Ripping and Loosening Soil

- (a) Prior to irrigation installation, scarify and rip areas to receive sod to a minimum depth of twelve inches (12") below rough grade to loosen compacted soil.
- (b) Cross rip using a minimum of two (2) perpendicular passes.

4. Ripping of Soils with Shallow Caliche or other Adverse Soil Conditions

- (a) When noted on Project Plans, areas with shallow caliche or other adverse conditions shall be ripped to a minimum depth of eighteen (18) inches or to the depth noted herein, whichever is greater.

- (b) The equipment used to scarify these areas shall have teeth with spacing of not more than eighteen (18) inches on-center. If a single ripping bar is used, passes shall be made eighteen (18) inches on-center.

- (c) After ripping, the area shall be graded to the lines and grades shown or noted on the Construction Documents and Civil Engineering Plans.

D. Soil Amendments

1. For areas to be sodded, after approximate finish grades have been established, add three (3) cubic yards of specified compost per 1,000 sq. feet of sod area.

2. Soil conditioning and fertilizers will be added as determined by soils testing. As a general guideline, the following rates shall be utilized.

(a) Fertilizer – Ammonium Sulfate (21-0-0)	2.5 lbs. per 1000 ft ²
(b) Gypsum	60 lbs. per 1000 ft ²
(c) Specified Compost	3.0 c.y. per 1000 ft ²
(d) Sand	1.0 c.y. per 1000 ft ²
3. All amendments shall be uniformly spread and cultivated into the top six (6) inches of soil by means of a mechanical tiller.

E. Fine Grading and Repair

1. Carefully smooth all surfaces to be sodded and roll areas to eliminate soil depressions and surface irregularities.
2. Re-establish grade and specified conditions to damaged sod areas prior to placing sod.
3. Re-grade as required.
4. All rocks with a dimension of one half (1/2) inch or larger shall be removed from the soil surface. Rock removal shall be repeated after the irrigation system has been made operational and the initial irrigation cycles conducted.
5. All foreign, deleterious materials and rocks and clods one half inch (1/2) in diameter or greater in the top six inches (6) of the soil will be removed from the site and disposed of appropriately.
6. Grading of Turf Grass Fields:
 - (a) The finished grades in all turf grass athletic fields shall be established using laser leveling techniques.
7. Surface Tolerances:
 - (a) The finished grades in turf grass areas shall be within plus or minus 1/10 of a foot of the grades noted on the Civil Engineering Plans or interpolated from the contours shown on the drawings. Within the field areas the surface shall not vary more than 3/4 inch from the bottom surface of a ten (10) foot straightedge when the straightedge is laid on the prepared soil surface.
8. Settling- Thoroughly water settle soil for two (2) to four (4) days before final grading.
9. The Owner's Representative will review and approve areas designated to receive stolons for finished grading and proper site drainage before the start of hydrostolon installation.

F. Smoothing

1. Plow, disk or till all areas to a minimum depth of six (6) inches to break up large clods or fill voids.
2. Drag rake turf areas.
3. Establish grade at walls, walks and curbs per details.

G. Drainage

1. Ensure finished areas of hydrostolonized turf are such that positive drainage of storm and irrigation water will occur and ponding of water will be minimized.

H. Weeding

1. If the area to be developed is infested with noxious or invasive weeds, a chemical application will be required, at a rate recommended on the chemical's product label.

I. General Irrigation System Requirements

1. The irrigation system shall be fully operational and approved by the Owner's Representative prior to starting sod installation.
2. Adjust irrigation heads for proper coverage and to minimize spray outside of turf area prior to the installation of sod.
3. Locate, protect and maintain the irrigation system during sod installations.
4. Repair irrigation system components damaged during sod installation at the Contractor's expense.

J. Adjustment

1. Adjust irrigation heads to proper watering height according to depth of sod material but lower than compacted blade height to enable lawn mowers to cut grass freely without damage to the sprinkler system.

K. Refer to maintenance portion of this section.

3.04 INSTALLATION

A. Finish Grade

Finish grade will be as per Construction Documents and Civil Engineering Plans.

B. Laying Sod

3.05 SODDING

A. Sodding

1. Soil on which sod is laid shall be slightly moist.
2. Lay with longest dimension parallel to contours and in continuous rows.
3. Tightly butt ends and sides of sod together. Stagger and compact vertical joints between sod strips by rolling so sod will be incorporated with the ground surface, insuring tight joints between adjacent pieces.

B. Rolling

1. When soil and sod are moist, roll sod lightly as soon as possible after it is laid. Delay rolling until just before the second watering.

C. Topsoil

1. Add along exposed edges to match adjacent grade. Feather topsoil out approximately one (1) ft. from edge of sod.

D. Drainage

1. Ensure finished areas of sod are such that positive drainage of storm and irrigation water will occur and ponding of water will be minimized.

3.06 REPAIR OF EXISTING SOD AREAS DISTURBED BY RENOVATION

A. Repair existing sod areas disturbed by renovation work (utilities, paving, etc.), in accordance with these Specifications and Construction Documents to satisfaction of the Owner's Representative.

B. Add washed masonry sand and re-sod as necessary to eliminate tire ruts and other depressions.

3.07 MAINTENANCE

A. Mowing

1. The mower blades or reels shall be sharpened and maintained to provide a smooth, even cut without tearing. The result shall be a uniform, level cut without ridges or depressions. Variations of weather from season to season may require additional or fewer mowings. Clippings need not be collected unless thatch build-up becomes a problem. Use mowers of proper size to mow difficult areas. Do not use heavy mower in areas prone to rutting. Do not leave tire marks on sidewalk.
2. Mow all turf areas during the growing season at an approximate height of one and one eighth inch (1-1/8) inch. Mowing shall be performed so that no more than one-third (1/3) of the grass blade is removed during each mowing in returning the grass to the accepted height, or one (1) time per week, whichever is more frequent. Mowing shall not be delayed until grass blades bend over and become matted. Remove grass clippings from pavement areas.
3. Mowing shall not be done when grass is wet.
4. Perform all mowing with equipment suitable for the type of turf.
5. Dispose of all clippings off-site in a legal manner, as necessary.
6. If Final Acceptance of area is more than fourteen (14) days after sod was laid, the Contractor shall mow all turf within the forty-eight (48) hours prior to the final walk through.

B. Trimming

1. Trim all turf areas inaccessible to mowers after each mowing. Trim to match the height of the open turf areas. Protect trees and shrubs from damage caused by trim lines. Replace all plant material killed or seriously injured by trim lines. Replace with plants of equal or better size and quality at no cost to the

Owner. Seriously injured is defined as when thirty percent (30%) or greater of the cambium layer of the trunk circumference has been removed by trim lines or when shrubs have been seriously deformed (in the Owner's Representative's opinion).

2. Protect fences, buildings, and other structures from damage caused by mowers or trim lines.
3. Dispose of all clippings off-site.

C. Edging

1. Edge irrigated turf areas only along all walks and curbs, using a steel bladed edger. Remove debris created by edging. Sweep walks and gutters to remove debris and provide a clean site.
2. Dispose of all clippings off-site in a legal manner.

D. Weed Control

1. All irrigated and non-irrigated areas shall be kept free of weeds. Weeding shall be done manually or by the use of a selective herbicide. The Contractor shall replace any desirable plants damaged as a result of his spraying.
2. Control broadleaf weeds with selective contact herbicides in spring, and spot control as needed throughout the summer. Application of pre-emergence herbicide to control grassy weeds is not included. If needed for a known weed problem, notify the Owner's Representative and furnish a price for applying the appropriate material.
3. Spray and remove all weeds growing in hard surface areas, such as between concrete gutters and sidewalks.
4. Protect all ornamental trees, shrubs, and ground covers from overspray.
5. Conform to legal requirements, the Owner Representative's requirements and manufacturer's recommendations. Submit all Material Safety Data Sheet (MSDS) to the Owner's Representative for approval prior to application.

E. Fertilization

1. Fertilization shall be conducted according to the following schedule:
 - (a) Week 2 application of 20-5-10-1% Fe 25% SCU at the rate of 5 lbs. per 1,000 sq. ft. for 1 lb. Actual Nitrogen per 1,000 sq. ft. Thoroughly sweep curb, gutter, and walks after application of fertilizer and prior to irrigating. Do not apply fertilizer during rainfall or when rainfall is imminent. Protect all concrete from iron spots due to fertilizer.
 - (b) Week 6 application of 24-6-12-3% Fe 40% SCU at the rate of 5 lbs. per 1,000 sq. ft. for 1 lb. Actual Nitrogen per 1,000 sq. ft. Thoroughly sweep curb, gutter, and walks after application of fertilizer and prior to irrigating. Do not apply fertilizer during rainfall or when rainfall is imminent. Protect all concrete from iron spots due to fertilizer. This application will consist of:
 - (i) 40% SCU slow release
 - (ii) 60% Urea Nitrogen
 - (iii) 8% Sulfate Sulfur
 - (iv) 3% Iron
 - (v) Trace element forms Zinc, Copper, Boron, and Manganese

F. Subsequent Fertilizer Application

1. Eight (8) to ten (10) weeks after the installation of sod the sports field turf and every forty five (45) days thereafter until Final Acceptance of project by the Owner's Representative, apply 1 lb. of nitrogen or 5 lbs. of fertilizer material per 1,000 sq. ft. using 20-10-5 with 50% sulfur coated urea to all sod and sports field turf seed areas.

G. General

1. The maintenance shall begin immediately after each area is sodded and continue until Final Acceptance of entire project. During this time, the Contractor shall be responsible for watering, mowing, spraying, weeding, aerating, fertilizing, and all related work as necessary to ensure that sodded areas are in vigorous growing condition. Contractor shall furnish all supervision, labor, material and equipment to maintain turf areas.
2. Activities and tasks associated with general maintenance shall include, but not be limited to:

- (a) Daily inspection of the site to check on-site conditions and to perform remedial activities required to correct safety deficiencies and/or to address field conditions impacting the health of the turf and landscape plantings.
- (b) Weekly mowing of all turf areas.
- (c) Weekly removal of surface rocks larger than one (1) inch from all turf areas.
- (d) Weekly repair of surface irregularities within all turf areas.
- (e) As-specified re-fertilization of turf areas.
- (f) As-needed application of horticultural chemicals to control diseases and pests.
- (g) As-needed repair of erosion.
- (h) As-needed clean-up.

H. Watering

- 1. Contractor shall know, understand, and abide by all local water restrictions, if applicable.
- 2. Contractor will be held responsible for any fines received for violating any watering restrictions in effect, if applicable.
- 3. The Contractor shall attempt to provide the minimum water necessary to maintain irrigated landscape areas, especially in times of drought and during summer months. The Owner's Representative will determine what appropriate level of distress is acceptable on turf areas.
- 4. Initial Irrigation.
 - (a) Water sod sufficiently to moisten subsoil to a depth of at least four (4) inches, in a manner not to cause erosion or damage to adjacent finished surfaces for a number of repeat cycles to prevent sod from drying out until rooting develops. Water shall be free of substances harmful to plant growth. The Contractor shall be responsible for furnishing water from underground sprinkler system.
- 5. Subsequent Irrigation.
 - (a) Thoroughly water the completed lawn surfaces, moistening soil at least eight (8) inches deep every second day, or at other appropriate interval, until Final Acceptance of the work.
 - (b) Repeat sprinkling at regular intervals to keep sod moist at all times until rooted.
 - (c) After sod is established, decrease the frequency and increase amount of water per application as necessary.
 - (d) The amount of water and the frequency at which it is applied shall be reduced during winter months.
 - (e) Run-off, puddling, and wilting shall be prevented.

I. Re-sodding

- 1. Re-sod spots larger than nine (9) inches square and not having healthy, uniform stand of grass.

J. Insect and Disease Control:

- 1. As required, using insecticides and fungicides approved by Owner's Representative.

3.08 NOTIFICATION OF INSPECTION

A. Notification

- 1. Give notice requesting inspection by the Owner's Representative at least seven (7) calendar days prior to the anticipated date of completion. All sod must be healthy and significantly rooted in place in order to be considered complete.

B. Deficiencies

- 1. If deficiencies exist, the Owner's Representative shall specify such deficiencies to the Contractor who shall make satisfactory adjustments and will again notify the Owner's Representative for final inspection.

3.09 CLEANING

- A. Remove pallets, unused sod, and other debris from site. Clean paved and finished surfaces soiled as a result of work under this Section in accordance with directions given by Owner's Representative. Clean out drainage inlet structures.

3.10 PROTECTION

- A. Provide and install barriers as required and as directed by Owner's Representative, or as needed, to protect sodded areas against damage from pedestrian and vehicular traffic until acceptance by Owner's Representative. Contractor is responsible for malicious destruction of sodding caused by others until Final Acceptance (not including Warranty Period).

END OF SECTION

SECTION 029230

HYDROSEEDING WITH NATIVE SEED

PART 1 - GENERAL

1.01 SUMMARY

- A. This section covers work necessary for installing the hydroseeding by native seed areas as indicated on the Construction Documents and details in accordance with the Contract Documents.

1.02 DESCRIPTION OF WORK

- A. The Contractor shall supply all material and labor necessary for seeding of non-irrigated native seed mix, in the areas shown on plans. The work shall include, but is not limited to, all labor, material procurement, equipment, tools, transportation, and services required for complete installation of a native seed mulch mixture as indicated or reasonably implied on the Construction Documents and/or specified herein.
- B. The Contractor will be expected to ensure that native plants are established or germinating consistent with seasonal temperatures and precipitation by the end of the one (1) year Establishment Period.
- C. The Contractor shall ensure that seeded areas are free from erosion and displacement of soil material.
- D. Areas where seed and mulch have been displaced shall be reseeded and remulched.
- E. Contractor shall retain a copy of the Construction Documents on the project site until final project acceptance.
- F. If any discrepancies exist between the plans and the specifications, the specifications will prevail.
- G. Contractor shall be responsible for obtaining all necessary permits required for installation of landscape.

1.03 REFERENCES

- A. Reference Standards: Comply with U.S. Department of Agriculture Rules and Regulations under Federal Seed Act and be equal in quality to standards for Certified Seed.
- B. Hydroseeding shall be per the Pima Association of Governments Standard Specifications for Public Improvements 2015 Edition.
- C. Section 02900 – General Landscape
- D. Section 029100 – Landscape Establishment and Maintenance
- E. Section 029140 – Fine Grading and Soil Preparation

1.04 SUBMITTALS

- A. Section 013300 – Submittals
- B. Section 02900 – General Landscape
- C. Seed Procurement
 - 1. Contractor will provide written documentation verifying the species, quantity and source of all seed to the Owner's Representative.
 - 2. Documentation to include name and telephone number of seed source.

1.05 SYSTEM DESCRIPTION

- A. Performance Requirements
 - 1. Non-irrigated Native Seeded Areas
 - (a) This includes all areas within the limits of work that are recently seeded, and do not receive supplemental watering. Contractor should monitor these areas on a regular basis for the presence of weeds. Areas will require individual attention and separate maintenance schedules, thus the

Contractor is responsible for developing and sustaining a weed-free, lush stand of native plant material per the 2.01 B. Manual methods should be implemented to prevent the spread of weeds. Contractor will be expected to re-seed or over-seed areas as bare spots develop.

1.06 QUALITY ASSURANCE

- A. Section 02900 – General Landscape
- B. Qualifications
 1. The Contractor will provide, upon request of the Owner's Representative, past performance data indicating that equipment and procedure are suitable.
- C. Equipment And Procedure Approval
 1. The Owner's Representative has final approval as to equipment and procedure for the hydroseeding process.
- D. Inspections
 1. The Contractor will notify the Owner's Representative at least two (2) days prior to commencing seeding operations for inspection of the materials at the off-site location.
 2. At this time if it is determined by the Contractor that the temporary chain link construction fencing is obstructing the hydroseeding operation the Contractor shall propose an alternate location for the fencing keeping in mind the site must be secured at all times.
 3. The Contractor shall be responsible for the establishment of seeded areas (naturalized areas). After a period of two years there should be 70% of background density.
- E. Rejection of Work
 1. Any native seed mix area that fails to produce, in the opinion of the Owner's Representative, will be rejected and reinstalled at no cost to the Owner.
 2. Any method of installation or use of materials not in conformance with these specifications will be reinstalled, repaired or removed as directed by the Owner's Representative at no additional cost to the Owner.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with Sections 029005
- B. Deliver seed in sealed standard containers stating correct name and composition on the outside of the container and as per Sub-Section 2.01 MATERIALS, A. General Requirements. Seed damaged in transit or storage will not be accepted and removed from the site immediately.

1.08 PROJECT/SITE CONDITIONS

- A. Existing Conditions
 1. Vehicular accessibility on-site shall be as directed by Owner's Representative. Repair damage to prepared ground and surfaces caused by vehicular movement during work under this Section to original condition at no additional cost to Owner.
 2. Do not spray directly on or adjacent to temporary chain link construction fencing or any other improvement as prescribed in the Construction Documents.
 3. If it is determined by the Contractor that the temporary chain link construction fencing is obstructing seeding operations it must be relocated to allow for seeding operations to commence. The site must remain secure at all times therefore the location of temporary chain link construction fencing must be approved by the Owner's Representative prior to its relocation.
- B. Environmental Conditions
 1. Do not seed during windy weather or when ground is un-tillable.

1.09 WARRANTY

- A. At completion of work, furnish written warranty to Owner's Representative based upon requirements as specified herein.

1.10 MAINTENANCE

- A. The interim maintenance period shall begin immediately after each area is seeded and continue until substantial completion of entire project. Final Acceptance of seeded areas will not be given until Owner's Representative is satisfied with germination and that the entire seeded area is in a vigorous growing condition, with consistency and completion of coverage. During this time, Contractor shall be responsible for weeding, fertilizing and all related work as necessary to ensure that seeded areas are in a vigorous growing condition. Provide all supervision, labor, material and equipment to maintain seeded areas.

1.11 STANDARDS FOR FINAL ACCEPTANCE

- A. Surfacing is free from erosion and displacement of material.
- B. The finished grade of surfacing material has been maintained and the surface has been raked to provide neat and clean appearance.
- C. The reveal where the surfacing material abuts paved surfaces has been maintained or re-established as detailed or noted on Construction Documents and Civil Engineering Plans.
- D. Surfacing is free of weeds, turf grass, and other plants except as shown noted on plans.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General Requirements
 1. The species, variety, and strain of seed (designated elsewhere herein as contract-specified seed) shall be as shown on the Construction Documents or as specified herein. The contract-specified seed shall be obtained from seed suppliers through harvesting of wildland collections, or field-grown seeds grown prior to or during the Contract Period.
 2. The seed shall be delivered to the project site premixed in standard, sealed, undamaged containers for each seed species. Each container shall be labeled in accordance with the appropriate provisions of the Arizona Revised Statutes and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act. Labels shall indicate the variety or strain of seed, the percentage of germination, purity and weed content, the date of analysis which shall not be more than nine months prior to the delivery date, and testing information. A Certificate of Analysis from an accredited seed-testing laboratory shall accompany each container of seed.
 3. Unless otherwise approved by the Owner's Representative, weed content of the contract-specified seed mix shall not exceed 0.5 percent.
 4. The Contractor shall provide all seed tag labels to the Owner's Representative. No payment will be made for seed unless tag labels from all seed to be used on the project have been submitted as specified.
 5. The Contractor shall store seed under dry conditions, at temperatures of between 35 °F and 120 °F, and out of direct sunlight. Prior to using the seed, the Contractor shall provide a certification letter to the Engineer that the seed was stored as specified herein.
 6. Legume seed shall be inoculated with appropriate bacteria cultures approved by the Owner's Representative, in accordance with the culture manufacturer's instructions.
 7. Tetrazolium staining shall be acceptable to test for germination and hard seed. Cut or fill testing will not be allowed. As directed by the Owner's Representative, seeds with an expiration date past the acceptable test date or not meeting the specified conditions for storage shall be retested by the Contractor. The Owner's Representative may perform random sampling of seeds throughout the project. Mixing of the specified seed at the project site shall be under the supervision of the Owner's Representative.
 8. Application rates of seed as specified are for Pure Live Seed (PLS). PLS is determined by multiplying the sum of the percent germination of seeds, including hard or dormant seeds, by the percent purity.
- B. Native Seed Mix

1. The native seed mix will consist of seeds from the following species and application rate:

<u>Scientific Name</u>	<u>Common Name</u>	<u>PLS Pounds per Acre</u>
Ambrosia deltoidea	Triangleleaf Bursage	1.0
Ambrosia dumosa	White Bursage	1.0
Aristida purpurea	Purple Three-Awn	0.75
Asclepias subulata	Milkweed	1.0
Baileya multiradiata	Desert Marigold	1.0
Encelia farinosa	Brittlebush	2.0
Eschscholtzia mexicana	Mexican Gold Poppy	1.0
Larrea Iridentata	Creosote Bush	1.0
Lesquerella gordonii	Gordon Bladder Pod	1.0
Lupinus sparsiflorus	Desert Lupine	1.0
Penstemon eatonii	Firecracker Penstemon	0.5
Phacelia crenulata	Desert Bluebells	1.5
Plantago ovata	Desert Indian Wheat	0.5
Salvia columbariae	Desert Chia	0.5
Sphaeralcea ambigua	Globe Mallow	1.0
Sporobolus cryptandrus	Sand Dropseed	0.1
Total		14.85 lbs/acre

2. The seed source will be from elevations below three thousand (3,000) feet.
3. The seed will be delivered to the project site in standard, sealed, undamaged containers.
4. Each container will be labeled in accordance with Arizona Revised Statutes and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act.
5. Labels will indicate the following:
 - (a) Variety or strain of seed.
 - (b) The percentage of germination (pure live seed only).
 - (c) Purity and weed content.
 - (d) The date of analysis (not more than nine months before the delivery date).
6. Weed content of seed will not exceed 0.5 percent.

C. Tackifier

1. Tacking agent shall be a naturally occurring organic compound and be non toxic.
2. It shall be a product typically used for binding soil and mulch in seeding or erosion control operations. Approved types shall consist of mucilage or gum by dry weight as active ingredient obtained from guar or plantago.
3. The tacking agent shall be labeled indicating the type and mucilage purity.
4. The Contractor shall have the tacking agent swell volume tested by an approved testing laboratory using the USP method.
5. The standard swell volume shall be considered at thirty (30) milliliters per gram. Material shall have a swell volume of at least twenty-four (24) milliliters per gram.
6. Certified laboratory test results shall be furnished to the Owner's Representative for each shipment of homogenous consistency to be used on project areas or as directed by the Owner's Representative.
7. Tacking agent rates shall be adjusted to compensate for swell volume variation. Material tested with lesser volume shall have the tacking agent rate increased by the same percentage of decrease in swell volume from the standard thirty (30) milliliters per gram. Material tested with greater volume may reduce tacking agent rates by the same percentage of increase in swell volume from the standard 30 milliliters per gram.
8. Tacking agent shall be pure material without other starches, bentonite, or other compounds that would alter the swell volume test results of mucilage, or the effectiveness of the tacking.

D. Wood Fiber Mulch

1. The cellulose fiber will consist of at least ninety percent (90%) specially prepared virgin wood

cellulose fiber, which has been thermo-mechanically processed, for specific use as hydromulch. It will contain no growth inhibiting factors and will have the following properties:

Virgin Wood Cellulose Fiber	90 % (minimum)
Recycled Cellulose Fiber	10% (maximum)
Ash Content	0.8% +/- 0.3% (maximum)
pH	4.5 +/- 1.0
Water Holding Capacity ratio: water:fiber	10:1

2. Cellulose fiber will be delivered in undamaged containers with product labeled and bearing the name of the manufacturer.
3. Containers must show the air-dry weight content as the maximum being 12 percent (± 3 percent at the time of manufacture) and with a pH range of 4.5 to 6.5.
4. The fiber will be dyed green to allow visual monitoring during application.
5. The dye will be non-injurious to plant growth.

E. Amendments

1. Chemical fertilizer will be furnished in standard containers with the name, weight, and guaranteed analysis of the contents clearly marked.
2. Fertilizer shall be composed of a mixture of the following:
 - (a) One part Sulfur-Coated Urea (25-4-8). Chemical fertilizer will be standard commercial fertilizer, suitable for application with approved equipment and containing the minimum analysis and in the physical form of 25-4-8.
 - (i) The sulfur-coated urea, a blended fertilizer 25-4-8, shall have 80 percent of the nitrogen defined as slow release, and contain 5 percent Iron, 10 percent sulfur and trace amounts of zinc and manganese.
 - (b) One part Monammonium Phosphate Fertilizer (11-52-0). Chemical fertilizer will be standard commercial fertilizer, suitable for application with approved equipment and containing the minimum analysis and in the physical form of 11-52-0.
 - (c) Methylene Urea. Methylene Urea will be a water insoluble form, suitable for application with approved equipment and containing the minimum analysis and in the physical form of 38-0-0.
 - (d) The resulting 24-18-2 chemical blended fertilizer, as specified herein, shall be applied at the rate of 200 pounds per acre.
 - (e) In addition to the fertilizer mixture, agricultural sulfur compounds, comprised of between 80 percent and 96 percent sulfur, shall be applied at the rate of 200 pounds per acre.
 - (f) This fertilizer is available premixed from:
 - (i) Fertizona – Casa Grande, L.L.C., 2850 South Peart Road, Casa Grande, Arizona 85293, ph: (520) 836-7477, fax: (520) 836-3447. Contact Person is Larry McGee.
3. Compost
A totally organic product that has been aerobically and naturally processed without the addition of coarse wood chips, in such a manner as to maintain a consistent temperature of 140 degrees Fahrenheit or greater for a period of time sufficient to create the following characteristics, measured by dry weight.
 - (a) Moisture content of 30%-35%
 - (b) Organic matter to nitrogen ratio: 25:1 to 30:1.
 - (c) pH: 6.0 to 8.0 pH.
 - (d) Salts: maximum of 10 mmhos/cm.
 - (e) Less than 1% soil, dirt or sand.
 - (f) Maximum particle size of 1/2 inch diameter.
 - (g) Eradication of all harmful weed seeds, pathogens and bacteria.

F. Water

1. Water will be in sufficient quantity to form a homogeneous mixture capable of being applied by commercial hydro mulching equipment.
2. The water will be potable and free of oil, acid, salts, or other substances harmful to plants.

2.02 NATIVE SEED MIX INSTALLATION EQUIPMENT

The Contractor will use equipment that will successfully apply the native seed mix slurry and tackifier in a two-step process.

2.03 SOURCE QUALITY CONTROL

A. Inspection

1. Primarily for quality; however, other requirements are not waived even though visual inspection results in acceptance.
2. Inspection will be made periodically during seeding, at completion and at end of Warranty Period by Owner's Representative.
3. Seed material is subject to inspection and acceptance. Owner's Representative reserves the right to reject at any time prior to acceptance, any work and/or seed which in Owner's Representative's opinion fails to meet specification requirements.

B. Testing Requirements

1. Seed and seed labels shall conform to current State and Federal regulations and be subject to testing provisions of the Association of Official Seed Analysis and the U.S. Department of Agriculture rules and regulations under the Federal Seed Act.
2. The Owner's Representative may require tests of seed verification at the Contractor's expense.

PART 3 - EXECUTION

3.01 EXAMINATION

Verify that existing site conditions are as specified and indicated before beginning work under this section.

A. Layout / Location

1. Verify layout of seeding areas as indicated prior to starting seeding operations.
2. Native seed mix installation will not be performed outside the construction limits of the project unless damage from construction occurs off site. Off-site treatment will be at the direction of the Owner's Representative.

B. Rough Grading

1. Inspect to verify that rough grading is within 0.2 foot of grades specified and indicated.

C. Scheduling

1. Perform native seed mix installation only after other work affecting the areas to receive seed mix is complete.
2. The Owner's Representative, in conjunction with the Contractor, will establish exact dates to begin native seed mix installation.
3. Depending on the timing of the hydroseed operations as called out on the plans, in the contract documents and herein all areas of the site must be stabilized per the Arizona Department of Environmental Quality Approved Storm Water Pollution Prevention Plan (refer to Section 010000 Special Conditions Part 16 - Environmental herein).

D. Unsatisfactory Conditions

1. Report in writing to Contractor with a copy to the Owner's Representative.
2. Native seed mix installation will not be performed when wind would prevent uniform applications of materials or would carry materials outside designated areas.
3. The Owner's Representative, in conjunction with the Contractor, may adjust the schedule of native seed mix installation, until conditions are suitable.

E. Acceptance

Beginning of installation means acceptance of existing conditions by this Contractor.

3.02 PREPARATION

- A. All preparation will be by the Contractor.
- B. Protection
 1. Be responsible for proper repair to landscape, utilities, fences, pavements and other site improvements damaged by operations under this Section.
 2. Pay for repairs made by Contractor(s) designated by Owner.
 3. Identify prepared seeding areas requiring protection and erect barriers for proper protection and traffic control.
- C. Erosion Control
 1. Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.
 2. All areas that are eroded shall be restored to the specified condition, grade and slope as directed before seeding.
- D. Seeding Areas
 1. Remove weeds, debris and rocks one half (1/2) inch in diameter or greater in the top six (6) inches of the soil which may binder seeding or subsequent operations.
 2. Dispose of accumulated debris at direction of Owner's Representative.
- E. Fine Grading

Perform as required to maintain positive drainage, prevent ponding and direct run-off into catch basins, drainage structures, etc. and as required to provide smooth well-contoured surface prior to proceeding. Tolerance: + 0.04 foot.
- F. Soil Preparation
 1. Soil preparation in all native seed areas is critical to the success and establishment of the plant material. Contractor is to ensure that all areas receive proper and adequate soil preparation per this specification and industry standards.
 2. If the area to be developed is infested with noxious or invasive weeds, a chemical application will be required, at a rate recommended on the chemical's product label.
 3. Ripping and Loosening Soil
 - (a) Prior to irrigation installation for adjacent planting area, prepare the areas to be seeded by using the appropriate equipment to rip and loosen the surface soil along the natural site contours to a minimum depth of four (4") inches.
 - (b) Break up large clods and fill voids where required to produce a friable soil.
 4. Soil Amendments
 - (a) Incorporate a custom blend 24-18-2 fertilizer at 200 pounds per acre during the soil scarification process (ripping and loosening soil).
 - (b) Incorporate compost at a rate of 12 cu. yds. per acre during the soil scarification process (ripping and loosening soil).
- G. Pre-Installation Weed Control
 1. Contractor will take all precautions necessary to keep planting areas totally free from any grass or weeds before starting the hydromulch process.
 2. No pre-emergent herbicides will be applied to areas designated to receive hydromulch.

3.03 HYDROSEEDING

- A. The hydromulch mixture will be applied in a two-step process.
 1. Step one - apply approved premixed seed mix at the rates called for in 2.01 B along with the wood cellular mulch at a rate of 200 pounds per acre and the high swell tackifier at a rate of 40 pounds per acre shall be applied in a slurry mix.
 2. Seed shall not be in the slurry for more than thirty (30) minutes.

3. Step two (erosion control) apply Wood Fiber Mulch at the following rates based on the slope at which the mulch is being applied. See chart below:

WOOD FIBER MULCH		
Slope (H:V)	Tacking agent (Pounds pure mucilage per acre)	Wood Fiber Mulch (Pounds per acre)
Flat to 4:1	50	1,000
From greater than 4:1 to 3:1	100	2,000
From greater than 3:1 to 2:1	150	2,500
Greater than 2:1	200	3,000
Erosive Soil Slopes*	300	3,500

*As determined by Engineer

B. Slurry Mix Requirements

1. Each mix will be thoroughly mixed a minimum of five minutes to make a homogenous slurry before starting the application.

C. Time Limits

1. The slurry will be applied within thirty (30) minutes after mixing with water.

3.04 RESEEDING

Areas shall be reseeded if they exhibit areas greater than the acceptable amounts noted in Part 1 of this Section. Reseeding shall occur continually during the Establishment Period.

3.05 EROSION CONTROL

- A. Apply erosion control netting to any area which is vulnerable to soil erosion such as swales or steep slopes. (2:1 or steeper slopes)
- B. If Contractor fails to net such areas and soil erosion subsequently occurs, Contractor shall re-establish finish grade, soil preparation, seed bed, and apply jute netting at his own expense.
- C. Erosion Control Netting
 1. Roll out in direction of flow after seeding and mulching.
 2. Apply material loosely and smoothly on soil surface without stretching.
 3. Avoid walking directly on seed-bed either before or after jute is applied.
 4. In cases where one roll of netting ends and second roll is needed, overlap up-channel piece over second roll by at least eighteen (18) inches. Where two or more widths of netting are applied side by side, make overlap of at least four (4) inches.
 5. Outside Edges of Netting
 - (a) Spread loose topsoil over edges to allow for smooth entry of water.
 6. Stapling
 - (a) Staple overlaps which run parallel to direction of flow in channel bottoms on two (2) foot intervals.
Staple outside edges, centers and overlaps on banks on two (2) foot intervals.
 7. Each Width of Cloth
 - (a) Install row of staples down center as well as along each side.
 - (b) Staple check slots and junctions of new rolls across channel on six (6) inch intervals.
 - (c) On soft or sandy soil or in windy areas, apply staples in alternate slanting position and space at fourteen (14) inches to eighteen (18) inches.
 - (d) For extra hard soil or shale areas, use sharp hardened steel three (3) inch fence type staples. Do not use three (3) staples on normal turf.

3.06 NOTIFICATION AND INSPECTION

- A. Inspection
 - 1. When germination is complete, and plants are visible, the Contractor shall notify the Owner's Representative. Owner's Representative shall be notified at least forty eight (48) hours prior to inspection. The inspection will be used to determine if the area is substantially complete and if the Warranty Period should commence.
 - 2. All washouts, thin, weak, or dead areas should be repaired prior to the inspection.
- B. Seeding Acceptance
 - 1. After application the Owner's Representative has inspect the seeded areas or sub-areas for conformance to the contract requirements. The Contractor shall correct, to the satisfaction of the Owner's Representative, any areas not conforming to the specifications. The 42-day maintenance period will begin upon acceptance of the area by the Owner's Representative.
 - 2. The Contractor shall maintain and stabilize each area or sub-area, including shoulder build-up areas, for a minimum period of forty-two (42) calendar days (6 weeks) after application of the seeding and mulching materials, and acceptance by the Owner's Representative unless otherwise required by the Arizona Department of Environmental Quality's Storm Water Pollution Prevention Plan.
- C. Deficiencies
 - 1. Any areas damaged from erosion, or that has less than ninety percent (90%) of applied mulch remaining, shall be re-seeded, re-mulched, and re-tacked at no additional cost to the Owner.
 - 2. Owner's Representative will specify deficiencies to Contractor who shall make satisfactory adjustments and shall again notify Owner's Representative for final inspection.

3.07 CLEANING

- A. Remove debris and excess materials from site. Clean paved and finished areas soiled as a result from work under this Section, in accordance with direction given by Owner's Representative. Clean out drainage inlet structures.
- B. Remove mulch, from seeding operations, immediately from trees, shrubs, and sod to prevent damage to same.

3.08 PROTECTION

- A. Protection of Native Seed Mix Areas
 - 1. The Contractor will provide protective devices / barriers as required and as directed by Owner's Representative or as required by the Arizona Department of Environmental Quality's Storm Water Pollution Prevention Plan.
 - 2. The Contractor shall protect seeded areas from damage from pedestrian and vehicular traffic for forty-two (42) calendar days (6 weeks). Contractor is responsible for malicious destruction of seeding caused by others.
 - 3. Repair and re-seed areas damaged by erosion or poor growth.
- B. Protection of Surfaces
 - 1. Any materials spilled or sprayed onto areas not indicated for hydroseed will be cleaned up at the Contractor's expense to the satisfaction of the Owner's Representative.
- C. Protection of Existing Features
 - 1. Protect existing utilities, paving, irrigation systems, and other facilities from damage caused by hydro mulch operations.

END OF SECTION

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Formwork for cast-in place concrete.
 - 2. Shoring, bracing, and anchorage.
 - 3. Form liners.
 - 4. Form accessories.
 - 5. Form stripping.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications for Structural Concrete.
 - 3. ACI 302 – Guide to Concrete Floor and Slab Construction
 - 4. ACI 318 - Building Code Requirements for Structural Concrete.
 - 5. ACI 347 - Guide to Formwork for Concrete.
- B. American Forest and Paper Association:
 - 1. AF&PA - National Design Specifications for Wood Construction.
- C. The Engineered Wood Association:
 - 1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.
- D. American Society of Mechanical Engineers:
 - 1. ASME A17.1 - Safety Code for Elevators and Escalators.
- E. ASTM International:
 - 1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
 - 2. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
- F. West Coast Lumber Inspection Bureau:
 - 1. WCLIB - Standard Grading Rules for West Coast Lumber.

1.3 DESIGN REQUIREMENTS

- A. Design, engineer, and construct formwork, shoring and bracing in accordance with ACI 301 and ACI 318 and as recommended in ACI 347 to conform to design and applicable code requirements to achieve concrete shape, line and dimension as indicated on Drawings including any special requirements due to the use of plasticizer and/or retarder set concrete.
- B. Design and engineering of formwork, shoring and re-shoring as well as its construction is responsibility of Contractor.

- C. Design requirements:
 - 1. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local Building Code.
 - 2. When using high range water reducer (superplasticizer) in concrete, forms shall be designed for full hydrostatic pressure per ACI 347.
 - 3. Design formwork shall be watertight and shall limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/360th of span between structural members.
- D. For slabs and beams not cast on ground, develop a procedure and schedule for removal of shores and for calculating loads transferred to structure during this process.
 - 1. Perform structural calculations as required to prove that all portions of structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus loads placed thereon.
 - 2. When developing procedures, schedules, and structural calculations, consider the following at each stage of construction:
 - a. Safety of people involved with use of forms (forming, placing concrete, stripping forms).
 - b. Effects of all loads during construction.
 - c. Strength of concrete.
 - d. Influence of deformations of structure and shoring system on distribution of dead loads and construction loads.
 - e. Strength and spacing of shores or shoring systems used, as well as method of shoring, bracing, shore removal, and re-shoring including minimum time intervals between various operations.
 - f. Any other loading or condition that affects safety or serviceability of structure during construction.

1.4 QUALIFICATIONS

- A. Design formwork under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Texas.

1.5 PERFORMANCE REQUIREMENTS

- A. Plastic Vapor Retarder
 - 1. Performance-Based Specification: Vapor retarder membrane shall be manufactured from virgin polyolefin resins and shall meet or exceed all requirements of ASTM E1745, Class A.
 - 2. Maximum Water Vapor Permeance (ASTM E154 Sections 7, 8, 11, 12, 13, by ASTM E96, Method B or ASTM F1249)
 - a. As received: 0.0183 perms.
 - b. After Wetting and Drying: 0.0219 perms.
 - c. Resistance to Plastic Flow and Temperature: 0.0197 perms.
 - d. Effect Low Temperature and Flexibility: 0.0212 perms
 - e. Resistance to Deterioration from Organisms and Substances in Contacting Soil: 0.0198 perms.
 - f. Puncture Resistance (ASTM D1709): 4,394 grams.
 - g. Tensile Strength ASTM E154, Section 9: 52 Lb. Force/Inch

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures
- B. Shop Drawings: All forms and shoring shall be designed by a professional engineer in the State of Texas.
 - 1. Submit formwork, shoring, and re-shoring shop drawings.
 - 2. Indicate the following:
 - a. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding and bracing, and temporary supports.
 - b. Layout of panels joints and tie hole pattern
 - c. Means of sealing form tie holes.
 - d. Sequence and timing of erection and stripping assumed compressive strength at time of stripping, height of lift and height of drop during placement.
 - e. Vertical, horizontal and special loads in accordance with ACI 347, Section 2.2 and camber diagrams, when applicable.
 - f. Notes to formwork erector showing size and location of conduits and piping embedded in concrete in accordance with ACI 318, Section 6.3.
 - g. Procedure and schedule for removal of shores and installation and removal of re-shores.
- C. Product Data: Submit data on void form materials and installation requirements.
- D. Design Data:
 - 1. Indicate design data for formwork and shoring.
 - 2. Indicate loads transferred to structure during process of concreting, shoring and re-shoring.
 - 3. Include structural calculations to support design.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 347.
- B. For wood products furnished for work of this Section, comply with AF&PA.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements
- B. Deliver void forms and installation instructions in manufacturer's packaging.
- C. Store off ground in ventilated and protected manner to prevent deterioration from moisture.

1.9 DEFINITIONS

- A. Words and terms used in these Specifications are defined in ACI 116R.

PART 2 PRODUCTS

2.1 GENERAL

- A. Forms used for cast-in-place concrete shall be made of wood, metal, or other approved material and shall be like new to new condition.

2.2 WOOD FORM MATERIALS

- A. Plywood: Douglas Fir, solid one side grade, sound undamaged sheets with clean, true edges free from knotholes or loose knots and sufficiently tight to prevent leakage.
- B. Lumber Forms:
 1. Application: Use for edge forms and unexposed finish concrete.
 2. Boards: 6 inches or 8 inches in width, ship-lapped or tongue and groove, "Standard" Grade Douglas Fir, conforming to WCLIB Standard Grading Rules for West Coast Lumber. Surface boards on four sides.
 3. Lumber sufficiently tight to prevent leakage.
- C. Plywood Forms for Exposed Finish Concrete:
 1. Forms: Conform to PS 1; full size 4 x 8 feet panels; each panel labeled with grade trademark of APA/EWA.
 2. Plywood for Surfaces to Receive Membrane Waterproofing: Minimum of 3/4 inch thick; APA/EWA "B-B Plyform Structural I Exterior" grade.
 3. Plywood "Smooth Finish" is required on both the interior and exterior exposed faces: APA/EWA "HD Overlay Plyform Structural I Exterior" grade, minimum of 3/4 inch thick.
- D. Void Forms:
 1. Shall be continuous.
 2. Specially designed and manufactured for purpose of creating a void area directly under concrete members which will allow a space for soil vertical upward movement.
 3. Able to support weight of concrete and construction loads to be placed thereon with no decrease in required void form depth.
 4. Constructed from double faced corrugated cardboard or fiberboard which is wax impregnated and laminated with moisture-resistant adhesive.
 5. Capable of resisting moisture with no loss of load carrying strength or change in depth or configuration.

2.3 PREFABRICATED FORMS

- A. Manufacturers:
 1. Meva
 2. Peri
 3. EFCO
 4. ULMA
 5. Substitutions: Not Permitted.
- B. Void Form Manufacturers:
 1. SureVoid Products, Inc.

2. Deslauriers, Inc.

- C. Preformed Forms: Plastic facing, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- D. Circular Structures: For circular structures straight panels may be substituted for circular panels if each panel is not more than 2 feet in width nor deflect more than 3.5 degrees per joint.
- E. Tubular Column Type: Fabricated steel or fiber reinforced plastic in bolted sections.
- F. Steel Forms: Sheet steel, suitably reinforced, and designed for particular use indicated on Drawings.
- G. Form Liners: Smooth, durable, grainless and non-staining.
- H. Aluminum forms shall not be used.

2.4 ACCESSORIES

- A. Form Ties: removable type, steel, conical or spherical type, with waterproofing washer, free of defects capable of leaving holes larger than 1-1/4 inch in concrete surface.
 - 1. Wire ties are not allowed.
 - 2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of concrete.
 - 3. 1 inch maximum diameter cones on both ends.
 - 4. Embedded portion of ties to be not less than 1-1/2 inch from face of concrete after ends have been removed.
- B. Water Stop Ties:
 - 1. Provide ties with built-in waterstops in all walls that are intended to retain fluids.
 - 2. Through-wall ties that are designed to be entirely removed are not allowed in all walls that are intended to retain fluids.
- C. Spreader Inserts: Conical or spherical type, designed to maintain positive contact with forming material leaving no metal closer than 1-1/2 inch to surface when removed. Wire ties, wood spreaders or through bolts are not permitted.
- D. Form Anchors and Hangers:
 - 1. Do not use anchors and hangers for exposed concrete leaving exposed metal at concrete surface.
 - 2. Symmetrically arrange hangers supporting forms from structural steel members to minimize twisting or rotation of member.
 - 3. Penetration of structural steel members is not permitted.
- E. Form Release Agent: Ready to use water based material formulated to reduce or eliminate surface imperfections, containing no mineral oil or organic solvents. Form release agents used in potable water containment structures shall be suitable for contact with potable water.
 - 1. Manufacturers:
 - a. BASF, Rheofinish 211

- b. Cresset Chemical, Crete-Lease 20-VOC
 - c. Unitex Chemical, Farm Fresh
 - d. Atlas Construction Supply, Bio-Guard
 - e. Substitutions: Not Permitted.
- F. Corners: Chamfer, rigid plastic type; 0.75" x 0.75" size; maximum possible lengths.
 - 1. Manufacturers:
 - a. Greenstreak Plastic Products; Style Number 622
 - b. Substitutions: Section 01 60 00 - Product Requirements
- G. Pre-molded Joint Filler:
 - 1. Bituminous Type: ASTM A994 or ASTM D1751.
 - 2. Sponge Rubber:
 - a. Neoprene, closed cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25% deflection limit. Use in both potable and non-potable water containing structures.
 - b. Manufacturer: Rubatex Corp; R-451-N
- H. Pre-molded Control Joint: One piece flexible, polyvinyl chloride joint former.
 - 1. Manufacturers:
 - a. Vinylex Corp, Kold-Seal Zip-Per Strip KSF-150-50-50
- I. Vapor Retarder: Where indicated on Drawings, 10 mil thick polyethylene sheet, as specified in Part 1 above.
- J. Pourable Joint Filler:
 - 1. Type 1 for Potable Water Containment Structures
 - a. NSF 61 approved
 - b. Multi-component sealant, self-leveling or nonsag as required for level, sloping, or vertical joints.
 - c. Color: White
 - d. Manufacturers
 - 1) Sika Chemical; Sikaflex-2C or Sikaflex-1A
 - 2) Product Research Chemical; Permapol RC-270SL Reservoir Sealant or RC-270 Gun Grade Reservoir Sealant with PRC Primer No. 57
 - 2. Type 2 for Other Water Containment Structures
- K. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength and character to maintain formwork in place while placing concrete.
- L. PVC Water Stops: Use PVC water stops throughout, unless approved by Engineer. Polyvinyl chloride, minimum 1,750 psi tensile strength, minimum 50 degrees F plus 175 degrees F working temperature range, 3/8 inch wide, maximum possible lengths, center bulb type, ribbed profile, preformed corner sections, heat welded jointing.
 - 1. Manufacturers:
 - a. Vinylex Corp, RB6-38H or RB9-38H
 - b. Greenstreak Plastic Products, 03150/GRD Style 732 or Style 735
 - c. Four Seasons Industries Durajoint, CSP-162 Type 9 or Type 10.
 - d. Substitutions: Not Permitted.

M. Hydrophilic Water Stop: Use hydrophilic water stops only for construction joints where new concrete is placed against existing concrete and only where space requirements do not allow for the use of PVC water stops. Material shall be non-bentonite rubber compound.

1. Manufacturers:
 - a. Greenstreak Plastic Products, Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
 - b. Adeka Ultra Seal, MC-2010M with 3M-2141 adhesive and P-201 sealant.
 - c. Substitutions: Not Permitted.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements
- B. Verify lines, levels, and centers before proceeding with formwork. Verify dimensions agree with Drawings.
- C. When formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement before proceeding, request instructions from Engineer.

3.2 INSTALLATION

- A. Earth Forms:
 1. Trench earth forms are allowed only for below ground grade beams for concrete foundations.
 2. Trench earth forms neatly, accurately, and at least 2 inches wider than footing widths indicated on Drawings.
 3. Trim sides and bottom of earth forms.
 4. Construct wood edge strips at top of each side of trench to secure reinforcing and prevent trench from sloughing.
 5. Form sides of footings where earth sloughs.
 6. Tamp earth forms firm and clean forms of debris and loose material before depositing concrete.
- B. Formwork - General:
 1. Follow applicable recommendations of ACI 347.
 2. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.
 3. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.
 4. Camber forms where necessary to produce level finished soffits unless otherwise shown on Drawings.
 5. Carefully verify horizontal and vertical positions of forms. Correct misaligned or misplaced forms before placing concrete.
 6. Complete wedging and bracing before placing concrete.
 7. Make forms sufficiently tight to prevent loss of mortar from concrete.

- C. Forms for Smooth Finish Concrete:
 - 1. Use steel, plywood or lined board forms.
 - 2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.
 - 3. Install form lining with close-fitting square joints between separate sheets without springing into place.
 - 4. Use full size sheets of form lines and plywood wherever possible.
 - 5. Tape joints to prevent protrusions in concrete.
 - 6. Use care in forming and stripping wood forms to protect corners and edges.
 - 7. Level and continue horizontal joints.
 - 8. Keep wood forms wet until stripped.
- D. Forms for Surfaces to Receive Membrane Waterproofing: Use plywood or steel forms. After erection of forms, tape form joints to prevent protrusions in concrete.
- E. Framing, Studding and Bracing:
 - 1. Space studs at 16 inches on center maximum for boards and 12 inches on center maximum for plywood.
 - 2. Size framing, bracing, centering, and supporting members with sufficient strength to maintain shape and position under imposed loads from construction operations.
 - 3. Construct beam soffits of material minimum of 2 inches thick.
 - 4. Distribute bracing loads over base area on which bracing is erected.
 - 5. When placed on ground, protect against undermining, settlement or accidental impact.
- F. Erect formwork, shoring, and bracing to achieve design requirements, in accordance with requirements of ACI 318 and in accordance with manufacturer's instructions (if applicable).
- G. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- H. Obtain Engineer's approval before framing openings in structural members not indicated on Drawings.
- I. Install $\frac{3}{4}$ inch fillet and chamfer strips on external corners of all exposed surfaces of beams, walls, foundations, pump and housekeeping pads, and columns to produce $\frac{3}{4}$ inch wide beveled edges.
- J. Install void forms in accordance with manufacturer's recommendations.
- K. Do not reuse wood forms for concrete surfaces to be exposed to view unless in a like "new" condition and approved by the Engineer. Do not patch formwork.
- L. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
 - 1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 feet apart

- M. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.
- N. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 feet wide.
 - 1. Brace and tie formwork to maintain correct position and shape of members.
- O. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.
- P. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.
- Q. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
 - 1. Securely brace forms against lateral deflection.
 - 2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.
- R. After void forms are in place and before concrete is placed thereon, cover joints between abutting form sections and cover ends of forms to prevent intrusion of soil, concrete or any other materials.
 - 1. Install void forms in accordance with manufacturer's instructions.

3.3 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
 - 1. Before placing either reinforcing steel or concrete, cover surfaces of forms with an approved coating material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
 - a. A field applied form release agent or sealer of approved type of a factory applied non-absorptive liner may be used.
 - b. Form oil shall not be toxic 30 days after application.
 - 2. Do not allow excess form coating material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.
- C. Do not apply form release agent where concrete surfaces are indicated to receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.
- D. Reuse and Coating of Forms: Thoroughly clean forms and reapply form coating before each reuse. For exposed work, do not reuse forms with damaged faces or edges. Apply form coating to forms in accordance with manufacturer's specifications. Do not coat forms for concrete indicated to receive "scored finish". Apply form coatings before placing reinforcing steel.

3.4 INSTALLATION - INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Install formed openings for items to be embedded in or passing through concrete work.
- B. Locate and set in place items required to be cast directly into concrete.
- C. Coordinate with Work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.
- D. Install accessories straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Install water stops continuous without displacing reinforcement. Heat seal joints watertight.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.
- H. Form Ties:
 1. Use sufficient strength and sufficient quantity to prevent spreading of forms.
 2. Place ties at least 1 inch away from finished surface of concrete.
 3. Leave inner rods in concrete when forms are stripped.
 4. Space form ties equidistant, symmetrical and aligned vertically and horizontally unless otherwise shown on Drawings.
- I. Arrangement: Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.
- J. Construction Joints:
 1. Install surfaced pouring strip where construction joints intersect exposed surfaces to provide straight line at joints.
 2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.
 3. Show no overlapping of construction joints. Construct joints to present same appearance as butted plywood joints.
 4. Arrange joints in continuous line straight, true and sharp.
 5. Where possible, locate juncture of built-in-place wood or metal form at architectural lines, control joints, or construction joints.

- K. Embedded Items:
 - 1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, water stops, and other features.
 - 2. Do not embed wood or uncoated aluminum in concrete.
 - 3. Obtain installation and setting information for embedded items furnished under other Specification sections.
 - 4. Securely anchor embedded items in correct location and alignment prior to placing concrete.
 - 5. Verify conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 for size and location limitations.
- L. Openings for Items Passing Through Concrete:
 - 1. Frame openings in concrete where indicated on Drawings. Establish exact locations, sizes, and other conditions required for openings and attachment of work specified under other sections.
 - 2. Coordinate work to avoid cutting and patching of concrete after placement.
 - 3. Perform cutting and repairing of concrete required as result of failure to provide required openings.
- M. Screeds:
 - 1. Set screeds and establish levels for tops of concrete slabs and levels for finish on slabs.
 - 2. Slope slabs to drain where required or as shown on Drawings.
 - 3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms. Remove freestanding water.
- N. Scree Support:
 - 1. For concrete over waterproof membranes and vapor retarder membranes, use cradle, pad or base type screed supports which will not puncture membrane.
 - 2. Staking through membrane is not permitted.
- O. Cleanouts and Access Panels:
 - 1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris and waste material.
 - 2. Clean forms and surfaces against which concrete is to be placed. Remove chips, saw dust and other debris. Thoroughly blow out forms with compressed air just before concrete is placed.

3.5 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
- C. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.

3.6 ERECTION TOLERANCES

A. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances specified in ACI 117 and ACI 347.

1. Variation from plumb:
 - a. In lines and surfaces of columns, piers, walls, and in risers:
 - 1) Maximum in any 10 feet of height: $\frac{1}{4}$ inch.
 - 2) Maximum for entire heights: $\frac{1}{2}$ inch.
 - b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
 - 1) Maximum in any 20 feet length: $\frac{1}{4}$ inch.
 - 2) Maximum for entire length: $\frac{1}{2}$ inch.
2. Variation from level or from grades specified:
 - a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
 - 1) Maximum in any 10 feet of length: $\frac{1}{4}$ inch.
 - 2) Maximum in any bay or in any 20 feet length: $\frac{3}{8}$ inch.
 - 3) Maximum for entire length: $\frac{3}{4}$ inch.
 - b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
 - 1) Maximum in any bay or in 20 feet length: $\frac{1}{4}$ inch.
 - 2) Maximum for entire length: $\frac{1}{2}$ inch.
3. Variations of linear structure lines from established position in plan and related position of columns, walls, and partitions:
 - a. Maximum in any bay: $\frac{1}{2}$ inch.
 - b. Maximum in any 20 feet of length: $\frac{1}{2}$ inch.
 - c. Maximum for entire length: 1 inch.
4. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of $+1/2$ inch.
5. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of $+1/2$ inch.
6. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of $-1/4$ inch to $+1/2$ inch.
7. Footings and foundations:
 - a. Variations in concrete dimensions in plan: $-1/2$ inch to $+2$ inch.
 - b. Misplacement or eccentricity:
 - 1) 2% of footing width in direction of misplacement but not more than 2 inches.
 - c. Thickness:
 - 1) Decrease in specified thickness: 5% .
 - 2) Increase in specified thickness: No limit except that which may interfere with other construction.
8. Variation in steps:
 - a. In a flight of stairs:
 - 1) Rise: $+1/8$ inch.
 - 2) Tread: $+1/4$ inch.
 - b. In consecutive steps:
 - 1) Rise: $+1/16$ inch.
 - 2) Tread: $+1/8$ inch.

9. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and bench marks to be used for reference purposes to check tolerances.
10. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
11. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.
12. Camber slabs and beams $\frac{1}{4}$ inch per 10 feet in accordance with ACI 318.

3.7 FORM REMOVAL

- A. Leave forms in place for minimum number of days as specified in ACI 347.
- B. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads and removal has been approved by Engineer.
- C. No construction loads shall be supported on, nor any shoring removed from, any part of structure under construction except when that portion of structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
 1. Non-supporting forms (sides of beams, walls, columns, and similar parts of Work) may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:
 - a. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
 - b. Curing and protection operations are maintained.
- D. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.
- E. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.
 1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Section 03 30 00 – Cast-in-Place Concrete.
- F. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- G. Formwork for columns, walls, sides of beams, and other parts not supporting weight of concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal.
- H. Where no re-shoring is planned, leave forms and shoring used to support weight of concrete in place until concrete has attained its specified 28 day compressive strength and not less than required below.
 1. Where re-shoring procedure is planned, supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

2. Leave forms in place until 28 day compressive strength is attained but not less than:

Span, L	Days
$L \leq 10'$	7
$10' < L < 20'$	14
$20' \leq L$	21

3. Contractor may submit a proposed form removal plan and schedule for approval by Engineer.

- I. When shores and other vertical supports are so arranged that non-load-carrying form facing material may be removed without loosening or disturbing shores and supports, facing material may be removed when concrete has sufficiently hardened to resist damage from removal.
- J. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged. Discard damaged forms.

3.8 RESHORING

- A. No construction loads shall be supported on, nor any shoring removed from, any part of structure under construction except when that portion of structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.
- B. While re-shoring is underway, no superimposed dead or live loads shall be permitted on new construction.
- C. During re-shoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.
- D. Place re-shores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.
- E. Tighten re-shores to carry their required loads without overstressing.
- F. Shoring, re-shoring and supporting formwork may be removed when concrete has reached concrete strength required by formwork designer's structural calculations.
- G. For floors supporting shores under newly placed concrete leave original supporting shores in place or re-shore.
 - 1. Re-shoring system shall have a capacity sufficient to resist anticipated loads.
 - 2. Locate re-shores directly under a shore position above.
- H. In multi-story structures, extend re-shoring over a sufficient number of stories to distribute weights of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.9 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements

- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties, and items are secure.
- C. Notify Engineer for observation after placement of reinforcing steel in forms, but prior to placing concrete.
- D. Schedule concrete placement to permit formwork inspection before placing concrete.

3.10 REUSE OF FORMS

- A. Forms may be reused only if in excellent condition and only if acceptable to Engineer. Light standing between uses will be required wherever necessary to obtain uniform surface texture on all exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. Regarding forms used on inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to Engineer.

END OF SECTION

SECTION 03 20 00 - CONCRETE REINFORCING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Reinforcing bars.
 - 2. Welded wire fabric.
 - 3. Reinforcement accessories.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete
 - 2. ACI 315 - Details and Detailing of Concrete Reinforcement
 - 3. ACI 318 - Building Code Requirements for Structural Concrete.
 - 4. ACI 530.1 - Specifications for Masonry Structures.
 - 5. ACI SP-66 - Detailing Manual.
- B. ASTM International:
 - 1. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - 2. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - 3. A185/A185M-07 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 4. ASTM A496/A496M - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
 - 5. ASTM A497/A497M - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 - 6. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 7. ASTM A704/A704M - Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement.
 - 8. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
- C. American Welding Society:
 - 1. AWS D1.4 - Structural Welding Code - Reinforcing Steel.
- D. Concrete Reinforcing Steel Institute:
 - 1. CRSI - Manual of Standard Practice.
 - 2. CRSI - Placing Reinforcing Bars.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures

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- B. Shop Drawings:
 - 1. Prepare in accordance with ACI SP-66 Detailing Manual.
 - 2. Indicate bar sizes, spacing, locations, and quantities of reinforcing steel and welded wire fabric, bending and cutting schedules, and supporting and spacing devices.
- C. Certificates: Submit AWS qualification certificate for welders employed on the Work per AWS S1.4/D1.4M.
- D. Test Results:
 - 1. Submit certified copies of mill test report of reinforcement materials analysis.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with CRSI - Manual of Standard Practice and ACI 301.
- B. Prepare shop drawings in accordance with ACI SP-66.
- C. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

- A. Welders: AWS, D1.4/D1.4M certified within previous 12 months.

1.6 COORDINATION

- A. Section 01 30 00 - Administrative Requirements
- B. Coordinate with placement of formwork, formed openings and other Work.

PART 2 PRODUCTS

2.1 REINFORCEMENT

- A. Materials shall be new, of domestic manufacture, and shall comply with the following material specifications.
- B. Reinforcing Steel: All reinforcing bars to be deformed billet-steel, uncoated as follows:
 - 1. Where welding is not required, ASTM A615/A615M, Grade 60, deformed billet bars, uncoated finish.
 - 2. Where reinforcing to be welded, ASTM A706/A706M, Grade 60.
- C. Welded Plain Wire Fabric: ASTM A185/A185M; 75 ksi minimum tensile strength; in flat sheets, not rolls or coils; unfinished.
- D. Dowel Bars: Dowel bars shall be plain steel bars conforming to ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement, or ASTM A966 and shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site each dowel bar shall be painted with one coat of paint conforming to MIL-DTL-24441/20A.SSPC Paint 5 or SSPC Paint 25. Metal or

plastic collars (when indicated on Drawings) shall be full circular device supporting the dowel until the epoxy hardens.

The sleeves for dowel bars used in expansion joints shall be translucent of an approved design to cover 2 inches (minimum) of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1½ inches from the closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

E. Mechanical Splices and Connections:

1. Metal Sleeve Splice: Furnish with cast iron filler metal capable of developing 125% of tensile bar strength. Manufacturer shall be Erico Products, Cadweld T-Series.
2. Mechanical Threaded Connections: Furnish with metal coupling sleeve with internal threads engaging threaded ends of bars developing 125% of yield strength of bar. Manufacturer shall be Erico Products, Lenton Reinforcing Steel Couplers or Richmond Screw Anchor, Richmond DB-SAE Dowel Bar Splicers.

2.2 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16-gauge black annealed type wire.
- B. Chairs and Supports, Spacers: Chairs and Supports shall be steel, precast mortar or concrete blocks cast in molds meeting the approval of the Engineer or designated representative of sufficient strength to position the reinforcement as indicated on the drawings when supporting the dead load of the reinforcement, the weight of the workers placing concrete and the weight of the concrete bearing on the steel. Chairs shall be plastic coated when indicated on the drawings.

Chair Types and Applicable Uses	
Structural Elements (columns, beams, walls, slabs) exposed to weather, not subjected to sand blasting, water blasting or grinding.	Galvanized steel or steel chairs with plastic coated feet (CRSI Bar Support Specifications).
Structural Elements exposed to weather and subject to sand blasting, water blasting or grinding.	Stainless steel chairs (CRSI Bar Support Specifications).
Structural Elements not exposed to weather or corrosive conditions.	Uncoated steel chairs
Slabs and grade beams cast on grade.	Steel chairs with a base with 9 inch ² minimum area or sufficient area to prevent the chair from sinking into fill or subgrade.

- C. Epoxy Coating Patching Material: Type as recommended by coating manufacturer.

2.3 CONCRETE DOWELING

- A. Meet requirements of ASTM C881/C881M.

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- B. Use two component, insensitive to moisture, designed to be installed in adverse freeze/thaw environments.
- C. Manufacturers:
 - 1. Hilti, HIT Doweling Anchor System, HIT RE 500 SD.
 - 2. ITW Ramset/Red Head, Epcon Ceramic 6 Epoxy or A7 Adhesive Anchor System
 - 3. Simpson Strong-Tie, Epoxy Adhesive ET22.
 - 4. Covert Operations, CIA-Gel 7000 Epoxy Anchors
 - 5. Unitex, Pro-Poxy 300 Fast Epoxy Adhesive Anchors.

2.4 FABRICATION

- A. Fabricate concrete reinforcement in accordance with CRSI Manual of Practice.
- B. Form standard hooks for 180 degree bends, 90 degree bend, stirrup and tie hooks, and seismic hooks as indicated on Drawings.
- C. Form reinforcement bends with minimum diameters in accordance with ACI 318.
- D. Fabricate column reinforcement with offset bends at reinforcement splices.
- E. Form spiral column reinforcement from minimum 3/8 inch diameter continuous deformed bar or wire.
- F. Form ties and stirrups from the following:
 - 1. For bars No. 10 and Smaller: No. 3 deformed bars.
 - 2. For bars No. 11 and Larger: No. 4 deformed bars.
- G. Weld reinforcement in accordance with AWS D1.4.
- H. Locate reinforcement splices not indicated on Drawings, at point of minimum stress. Review location of splices with Engineer.

PART 3 EXECUTION

3.1 STORING

- A. Steel reinforcement shall be stored above the surface of the ground upon platforms, skids or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, reinforcement shall be free from dirt, paint, grease, oil or other foreign materials. Reinforcement shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross sectional area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel indicated on the drawings.

3.2 SPLICES

- A. Splicing of bars, except when indicated on the drawings or specified herein, will not be permitted without written approval of the Engineer or designated representative. No substitution of bars will be allowed without the approval of the Engineer or designated representative. Any splicing of substituted bars shall conform to the requirements in the Table below.
- B. Splices not indicated on the drawings will be permitted in slabs (not more than 15 inches) in thickness, columns, walls and parapets.
- C. Splices will not be permitted in bars 30 feet or less in plan length unless otherwise approved. For bars exceeding 30 feet in plan length, the distance center to center of splices shall not be less than 30 feet minus 1 splice length, with no more than 1 individual bar length less than 10 feet. Splices not indicated on the drawings, but permitted hereby, shall conform to the Table below. The specified concrete cover shall be maintained at such splices and the bars placed in contact and securely tied together.

Minimum Lap Requirements	
Bar Number (in 1/8 inches)	Grade 60
3	1 foot 4 inches
4	1 foot 9 inches
5	2 feet 2 inches
6	2 feet 7 inches
7	3 feet 5 inches
8	4 feet 6 inches
9	5 feet 8 inches
10	7 feet 3 inches
11	8 feet 11 inches

- D. Spiral steel shall be lapped a minimum of 1 turn. Bar No. 14 and No. 18 may not be lapped.
- E. Welded wire fabric shall be spliced using a lap length that includes an overlap of at least 2 cross wires plus 2 inches on each sheet or roll.
- F. Splices using bars that develop equivalent strength and are lapped in accordance with the table above are permitted.
- G. Welding of reinforcing bars may be used only where indicated on the drawings or as permitted herein. All welding operations, processes, equipment, materials, quality of work and inspection shall conform to the requirements indicated on the drawings. All splices shall be of such dimension and character as to develop the full strength of the bar being spliced.

- H. End preparation for butt-welding reinforcing bars shall be done in the field, except Bar No. 6 and larger shall be done in the shop. Delivered bars shall be of sufficient length to permit this practice.
- I. For box culvert extensions with less than 1 foot of fill, the existing longitudinal bars shall have a lap with the new bars as shown in the table above. For box culvert extensions with more than 1 foot of fill, a minimum lap of 12 inches will be required.
- J. Unless otherwise indicated on the drawings, dowel bars transferring tensile stresses shall have a minimum embedment equal to the minimum lap requirements shown in the table above. Shear transfer dowels shall have a minimum embedment of 12 inches.

3.3 PLACEMENT

- A. Reinforcement shall be placed as near as possible in the position indicated on the drawings. Unless otherwise indicated on the drawings, dimensions shown for reinforcement are to the centers of the bars. In the plane of the steel parallel to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/12 of the spacing between bars. In the plane of the steel perpendicular to the nearest surface of concrete, bars shall not vary from plan placement by more than 1/4 inch. Cover of concrete to the nearest surface of steel shall be as follows:
- B. Maintain concrete cover around reinforcement in accordance with ACI 318 as follows:

Reinforcement Location		Minimum Concrete Cover
Footings and Concrete Formed Against Earth		3 inches
Concrete exposed to earth or weather	No. 6 bars and larger	2 inches
	No. 5 bars and smaller	1-1/2 inches
Supported Slabs, Walls, and Joists	No. 14 bars and larger	1-1/2 inches
	No. 11 bars and smaller	3/4 inches
Beams and Columns		1-1/2 inches
Shell and Folded Plate Members	No. 6 bars and larger	3/4 inches
	No. 5 bars and smaller	1/2 inches

- C. Space reinforcement bars with minimum clear spacing in accordance with ACI 318 of one bar diameter, but not less than 1 inch.
 - 1. Where bars are indicated in multiple layers, place upper bars directly above lower bars.
- D. Vertical stirrups shall always pass around the main tension members and be attached securely thereto. The reinforcing steel shall be spaced its required distance from the form surface by means of approved galvanized metal spacers, metal spacers with plastic coated tips, stainless steel spacers, or plastic spacers. For approval of plastic spacers, representative samples of the plastic shall show no visible indications of deterioration after immersion in a 5 percent solution of sodium hydroxide for 120 hours.

- E. All reinforcing steel shall be tied at all intersections, except that where spacing is less than 1 foot in each direction, alternate intersections only need be tied. For reinforcing steel cages for other structural members, the steel shall be tied at enough intersections to provide a rigid cage of steel. Mats of wire fabric shall overlap each other 1 full space as a minimum to maintain a uniform strength and shall be tied at the ends and edges.
- F. Where prefabricated deformed wire mats are specified or if the Contractor requests, welded wire fabric may be substituted for comparable area of steel reinforcing bar plan, subject to the approval of the Engineer.
- G. Reinforcement shall be supported and tied in such a manner that a sufficiently rigid cage of steel is provided. If the cage is not adequately supported to resist settlement or floating upward of the steel, or movement in any direction during concrete placement, permission to continue concrete placement will be withheld until corrective measures are taken. Sufficient measurements shall be made during concrete placement to ensure compliance with the above.
- H. No concrete shall be deposited until the Engineer has reviewed the placement of the reinforcing steel and all mortar, mud, dirt, etc., shall be cleaned from the reinforcement, forms, and tools.

3.4 ERECTION TOLERANCES

- A. Section 01 40 00 - Quality Requirements
- B. Install reinforcement within the following tolerances for flexural members, walls, and compression members:

Reinforcement Depth	Depth Tolerance	Concrete Cover Tolerance
Greater than 8 inches	plus or minus 3/8 inch	minus 3/8 inch
Less than 8 inches	plus or minus 1/2 inch	minus 1/2 inch

- C. Install reinforcement within the tolerances specified in ACI 530.1 for foundation walls.

3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements
- B. Perform field inspection and testing in accordance with ACI 318.
- C. Provide free access to Work and cooperate with appointed firm.
- D. Reinforcement Inspection:
 1. Placement Acceptance: Specified and ACI 318 material requirements and specified placement tolerances.
 2. Welding: Inspect welds in accordance with AWS D1.1.
 3. Periodic Placement Inspection: Inspect for correct materials, fabrication, sizes, locations, spacing, concrete cover, and splicing.

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4. Weldability Inspection: Inspect for reinforcement weldability when formed from steel other than ASTM A706/A706M.
5. Continuous Weld Inspection: Inspect reinforcement as required by ACI 318.
6. Periodic Weld Inspection: Other welded connections.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes the requirements for all cast-in-place concrete.
- B. Related Sections:
 - 1. Section 03 10 00 - Concrete Forming and Accessories: Formwork and accessories.
 - 2. Section 03 20 00 - Concrete Reinforcing.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
 - 2. ACI 301 - Specifications for Structural Concrete.
 - 3. ACI 305 - Hot Weather Concreting.
 - 4. ACI 306.1 - Standard Specification for Cold Weather Concreting.
 - 5. ACI 308.1 - Standard Specification for Curing Concrete.
 - 6. ACI 318 - Building Code Requirements for Structural Concrete.
- B. ASTM International:
 - 1. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 3. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 4. ASTM C42/C42M - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 5. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
 - 6. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 7. ASTM C150 - Standard Specification for Portland Cement.
 - 8. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - 9. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 10. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - 11. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - 12. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
 - 13. ASTM C685/C685M - Standard Specification for Concrete Made By Volumetric Batching and Continuous Mixing.
 - 14. ASTM C845 - Standard Specification for Expansive Hydraulic Cement.
 - 15. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
 - 16. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.

17. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
18. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
19. ASTM C1157 - Standard Performance Specification for Hydraulic Cement.
20. ASTM C1218/C1218M - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
21. ASTM D994 - Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
22. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
23. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
24. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
25. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
26. ASTM E1643 - Standard Practice for Installation of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
27. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

1.3 PERFORMANCE REQUIREMENTS

- A. Vapor Retarder Permeance: Per Section 03 10 00.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on joint devices, attachment accessories, and admixtures.
- C. Design Data:
 1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
 - a. Hot and cold weather concrete work.
 - b. Air entrained concrete work.
 2. Identify mix ingredients and proportions, including admixtures.
 3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.
- D. Manufacturer's Installation Instructions: Submit installation procedures and interface required with adjacent Work.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Accurately record actual locations of embedded utilities and components concealed from view in finished construction.

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1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 318.
- B. Conform to ACI 305 when concreting during hot weather, except as amended herein.
- C. Conform to ACI 306.1 when concreting during cold weather, except as amended herein.
- D. Acquire cement and aggregate from one source for Work.
- E. Batch Plant: Currently certified by the National Ready Mixed Concrete Association
- F. Mix Designer: Licensed professional engineer registered in the State of Texas or TXDOT approved mix designer.
- G. Maintain one copy of each document on site.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Maintain concrete temperature after installation at minimum 50 degrees F for minimum 7 days.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate placement of joint devices with erection of concrete formwork and placement of form accessories.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150, Type I – General Purpose, or Type II – General Purpose Moderate with Sulfate Resistance.
 - 1. Meet ASTM C150.
 - 2. Alkalies: Less than 60%.

- B. Normal Weight Aggregates: ASTM C33 furnished from a single source.
 - 1. Meet ASTM C33.
 - 2. Coarse Aggregate: In accordance with ACI 318 consisting of natural gravels, crushed gravels, crushed stone, or combination of these materials containing no more than 15% of flat, elongated particles (long dimension no more than 5 times short dimension). No more than 0.5% of coarse aggregate passing a 200 sieve.
 - 3. Fine Aggregate: Clean, sharp natural sand per ASTM C33 with no more than 4% of fine aggregate passing a 200 sieve.
- C. Water: ACI 318; potable, less than 250 ppm of chlorides.

2.2 ADMIXTURES

- A. General: Compatible with other admixtures and free from chlorides or other corrosive chemicals.
- B. Fly Ash (Pozzolan): Not allowed except where specified on structural drawings. See structural drawings for fly ash requirements.
- C. Air Entrainment:
 - 1. ASTM C260, non-toxic after 30 days containing no chlorides.
 - 2. Concrete with air-entrainment admixture shall maintain air percentage, as batched, within plus or minus 2% for the time required for placement.
- D. High Range Water Reducing Admixture (Superplasticizer): ASTM C494/C494M.
 - 1. Hold slump of 5" or greater for time required for placement.
 - 2. Use Type F or Type G.
 - 3. Manufacturers
 - a. BASF Admixtures Inc.; Rheobuild
 - b. Euclid Chemical Co.; Eucon 537
 - c. WR Grace & Co.; Daracem 100
- E. Water Reducing Admixture: ASTM C494/C494M, Type A or Type D.
 - 1. Manufacturers:
 - a. BASF Admixtures Inc.; Pozzolith or Polyheed
 - b. Euclid Chemical Co.; Eucon WR-91
 - c. WR Grace & Co.; HYCOL
- F. Silica Fume: Not Allowed.

2.3 ACCESSORIES

- A. Bond Breaker:
 - 1. Manufacturers:
 - a. Burke Co.; Burke Clean Lift Bond Breaker or Burke Tilt Free Bond Breaker
 - b. Nox-Crete Products Group; Silcoseal Select
 - c. Williams Distributors, Inc.; Williams Tilt-Up Compound.
 - d. Substitutions: Not Permitted.

- B. Bonding Agent: Two component modified epoxy resin.
 - 1. Manufacturers:
 - a. BASF Building Systems, Inc.; Concresive
 - b. Euclid Chemical Co.; Euco Epoxy System
 - c. Sika Chemical Corp.; Sikadur 32.
 - d. Substitutions: Not Permitted.
- C. Vapor Retarder: ASTM E1745 Class A; 10 mil thick clear polyethylene film type recommended for below grade application. Furnish joint tape recommended by manufacturer.
- D. Non-Shrink Grout: ASTM C1107/C1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 4,000 psi in 24 hours and 7,000 psi in 7 days.
 - 1. Manufacturers:
 - a. Euclid Chemical Company, Euco N-S Grout
 - b. Master Builders Masterflow 713
 - c. U.S. Grout Corp, Five Star Grout
 - d. Substitutions: Not Permitted.
- E. Concrete Reinforcing Fibers: ASTM C1116, high strength industrial-grade fibers specifically engineered for secondary reinforcement of concrete. Tensile strength -130 ksi; toughness, 15 ksi, 3/4 inch long fibers, 34 million/lb fiber count.
 - 1. Manufacturers:
 - a. W. R. Grace
 - b. Fibermesh
 - c. Forta
 - d. ProMesh
 - e. Substitutions: Section 01 60 00 - Product Requirements.

2.4 JOINT DEVICES AND FILLER MATERIALS

- A. Sealant and Primer: As specified in Section 07 90 00.

2.5 CONCRETE MIX DESIGN

- A. Design: Select and proportion ingredients using trial batches; sample, cure, and test concrete mix through approved independent testing laboratory in accordance with ACI 211.1
 - 1. Concrete Backfill and Concrete Encasement: Design for 2,000 psi at 28 days using 3/4-inch aggregate, 6" maximum slump, and 0.67 maximum water to cement ratio.
 - 2. Mud Slabs, Thrust Blocking, and Rip-Rap: Design for 2,500 psi at 28 days using 3/4-inch aggregate, 4.5" maximum slump and 0.48 maximum water to cement ratio.
 - 3. Structural Concrete Compressive Strength (F'c):
 - a. 4,000 psi at 28 days, unless otherwise shown.
 - b. 3,600 psi at 28 days for water quality and detention pond structures and retaining wall footings.
 - c. 3,000 psi at 28 days for drilled piers, curb and gutter, and sidewalks (unless indicated otherwise).
 - d. Design lab-cured trial mix cylinders.

- e. Use additional concrete above minimum specified to attain required average compressive strength (F'_{cr}).
- f. Use F'_{cr} as basis for selecting concrete proportions as set forth in ACE 301.
- g. F'_{cr} : Equal to $F'c$ plus 1,200 when data is not available to establish standard deviation.

B. Proportions:

- 1. Select proportions for normal weight concrete in accordance with ACI 211.1.
- 2. Unless specifically stated otherwise, water to cement ratio shall control the amount of total water added to concrete as follows:

Water to Cement Ratio		
Course Aggregate Size (inches)	Max. W/C Ratio (Superplasticizer)	Max. W/C Ratio (No Superplasticizer)
1-1/2	0.40	0.44
1	0.40	0.44
3/4	0.40	0.44

- 3. Minimum Cement Content:
 - a. 517 lbs./cu. yd. for 1-1/2" aggregate size.
 - b. 540 lbs./cu. yd. for 1" aggregate size.
 - c. 564 lbs./cu. yd. for 3/4" aggregate size.
 - d. Increase cement, as required, to obtain strength requirements and water-cement ratio.
- C. Select proportions for concrete in accordance with ACI 318 without trial mixtures or field experience when approved by Engineer.
- D. Admixtures: Include admixture types and quantities indicated in concrete mix designs only when approved by Engineer.
 - 1. Use accelerating admixtures in cold weather. Use of admixtures will not relax cold weather placement requirements.
 - 2. Do not use fly ash in any mix design, except where specified on structural drawings.
 - 3. Do not use calcium chloride nor admixtures containing calcium chloride.
 - 4. Use water reducers in all structural concrete.
 - 5. Use high range water reducers (superplasticizers) for all wall concrete and at the Contractor's option for slab or other than walls for workability.
 - 6. Air Content: 4% to 6% when tested per ACI C231.
- E. Slump Range at Site:
 - 1. 4.5" minimum, 8" maximum for concrete with high range water reducing admixture.
 - 2. 3" minimum and 5" maximum for concrete without high range water reducing admixture.
- F. Average Compressive Strength Reduction: Not permitted.
- G. Ready Mixed Concrete: Mix and deliver concrete in accordance with ASTM C685/C685M.
- H. Site Mixed Concrete: Mix concrete in accordance with ACI 318.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify requirements for concrete cover over reinforcement.
- C. Verify anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with placing concrete.

3.2 PREPARATION

- A. Prepare previously placed concrete by cleaning with steel brush and applying bonding agent. Remove laitance, coatings, and unsound materials.
- B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
- C. Remove debris and ice from formwork, reinforcement, and concrete substrates.
- D. Remove water from areas receiving concrete before concrete is placed.
- E. Joints:
 1. Locate expansion, control, contraction, and construction joints where shown.
 2. If not shown, provide construction joints at a maximum spacing of 40 feet.
 3. Vertical construction joints may not be greater than 20 feet from wall corners or intersections.

3.3 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301 and ACI 304R, except as modified herein.
- B. Notify testing laboratory and Engineer minimum 24 hours prior to commencement of operations.
- C. Discharge time: Not to exceed 90 minutes, unless otherwise approved by Engineer.
- D. Ensure reinforcement, inserts, embedded parts, formed expansion and contraction joints, and reinforcement supports are not disturbed during concrete placement.
- E. Install vapor retarder under interior slabs on grade in accordance with ASTM E1643. Lap joints minimum 6 inches and seal watertight by adhesive applied between overlapping edges and ends.
- F. Repair vapor retarder damaged during placement of concrete reinforcing. Repair with vapor retarder material; lap over damaged areas minimum 6 inches and seal watertight.
- G. Separate slabs on grade from vertical surfaces with 2 inch thick joint filler.

- H. Install construction joint devices in coordination with floor slab pattern placement sequence. Set top to required elevations. Secure to resist movement by wet concrete.
- I. Install joint device anchors. Maintain correct position to allow joint cover to be flush with floor and wall finish.
- J. Install joint covers in longest practical length, when adjacent construction activity is complete.
- K. Apply sealants in joint devices in accordance with Section 07 90 00.
- L. Deposit concrete at final position. Prevent segregation of mix.
- M. Place concrete in continuous operation for each panel or section determined by predetermined joints.
- N. Consolidate concrete.
- O. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- P. Place concrete continuously between predetermined expansion, control, and construction joints.
- Q. Do not interrupt successive placement; do not permit cold joints to occur.
- R. Place floor slabs in checkerboard or saw cut pattern.
- S. Saw cut joints within 12 hours after placing. Use 3/16 inch thick blade, cut into 1/4 depth of slab thickness.
- T. Screed floors and slabs on grade level, maintaining surface flatness of a maximum of 1/8 inch in 10 feet.
- U. Cold Weather:
 - 1. Do not place when ambient temperature is below 40 degrees F.
 - 2. Maintain surface temperature above 40 degrees F at all times.
 - 3. Provide surface thermometers to monitor surface temperatures during curing.
 - 4. Conform to ACI 306.1 and ACI 301 requirements.
- V. Hot Weather:
 - 1. Prepare, mix, place, cure, and protect per ACI 305R.
 - 2. Maintain concrete temperature below 90 degrees F at all times.
 - 3. Spray evaporation retardant on all exposed surfaces when temperature is greater than 90 degrees F.
 - 4. Ensure that admixtures do not produce flash set plastic shrinkage or cracking from heat of hydration.

3.4 SEPARATE FLOOR TOPPINGS

- A. Prior to placing floor topping, roughen substrate concrete surface and remove deleterious material. Broom and vacuum clean.
- B. Place required dividers, edge strips, reinforcing, and other items to be cast in.
- C. Apply bonding agent to substrate.
- D. Place concrete floor toppings to required lines and levels. Place topping in checkerboard panels, dimension not to exceed 20 feet.
- E. Screed toppings level, maintaining surface flatness of 1/8 inch in 10 feet.

3.5 CONCRETE FINISHING

- A. Finish concrete surfaces to requirements of Section 03 35 00.
- B. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1/4 inch per foot as indicated on Drawings.

3.6 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
 1. Protect concrete footings from freezing for minimum 5 days.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Cure concrete floor surfaces as specified in Section 03 39 00.
- D. Ponding: Maintain 100 percent coverage of water over floor slab areas continuously for 7 days.
- E. Spraying: Spray water over floor slab areas and maintain wet for 7 days.
- F. Backfill: Do not backfill against walls for a minimum of 28 days after placement, unless otherwise approved by the Engineer. Place backfill uniformly across the wall.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Field inspection and testing will be performed by Owner's testing laboratory in accordance with ACI 318.
- C. Provide free access to Work and cooperate with appointed firm.

- D. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of Work.
- E. Concrete Inspections:
 - 1. Continuous Placement Inspection: Inspect for proper installation procedures.
 - 2. Periodic Curing Inspection: Inspect for specified curing temperature and procedures.
- F. Strength Test Samples:
 - 1. Sampling Procedures: ASTM C172.
 - 2. Cylinder Molding and Curing Procedures: ASTM C31/C31M, cylinder specimens, standard cured.
 - 3. Sample concrete and make one set of four cylinders for every 150 cubic yards or less of each class of concrete placed each day and for every 5,000 square feet of surface area for slabs and walls.
 - 4. When volume of concrete for any class of concrete would provide less than 5 sets of cylinders, take samples from five randomly selected batches, or from every batch when less than 5 batches are used.
 - 5. Make one additional cylinder during cold weather concreting, and field cure.
- G. Field Testing:
 - 1. Slump Test Method: ASTM C143/C143M.
 - 2. Air Content Test Method: ASTM C173/C173M.
 - 3. Temperature Test Method: ASTM C1064/C1064M.
 - 4. Measure slump and temperature for each compressive strength concrete sample.
 - 5. Measure air content in air entrained concrete for each compressive strength concrete sample.
- H. Cylinder Compressive Strength Testing:
 - 1. Test Method: ASTM C39/C39M.
 - 2. Test Acceptance: In accordance with ACI 318
 - 3. Test one cylinder at 7 days.
 - 4. Test two cylinders at 28 days.
 - 5. Retain one cylinder for 28 days for testing when requested by Engineer.
 - 6. Dispose remaining cylinders when testing is not required.
- I. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

3.8 PATCHING

- A. Allow Engineer to inspect concrete surfaces immediately upon removal of forms.
- B. Excessive honeycomb or embedded debris in concrete is not acceptable. Notify Engineer upon discovery.
- C. Inject leaking cracks with injection epoxy equal to Sikadur 55 SLV.
- D. Repair cracks per Section 03 01 00 as approved by the Engineer.
- E. Patch imperfections as directed by Engineer in accordance with ACI 318.

F. Provide a structurally sound surface finish, uniform in appearance acceptable to the Engineer.

G. Tie Holes:

1. Fill with non-shrink grout.
2. Match color of concrete.
3. Compact using steel hammer or steel tool to high density.
4. Cure with water.

3.9 WATER LEAKAGE

A. Water Containing Structures:

1. Conduct leakage test after concrete has attained full design strength.
2. Perform leakage test before backfill is placed against the structure or coatings have been installed.
3. Install temporary plugs, bulkheads, or blind flanges as required for a complete seal.
4. Fill with water to maximum liquid level and maintain for 48 hours prior to start.
5. Measure water level for 72 hours after initial filling.
6. Volume loss shall not exceed 0.1% of liquid volume over the test period.
7. No visible seepage or damp areas shall be allowed.
8. Repair per Section 03 01 00.

3.10 DEFECTIVE CONCRETE

- A. Defective Concrete: Concrete not conforming to required lines, details, dimensions, tolerances or specified requirements.
- B. Repair or replacement of defective concrete will be determined by Engineer.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Engineer for each individual area.
- D. Repair all concrete damaged by construction

END OF SECTION

SECTION 03 35 00 – CONCRETE FINISHING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Finishing concrete structures.
 - 2. Finishing concrete pavement.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Prepared concrete floors ready to receive finish; control and formed expansion and contraction joints and joint devices.
 - 2. Section 03 39 00 - Concrete Curing.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 302.1 - Guide for Concrete Floor and Slab Construction.
- B. ASTM International:
 - 1. ASTM E1155 - Standard Test Method for Determining Floor Flatness and of Levelness Using the F-number System.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on concrete hardener, sealer, curing compounds and slip resistant treatment, compatibilities, and limitations.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit data on maintenance renewal of applied coatings.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 and ACI 302.1.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum ten years of experience.

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- B. Applicator: Company specializing in performing work of this section with minimum three years of experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Deliver materials in manufacturer's packaging including application instructions.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not finish floors until interior heating system is operational.
- C. Temporary Heat: Ambient temperature of 50 degrees F minimum.
- D. Ventilation: Sufficient to prevent injurious gases from temporary heat or other sources affecting concrete.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate the Work with concrete floor placement and concrete floor curing.

PART 2 PRODUCTS

2.1 CHEMICAL CURING COMPOUNDS

- A. Conforming to ASTM C-309, Type 1D, Class B with a minimum of 18 percent solids. No thinner may be used.
 - 1. Manufacturers:
 - a. Kaufman Products Inc. – SureCure Emulsion
 - b. Symons Corporation – Cure & Seal
 - c. Sonneborn Corporation – Kure N Seal W
 - d. Dayton Superior Corporation – DayChem Cure & Seal (J-22)
 - e. Master Builders – Acrylseal HS
 - f. Substitutions: Section 01 60 00 - Product Requirements.

2.2 COMPOUNDS - HARDENERS AND SEALERS

- A. Chemical Hardener: Magnesium fluorosilicate and zinc fluorosilicate blend type.
 - 1. Manufacturers:
 - a. Sonneborn – Lapidolith
 - b. Euclid Chemical – Surfhard
 - c. W. R. Meadows – Pena-lith
 - d. L&M Construction Chemicals – FluoHard

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- e. Kaufman Products - Diamond
- f. Substitutions: Section 01 60 00 - Product Requirements.

2.3 SLIP RESISTANT TREATMENT

- A. Abrasive Aggregate: Crushed emery, minimum 45 percent aluminum oxide.
 - 1. Manufacturers:
 - a. Sonneborn – Frictex H
 - b. AntiHydro International – Emerundum
 - c. Setcon Industries – Non-Slip Aggregate
 - d. Substitutions: Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify floor surfaces are acceptable to receive the Work of this section.

3.2 FLOOR FINISHING

- A. Finish concrete floor surfaces in accordance with ACI 301 and ACI 302.1.
- B. Float surfaces receiving quarry tile, ceramic tile, and cementations terrazzo with full bed setting system.
- C. Steel trowel surfaces receiving carpeting, resilient flooring, seamless flooring, terrazzo, quarry tile, thin set ceramic tile, and vinyl flooring.
- D. Steel trowel surfaces which are to be exposed.
- E. In areas with floor drains, maintain design floor elevation at walls; slope surfaces uniformly to drains at a minimum of 1/8 inch per foot nominal or as otherwise indicated on Drawings.

3.3 FLOOR SURFACE TREATMENT

- A. Apply liquid hardener on floor surfaces.
- B. Apply slip resistant finish as scheduled on floor surfaces.
- C. Apply sealer as scheduled on floor surfaces.
- D. Apply retarder to exposed aggregate finish on floor surfaces.

3.4 FINISHING OF FORMED SURFACES

- A. Rough Form Finish.
 - 1. No form facing material is required on rough form finish surfaces.

2. Patch tie holes and defects, and fins exceeding $\frac{1}{4}$ inch in height shall be chipped off.
3. A rough form finish may be used on concrete surfaces which will be concealed from view by earth or water in the completed structure except the top 2 feet of walls below final top of ground elevation and full depth of grade beams shall have a smooth form finish. In addition, surfaces scheduled to be permanently exposed during future expansion, at locations shown on the Drawings, shall have a smooth form finish.

B. Smooth Form Finish.

1. The form facing shall produce a smooth, hard, uniform texture on the concrete. Use plywood or fiberboard linings or forms in as large sheets as practicable and with smooth, even edges and close joints.
2. Patch tie holes and defects. Rub fins and join marks with wooden blocks to leave a smooth, unmarred finished surface. Remove all sharp edges on surfaces to receive a protective liner.
3. Provide a smooth form finish on all formed surfaces not concealed from view by earth in the completed structure. In addition, walls that will be exposed after future construction, at locations shown on the drawings, shall have a smooth form finish. Smooth form finish on exterior face of exterior walls shall extend 2 feet below final top of ground elevation. The exterior face of all perimeter grade beams shall have a smooth form finish for the full depth of the grade beam.

C. Related Unformed Surfaces. Tops of walls and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed. Float unformed surfaces to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

3.5 SLABS AND SIMILAR FLAT SURFACES

- A. Shaping to Contour. Use strike-off templates or approved compacting-type screeds riding on screed strips or edge forms to bring concrete surface to the proper contour. See Section 03 31 10, Concrete Formwork for edge forms and screeds. This system shall be used throughout the project.
- B. Consolidation. Thoroughly consolidate concrete in slabs and use internal vibration in beams and girders of framed slabs and along bulkheads of slabs on grade. Obtain consolidation of slabs and floors with vibrating bridge screeds, roller pipe screeds, or other approved means. Concrete to be consolidated must be as dry as practicable. Do not permit manipulation of surfaces prior to finishing operations.
- C. Tolerances for Finished Surfaces. Tolerances, checked by placing a straightedge of specified length anywhere on the slab, shall not exceed the limits specified in Section 3.7.
- D. Raked Finish. After concrete has been placed, struck off, consolidated and leveled to allowable tolerance, roughen the surface before final set. Roughen with stiff brushes or rakes to a depth of approximately $\frac{1}{4}$ inches. Notify the Engineer prior to placing concrete requiring the initial raked surface finish so that an acceptable raked finish standard may be established for the project. Provide a raked finish for surfaces to receive bonded concrete fill.

E. Floated Finish.

1. After concrete has been placed, struck off, consolidated and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared, or when the mix has stiffened sufficiently to permit proper operation of a power-driven float. Consolidate the surface with power-driven floats. Use hand floating with wood or cork-faced floats in locations inaccessible to a power-driven machine and on small, isolated slabs.
2. Recheck tolerance of the surface after initial floating with a 10-foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots to allowable tolerance. Immediately refloat slab to uniform, smooth, granular texture.
3. Provide a floated finish for the following:
 - a. Floor slabs of liquid-containing structures.
 - b. Pit floors, trench floors and curbed areas.
 - c. Exterior floor slabs and concrete walkways, unless noted otherwise.

F. Broom or Belt Finish.

1. Immediately after completing the floated finish, draw a broom or burlap belt across the surface to give a coarse transverse scored texture.
2. Provide a broom or belt finish for ramps.

3.6 REPAIRING FORMED SURFACE DEFECTS

- A. Defective Areas. Repair defective areas immediately after the removal of forms. Remove honeycombed and other defective concrete down to sound concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly coat the surface with a bonding grout containing the bonding admixture. The bonding agent must be used in conformance with the manufacturer's recommendations and instructions. While the bonding coat is still tacky, apply the premixed patching mortar. Thoroughly consolidate the mortar into place and strike off to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, leave undisturbed for at least 1 hour before final finishing. Keep the patched area damp for 7 days. Do not use metal tools in finishing patches in a formed wall which will be exposed.
- B. Tie Holes. Patch the holes immediately after removal of forms. After cleaning and thoroughly dampening the tie hole, fill hole solid with approved non-shrink epoxy that matches the appearance of the finished surface.
- C. Cracks. Cracks in excess of 0.01 inch shall be repaired by pressure injection of a moisture-insensitive, epoxy system per Section 03 01 00. Submit proposed material and method of repair for approval prior to making repairs.
- D. Structural Repair. Any required structural repairs shall be made after prior approval of the Engineer as to method and procedure, using the specified epoxy adhesive and/or approved epoxy mortar as specified in Section 03 01 00.

3.7 TOLERANCES

- A. Maximum Variation of Surface Flatness For Exposed Concrete Floors and Slabs: 1/8 inch in 10 ft.

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- B. Maximum Variation of Surface Flatness Under Seamless Resilient Flooring: 1/8 inch in 10 ft.
- C. Maximum Variation of Surface Flatness Under Carpeting: 1/4 inch in 10 ft.
- D. Correct defects in defined traffic floor by grinding or removal and replacement of defective Work. Areas requiring corrective Work will be identified. Re-measure corrected areas by same process.

END OF SECTION

SECTION 03 39 00 - CONCRETE CURING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes initial and final curing of horizontal and vertical concrete surfaces.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete.
 - 2. Section 03 35 00 - Concrete Finishing.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 302.1 - Guide for Concrete Floor and Slab Construction.
 - 3. ACI 308.1 - Standard Specification for Curing Concrete.
 - 4. ACI 318 - Building Code Requirements for Structural Concrete.
- B. ASTM International:
 - 1. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
 - 2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
 - 3. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
 - 4. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
 - 1. Submit data on curing compounds, mats, paper, film, compatibilities, and limitations.
 - 2. Submit manufacturer's certificate of compliance showing moisture retention requirements.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 30 9 and ACI 302.1.
- B. Maintain one copy of each document on site.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirement: Product storage and handling requirements.
- B. Deliver curing materials in manufacturer's packaging including application instructions.

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PART 2 PRODUCTS

2.1 MATERIALS

A. Curing Compound:

1. Water based, high solids content, non-yellowing curing compound meeting requirements of ASTM C309 and ASTM C1315.
 - a. Moisture Loss: Maximum of 0.40 kg/sq. meter over 72 hours.
 - b. Capable of meeting moisture retention at manufacturer's specified application rate.
2. Manufacturers:
 - a. Chemrex, Inc.; Masterkure
 - b. Euclid Chemical Co.; Super Diamond Clear VOX
 - c. WR Meadows, Inc.; VOCOMP-30.
 - d. Vexcon Chemical, Inc.; Starseal 1315.
 - e. Dayton Superior; Safe Cure and Seal 30%
 - f. Substitutions: Not Permitted.

B. Evaporation Retardent:

1. Fluorescent color tint that disappears completely upon drying
2. Manufacturers:
 - a. Master Builders; Confilm
 - b. Euclid Chemical Co.; Eucobar Substitutions
 - c. Section 01 60 00 - Product Requirements

C. Clear Sealer (One-Component Penetrating Silane Sealer).

1. Manufacturers:
 - a. Chemrex, Inc.; Masterseal SL
 - b. Euclid Chemical Co.; Eucoguard 200.
 - c. Substitutions: Not Permitted.

D. Absorptive Mats Type C: ASTM C171, burlap-polyethylene, minimum 9 oz/sq yd (305 grams/sq m) bonded to prevent separation during handling and placing.

E. Clear Floor Hardner:

1. Colorless, aqueous solution of zinc and magnesium fluorosilicate.
2. Each gallon shall contain a minimum of 2 pounds of fluorosilicate compound.
3. Manufacturers:
 - a. Chemrex, Inc.
 - b. Euclid Chemical Co.
 - c. Sonneborn
 - d. Substitutions: Not Permitted.

F. Water: Potable, not detrimental to concrete.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

- B. Verify substrate surfaces are ready to be cured.

3.2 INSTALLATION - HORIZONTAL SURFACES

- A. Cure concrete in accordance with ACI 308.1 using one of the following methods.
 1. Method 1: Protect the entire surface by submerging in water for a minimum of 7 days.
 2. Method 2: Cover with burlap or cotton mats and keep continuously wet for a minimum of 7 days.
 3. Method 3: Cover with 1-inch layer of wet sand and keep continuously wet for a minimum of 7 days.
 4. Method 4: Continuously sprinkle the entire exposed slab surface for a minimum of 7 days.
 5. Method 5: Curing Compound: ASTM C309, Type 2, Class B.
- B. Where water curing for slabs during cold weather is not possible, use Engineer-approved curing compounds at the manufacturer's recommended coverage application rate.
- C. Where curing compound cannot be used, special methods using moisture shall be agreed upon prior to the placing the concrete slabs.
- D. Protect slabs during cold weather with plastic sheets or other approved materials.
- E. Use only water curing where additional finishes such as a clear sealer, hardeners, painting, and special coatings are required.

3.3 INSTALLATION - VERTICAL SURFACES

- A. Cure concrete in accordance with ACI 308.1 using one of the following methods.
 1. General: Where vertical walls are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures.
 2. Method 1: Leave concrete forms in place and keep entire surfaces of forms and concrete wet for a minimum of 7 days.
 3. Method 2: Apply curing compound, where allowed, immediately after removal of forms: ASTM C309, Type 2, Class B.
 4. Method 3: Continuously sprinkle with water the entire exposed surface for a minimum of 7 days after removal of the forms.

3.4 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished Work.
- B. Do not permit traffic over unprotected floor surface.

END OF SECTION

SECTION 03 60 00 - GROUTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Portland cement grout.
 - 2. Rapid curing epoxy grout.
 - 3. Non-shrink cementations grout.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete.

1.2 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 318 - Building Code Requirements for Structural Concrete.
- B. American Society of Testing and Materials:
 - 1. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 2. ASTM C40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - 3. ASTM C150 - Standard Specification for Portland Cement.
 - 4. ASTM C191 - Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
 - 5. ASTM C307 - Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
 - 6. ASTM C531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
 - 7. ASTM C579 - Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, monolithic Surfacings and Polymer Concretes.
 - 8. ASTM C827 - Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
- C. U. S. Army Corps of Engineers Concrete Research Division (CRD):
 - 1. CRD C621 - Non-Shrink Grout.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit product data on grout and results of tests performed by a certified independent testing laboratory showing conformance to ASTM C 1107.
- C. Manufacturer's Installation Instructions: Submit manufacturer's instructions for mixing, handling, surface preparation and placing epoxy type and non-shrink type grouts.
- D. Manufacturer's Certificate: Certify grout meets or exceeds requirements of ASTM C1107, Grade C.

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1.4 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver grout in manufacturer's unopened containers with proper labels intact.
- C. Store grout in a dry shelter, protect from moisture.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not perform grouting if temperatures exceed 90 degrees F.
- C. Maintain minimum temperature of 45 degrees F before, during, and after grouting, until grout has set.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT GROUT MATERIALS

- A. Portland Cement: ASTM C150, Type I and II.
- B. Water:
 - 1. Potable; containing no impurities, suspended particles, algae or dissolved natural salts in quantities capable of causing:
 - a. Corrosion of steel.
 - b. Volume change increasing shrinkage cracking.
 - c. Efflorescence.
 - d. Excess air entraining.
- C. Fine Aggregate:
 - 1. Washed natural sand.
 - 2. Gradation in accordance with ASTM C33 and represented by smooth granulometric curve within required limits.
 - 3. Free from injurious amounts of organic impurities as determined by ASTM C40.
- D. Mix:
 - 1. Portland cement, sand and water. Do not use ferrous aggregate or staining ingredients in grout mixes.

2.2 RAPID CURING EPOXY GROUT

- A. Manufacturers:
 - 1. Sika, Sikadur 42, Grout-Pak PT.
 - 2. L & M Construction Chemicals Inc., Crystex.
 - 3. Five Star Rapid Epoxy Grout

4. Substitutions: Section 01 60 00 - Product Requirements.

B. Rapid Curing Epoxy Grout: High strength, three component epoxy grout formulated with thermosetting resins and inert fillers. Rapid-curing, high adhesion, and resistant to ordinary chemicals, acids and alkalies.

Property	Test	Result
Compressive Strength	ASTM C579	12,000 psi at 7 days
Tensile Strength	ASTM C307	2,000 psi minimum
Coefficient of Expansion	ASTM C531	30x10-6 in per degree F
Shrinkage	ASTM C827	None

2.3 NON-SHRINK CEMENTATIOUS GROUT

A. Manufacturers:

1. The Euclid Chemical Company, "Euco N-S Grout."
2. Master Builders, "Masterflow 713."
3. U.S. Grout Corporation, "Five Star Grout."
4. Substitutions: Section 01 60 00 - Product Requirements.

B. Non-shrink Cementations Grout: Pre-mixed ready for use formulation requiring only addition of water; non-shrink, non-corrosive, non-metallic, non-gas forming, no chlorides.

C. Properties: Certified to maintain initial placement volume or expand after set and meet the following minimum properties when tested in accordance with CRD-C621, for Type D non-shrink grout:

Property	Test	Time	Result
Setting Time	ASTM C191	Initial	2 hours (Approx)
		Final	3 hours (Approx)
Expansion			0.10% - 0.4% Maximum
Compressive Strength	CRD-C621	1 day	4,000 psi
		7 days	7,000 psi
		28 days	10,000 psi to 10,800 psi

2.4 FORMWORK

A. Refer to Section 03 11 00 for formwork requirements.

2.5 CURING

A. Prevent rapid loss of water from grout during first 48 hours by use of approved membrane curing compound or with use of wet burlap method.

PART 3 EXECUTION

3.1 GENERAL

- A. Use rapid curing epoxy grouts for setting of base plates, installation of anchors and dowels, and in aggressive chemical environments.
- B. Use non-shrink grout for concrete repair, filling of construction joints where indicated on the Drawings, and other locations as indicated on the Drawings.

3.2 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify areas with Engineer to receive grout.

3.3 PREPARATION

- A. Remove defective concrete, laitance, dirt, oil, grease and other foreign material from concrete surfaces by brushing, hammering, chipping or other similar means until sound, clean concrete surface is achieved.
- B. Rough concrete lightly, but not enough to interfere with placement of grout.
- C. Remove foreign materials from metal surfaces in contact with grout.
- D. Align, level and maintain final positioning of components to be grouted.
- E. Saturate concrete surfaces with clean water; remove excess water, leave none standing.

3.4 INSTALLATION - FORMWORK

- A. Construct leakproof forms anchored and shored to withstand grout pressures.
- B. Install formwork with clearances to permit proper placement of grout.

3.5 MIXING

- A. Mix and prepare rapid curing epoxy grout in accordance with manufacturer's instructions.
 - 1. Capable of developing minimum compressive strength of 2400 psi in 48 hours and 6800 psi in 28 days.
- B. Mix and prepare non-shrink cementations grout in accordance with manufacturer's instructions.
 - 1. Capable of developing minimum compressive strength of 2400 psi in 48 hours and 6800 psi in 28 days.
- C. Mix grout components in proximity to work area and transport mixture quickly and in manner not permitting segregation of materials.

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3.6 PLACING GROUT

- A. Place grout material quickly and continuously.
- B. Do not use pneumatic-pressure or dry-packing methods.
- C. Apply grout from one side only to avoid entrapping air.
- D. Do not vibrate placed grout mixture, or permit placement when area is being vibrated by nearby equipment.
- E. Thoroughly compact final installation and eliminate air pockets.
- F. Do not remove leveling shims for at least 48 hours after grout has been placed.

3.7 CURING

- A. Immediately after placement, protect grout from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. After grout has attained its initial set, keep damp for minimum of 3 days.

3.8 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Field inspection and testing will be performed in accordance with ACI 318 and under provisions of Section 01 40 00 - Quality Requirements.
- C. Submit proposed mix design of each class of grout to inspection and testing firm for review prior to commencement of Work.
- D. Tests of grout components may be performed to ensure conformance with specified requirements.

END OF SECTION

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SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Structural steel.
2. Prefabricated building columns.
3. Shear stud connectors, field welded.
4. Shrinkage-resistant grout.

1.2 DEFINITIONS

A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in ANSI/AISC 303.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data:

1. Structural-steel materials.
2. High-strength, bolt-nut-washer assemblies.
3. Shear stud connectors.
4. Anchor rods.
5. Threaded rods.
6. Shop primer.
7. Galvanized-steel primer.
8. Galvanized repair paint.
9. Shrinkage-resistant grout.

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B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment Drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
5. Identify members not to be shop primed.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural-steel materials, including chemical and physical properties.
- E. Product Test Reports: For the following:
 1. Bolts, nuts, and washers, including mechanical properties and chemical analysis.
 2. Direct-tension indicators.
 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 4. Shear stud connectors.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control reports.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category BU or is accredited by the IAS Fabricator Inspection Program for Structural Steel (Acceptance Criteria 172).
- B. Installer Qualifications: A qualified Installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

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1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with applicable provisions of the following specifications and documents:
 - 1. ANSI/AISC 303.
 - 2. ANSI/AISC 360.
 - 3. RCSC's "Specification for Structural Joints Using High-Strength Bolts."
- B. Connection Design Information:
 - 1. Option 1: Connection designs have been completed and connections indicated on the Drawings.

2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: [ASTM A992/A992M] [ASTM A572/A572M, Grade 50]
- B. Channels, Angles: [ASTM A36/A36M].
- C. Plate and Bar: [ASTM A36/A36M].
- D. Hollow Structural Sections: [ASTM A500/A500M, Grade B] [ASTM A500/A500M, Grade C] [ASTM A1085/ASTMA1085M] structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
- F. Steel Castings: ASTM A216/A216M, Grade WCB, with supplementary requirement S11.

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- G. Steel Forgings: ASTM A668/A668M.
- H. Welding Electrodes: Comply with AWS requirements.

2.3 BOLTS AND CONNECTORS

- A. All stainless steel bolts, nuts, and washers shall conform to AISI 316.
- B. Shear Stud Connectors: ASTM A108, AISI C-1015 through C-1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

2.4 RODS

- A. Headed Anchor Rods: unless noted otherwise shall conform to the following, [ASTM F1554, Grade 36], straight.
 1. Nuts: ASTM A563 [heavy-]hex carbon steel.
 2. Plate Washers: ASTM A36/A36M carbon steel.
 3. Washers: ASTM F436, Type 1, hardened carbon steel.
 4. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- B. Threaded Rods: unless noted otherwise shall conform to the following, [ASTM A36/A36M].
 1. Nuts: ASTM A63 [heavy-]hex carbon steel.
 2. Washers: [ASTM F436 , Type 1, hardened] [ASTM A36/A36M] carbon steel.
 3. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.

2.5 SHRINKAGE-RESISTANT GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and non staining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate in accordance with ANSI/AISC 303 and to ANSI/AISC 360.
 1. Camber structural-steel members where indicated.
 2. Fabricate beams with rolling camber up.
 3. Identify high-strength structural steel in accordance with ASTM A6/A6M and maintain markings until structural-steel framing has been erected.
 4. Mark and match-mark materials for field assembly.
 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

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1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.7 SHOP CONNECTIONS

- A. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in ANSI/AISC 303 for mill material.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel in accordance with ASTM A123/A123M.
 1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in

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intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated on Drawings.

1. Do not remove temporary shoring supporting composite deck construction and structural-steel framing until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and in accordance with ANSI/AISC 303 and ANSI/AISC 360.
- B. Baseplates Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 4. Promptly pack shrinkage-resistant grout solidly between bearing surfaces and plates, so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for grouting.
- C. Maintain erection tolerances of structural steel within ANSI/AISC 303.
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 1. Level and plumb individual members of structure. Slope roof framing members to slopes indicated on Drawings.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by Structural Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts" for bolt and joint type specified.
 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

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1. Comply with ANSI/AISC 303 and ANSI/AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
- C. Shear Stud Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Weld using end welding of headed-stud shear connectors in accordance with AWS D1.1/D1.1M and manufacturer's written instructions.

3.5 REPAIR

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing, and repair galvanizing to comply with ASTM A780/A780M.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
 1. Bolted Connections: Inspect bolted connections in accordance with RCSC's "Specification for Structural Joints Using High-Strength Bolts."
 2. Welded Connections: Visually inspect field welds in accordance with AWS D1.1/D1.1M.

END OF SECTION 051200

SECTION 22 00 00 - GENERAL PLUMBING REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes requirements that expand the requirements specified in Division 01 and applies to all Division 22 – Plumbing Specification Sections. It is the intent of the contract documents to provide an installation complete in every respect. Work shall be executed in a workmanlike manner and shall include all labor, materials, and supervision essential to provide complete functioning systems as described in the contract documents. In the event that additional details or special construction is required for work indicated, it shall be the responsibility of the Contractor to provide same as well as to provide material and equipment usually furnished with such systems or required to complete the installation at no expense to the Owner.
- B. Conflict Resolution: Where conflicts may exist between the minimum requirements of various laws, codes, authorities, and/or within the Contract Documents, the higher quality, greater quantity, more restrictive and/or more expensive requirement shall be the basis of Contractor pricing and the Contractor shall notify the Architect/Engineer and Owner's Representative for the resolution of the issue prior to executing the work in question.
- C. Should any errors, omissions, conflicts, or ambiguities exist in the drawings, the Contractor shall bring these to the attention of the Engineer immediately for adjustment in writing before signing the contract or proceeding with the work. Otherwise, he shall at his own expense, supply the proper materials and labor to make good any damage or defect caused by such unintentional error.
- D. Contractor is responsible for checking all contract documents, field conditions and dimensions for accuracy, and confirming that the work is buildable as shown and meets all applicable codes before proceeding with construction. If there are any questions regarding these or other coordination issues, the Contractor is responsible for obtaining a clarification from the Architect/Engineer before proceeding with the work in question or related work.
- E. Contractor shall direct all questions to the Owner's project coordinator. The Contractor shall verify all working conditions such as starting time, noise and vibration limitations, confined space, etc. Through the project coordinator and approval shall be received to start work.
- F. Related Sections:
 - 1. Drawings, Contract, including General and Supplementary Conditions, and Division 01 – General Requirements Specification Sections apply to this and all other Division 22 – Plumbing Specification Sections.

- G. Deviations to the intended design or the scope of the work must be approved by the project Engineer prior to commencing work. Failure to do so may result in the work to be removed at no cost to the Owner.
- H. All work shall be performed in accordance with all applicable local codes, standards, and amendments and/or other authorities that may have jurisdiction pertaining to the work. In addition, all work shall conform to the standards and practices of the Owner, where applicable.
- I. Coordination:
 1. The Contractor shall be responsible for ensuring full coordination with other trades and Contractors to accomplish the work as shown and noted in these contract documents. The Contractor shall compare the drawings of other trades and report any discrepancies to the Owner's representative.
 2. The Contractor shall not fabricate or install items as shown on the drawings if there are discrepancies or conflicts between the existing conditions and the information shown on the drawings until such discrepancies have been resolved. Prior to fabrication or installation, the Contractor shall immediately call such discrepancies or conflicts to the attention of the project coordinator.
 3. Ductwork, piping, conduit, cabling, etc. shown on drawings shall be coordinated with air distribution devices, special ceiling, floor, and structure construction, etc. Provide additional rises and drops to those indicated on the drawings as required to coordinate with architectural, structural or MEP elements shown on the contract documents. All utilities shall be routed in an orderly manner, grouped together wherever possible, and located so as to conserve building space. Ductwork, piping, conduit, cabling, etc. Shown on each plan is run above the ceiling on the floor where it is shown unless otherwise noted.
 4. Refer to civil-site drawings for buried pipe trenching and backfill specifications and details.
- J. As-Builts: The Contractor shall maintain his set of construction drawings on site at all times so that all changes between the drawings and the actual construction can be noted on the drawings. This includes all deviations from the original contract. The Contractor shall indicate all changes from the original plans made during the installation of his work in red ink on two blueline prints. At the end of construction, the Contractor shall sign and date the drawings certifying that they are an accurate reflection of the actual construction. As-built drawings are to be delivered to the Owner's project coordinator after project completion. Note that the final invoice for the contract will not be paid by the Owner until final as-built drawings are received.
- K. All work noted "NIC" or "Not in Contract" is to be accomplished by another Contractor and is not to be part of the construction agreement.

1.2 DEFINITIONS

- A. Furnish: To purchase and deliver products to the project site and prepare for installation.

- B. Install: To assemble, erect, secure, connect, and place furnished product into operation.
- C. Provide: To furnish and install.
- D. Products: Includes materials, systems, parts, and equipment.
- E. Concealed: Embedded in or installed behind walls, within partitions, above suspended ceilings, in trenches, in tunnels and crawl spaces.
- F. Exposed: Not installed underground or "concealed" as defined above.
- G. Specifications: These specifications plus the Codes and Standards referenced herein.

1.3 CONTRACTOR QUALIFICATIONS

- A. General: The firms that perform the installation of the work under this Division of specifications shall be one that maintains an established, experienced organization with a permanent, manned office within a radius of 150 miles of Round Rock, Texas.
- B. Plumbing Firm's Proficiency: The firm's proficiency in the installation, start up, adjustment and maintenance of plumbing systems shall have been demonstrated by the successful performance of work as specified herein on at least three systems with wall or floor mounted flush valve water closets, primary and secondary roof drainage systems, and 2 inch minimum domestic water service with reduced pressure zone backflow prevention protection. The firm shall have trained personnel, instruments, tools, and equipment to perform the installation and maintenance service specified. The firm shall have been in business performing services as specified herein for at least three years.

1.4 SAFETY:

- A. Contractor shall comply with all applicable safety standards including, but not limited to OSHA standards and Owner's requirements.
- B. All safety exposures or violations shall be rectified immediately by the Contractor. The Contractor shall be responsible for providing protection of persons and property, providing safe working conditions throughout the work progress, providing temporary coverings for openings through walls or floors, and providing temporary barriers, partitions and/or dust barriers where required to maintain OSHA and the Owner's safety standards and to prevent damage to property. All areas adjacent to the construction area or affected by the construction must be protected from damage, cleaned, and restored to the original condition at no additional expense to the Owner. The Contractor shall provide protective clothing and eyewear for all personnel who are required to handle hazardous chemical products or work in hazardous locations.
- C. Submit material safety data sheets and manufacturer's current recommended method of installation for all materials used to perform the work indicated by these documents. All submittals shall be prepared according to current Owner specifications and shall be

approved prior to starting any work. All chemicals or chemical compounds proposed for use on the property including, but not limited to paint thinners, solvents, adhesives, sealants, cleaning compounds, epoxies, etc. Must be approved by the Owner.

- D. Dispose of debris, trash, and hazardous materials in accordance with all applicable codes.
- E. The Contractor shall be responsible for training his/her employees and subcontractors as required by the Owner, and in the recognition and avoidance of unsafe conditions, and in the regulations and hazards which apply to the area in which the work will take place.
- F. Work areas shall be kept continuously, at all times, free of debris and non-hazardous material to the satisfaction of the project coordinator. All existing piping and conduits shall have temporary protection during construction. The Contractor shall coordinate storage of materials, parking of vehicles, and restrictions of work with the project coordinator. After project completion, the site shall be cleaned up and restored to its condition or better prior to the start of the project to the satisfaction of the project coordinator.

1.5 QUALITY CONTROL

- A. Comply with manufacturers' instructions, including each step in sequence.
- B. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- D. Conform to reference standard by date of issue current on date of Contract Documents date for receiving bids, except where a specific date is established by code.

1.6 SUBMITTALS

- A. Contractor shall provide product data submittals on all major equipment, components, and materials specified in these plans for Engineer's and Owner's review and acceptance prior to installation. ALL submittals shall be in .pdf format.
- B. Contractor Review: The Contractor shall check data carefully to insure compliance with these specifications prior to submitting. For product data describing two or more variants of the same model product, clearly mark the selected product and all included accessories and options. Stamp and sign each submittal section indicating review and approval and provide notes indicating any variances that exist.
- C. Submittal data for Section 22 00 00 – General Plumbing Requirements:
 1. Electrical Requirements List: Provide ~~typed on 8-1/2 x 11 inch plain bond paper~~ a list indicating the electrical requirements for each piece of plumbing equipment. The

list shall include all of the information shown on the sample list at the end of this Section. All of the information contained in the sheet shall be coordinated between the plumbing and electrical Contractors so that the data reflects actual requirements for the submitted plumbing equipment. Submittals for electrically powered equipment shall not be reviewed until this sheet is received by the Engineer completed and signed. See sample Electrical Requirements List at the end of this Section.

2. Coordination Drawings: Indicate the proposed locations of equipment, ductwork, piping, and materials by preparing floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations. The sheet metal drawing shall be the Base Sheet. Other drawings produced shall be coordination drawing overlays, so interferences can be detected. Prepare coordination drawings to a scale of 1/4" = 1'-0" or larger clearly indicating the following:
 - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
 - b. Clearances for installing and maintaining insulation.
 - c. Clearances for installing and maintaining valves, dampers, and their actuators.
 - d. Equipment connections and support details.
 - e. Exterior wall and foundation penetrations.
 - f. Fire-rated wall and floor penetrations.
 - g. Sizes and location of required concrete pads and bases.
 - h. Indicate locations where space is limited for installation and maintenance.
 - i. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
 - j. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
 - k. Fire Protection drawings shall be coordinated with other trades.

D. Submittal data for other Division 22 Specification Sections: Provide data as required in each individual Division 22 Specification Sections. Submittal data types are as follow:

1. Compliance Data: Published literature, certificates, and lists indicating the product's compliance with standards referenced in these specifications.
2. Published Literature: Indicate dimensions, weights, capacities, ratings, horsepower, gages, and finishes of materials, and electrical characteristics and connection requirements.
3. Performance Data: Performance data including fan curves, pump curves, and equipment output capacities complete with rating conditions as scheduled on contract drawings. As a minimum submitted data shall include all performance data scheduled or noted on contract drawings.
4. Sound Power Level Data: Equipment sound power level at 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz octave band center frequencies plus db A weighted sound level. Data shall include distance from equipment to test equipment.
5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

6. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
7. Manufacturer's Instructions: Include installation instructions.
8. Certificates: Signed letters certifying compliance with specified requirements.
9. Calculations: Design and/or design calculations.

E. Shop drawings: all shop drawings, including product data submittals, shall be reviewed by the Contractor prior to submitting to the Engineer. All shop drawings not reviewed by the Contractor will be returned without review. After review has been completed, submit a copy of each shop drawing to the Owner with the approval seal of the Engineer and the Contractor. The use of reproductions of these contract drawings by any Contractor, subcontractor, erector, fabricator or material supplier, in lieu of the preparation of shop drawings is forbidden. Shop drawings received bearing the Engineer's title and seal shall be promptly rejected.

1.7 SUBSTITUTIONS

- A. Basis of Design: Model numbers indicated in other Division 22 Specification Sections or shown on the drawings are the Basis of Design. The Contractor may request substitution of equal and approved equipment from manufacturers listed in this specification or set forth in an addendum provided said equipment meets all requirements of the plans and specifications, has like electrical characteristics (e.g., same voltage, phase, fusing/circuit breaker requirements, single or multiple points of connection as indicated on the electrical drawings), and will fit in the available spaces in the building as shown. Substitutions must be requested a minimum of 10 days before bids are due, as described below.
- B. If the Contractor chooses to provide equipment which meets all of the aforementioned requirements, but has different electrical characteristics, he shall bear all costs associated with that substitution including, but not limited to, breakers, fuses, disconnects, wiring, conduits, panels, starters, contactors, and the like. All electrical connections shall be coordinated with the Engineer and with the electrical subcontractor.
- C. Substitutions: Substitutions of specified items will be considered until 10 days prior to bid opening. Each request shall include a description of the proposed substitute, the name of material or equipment for which it is to be substituted, drawings, cuts, performance and test data for an evaluation and a statement from the equipment manufacturer's representative that the items to be substituted meet or exceed the specifications of the item substituted for.
 1. A request for substitution constitutes a representation that the Contractor:
 - a. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
 - b. Will provide the same warranty for the Substitution as for the specified Product.
 - c. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.

- d. Waives claims for additional costs or time extension which may subsequently become apparent.
- e. Will reimburse Owner [and Architect/Engineer] for review or redesign services associated with re-approval by authorities.

2. The Engineer will notify Contractor in writing of decision to accept or reject request.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver Products to the project in manufacturer's original shipping packaging, properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Acceptance at Site: Comply with the following requirements:
 - 1. Inspect shipments and immediately report any damage to the carrier and to the Construction Manager so that job progress will not be delayed.
 - 2. All items received by the Contractor shall be left in their original containers, or as shipped with dust caps, packing materials, and weather proof covers until installed in final locations.
- C. Storage and Protection: During construction maintain all delivered materials and equipment in an orderly manner and protect from damage by complying with the following minimum requirements:
 - 1. Products stored outside or in unheated spaces shall be covered with waterproof drop cloths or tarpaulins, and provided with blocking to raise the base of each item at least 6 inches above ground and water levels.
 - 2. Store electrical items that would be damaged by cold weather or condensation in a heated, enclosed space until placed into service.
 - 3. Products stored inside shall be protected from dirt, construction debris, welding and cutting spatters, paint dropping etc. either by original packaging or Contractor provided covers.
 - 4. All installed materials and equipment shall be in a like new condition. Damaged equipment or materials shall be repaired to like new conditions or replaced at no cost to the Owner.

1.9 SEQUENCING AND SCHEDULING

- A. Carefully examine the drawings and specifications of all other trades. Coordinate all work with other disciplines to avoid conflicts and delay of installation schedule.
- B. The Contractor shall install plumbing work so as not to interfere with the work of other disciplines or trades. If work is installed that does interfere, the work shall be corrected at no additional cost to the Owner. Occupation of a work space by any trade or discipline does not give the right of priority to the space.

- C. Tests: Test requirements shall be as specified in other Division 22 Specification Sections. Provide the Owner's Rep and Engineer 48 hours notification in advance of any test. Engineer, at his option, may witness test. Complete tests prior to insulating or otherwise covering work. Leaks shall be repaired, defective materials replaced, and system shall be retested. Conduct test prior to connecting to equipment or isolate equipment from system.

1.10 UTILITY CONNECTIONS AND PERMITS

- A. Natural Gas: Make arrangements with the gas utility company to provide new meter set, tap, and service from main to meter as applicable.
- B. Water: Make arrangements with the water utility company to provide water service and meter as shown on site plan as applicable.
- C. Sanitary Sewer: Make arrangements with the sewer utility for new sewer tap and service as applicable.
- D. The Contractor shall be responsible for securing and paying for all permits, licenses, clearances and certificates from the Owner and local authorities having jurisdiction as required prior to the commencement of the work.
- E. Prior to any cutting or trenching, verify with Owners rep., utility companies, and landlord that all available information is known regarding underground obstructions. Take caution when trenching not to disturb any existing utilities. Notify Owners representative immediately upon uncovering unknown utilities for further direction.

1.11 COMPLETION OF WORK

- A. Execute final cleaning prior to final inspection.
- B. Final Cleaning: Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- C. Clean construction debris from roof.
- D. Remove waste and surplus materials, rubbish, and construction facilities from the site.
- E. Contractor to provide start-up and commissioning services for all new systems and equipment, as well as training services for the Owner's maintenance personnel in the use of these systems and equipment. Adjust operating products and equipment to ensure smooth and correct operation.
- F. At the completion, an inspection shall be made and the entire system shall be shown to be in specified working condition. The following shall be available during the inspection:
 1. Owner's Representative.
 2. Contractor representative.

3. Mechanic with hand tools, ladder and flash light.
4. Complete specifications and drawings with all addenda and revisions.

1.12 GUARANTEE AND WARRANTIES

- A. **Warranties:** Provide manufacturer's equipment warranties prior to final inspection. Length of warranty period shall be as specified in individual Division 22 Specification Sections.
- B. **Guarantee:** All equipment and materials furnished and all work performed under this Division of specifications shall be guaranteed to be free of defective materials and workmanship for a period of one year from the date specified in A above. Upon notice from the Owner of failure of any part of the guaranteed equipment during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.

1.13 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 1. Drawings.
 2. Specifications.
 3. Addenda.
 4. Change Orders and other modifications to the Contract.
 5. Reviewed Shop Drawings, Product Data, and Samples.
 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. **Contract Close-Out Record Documents:** Prepare construction record documents indicating the following installed conditions:
 1. Mains and branches of piping systems, with valves and control devices located, concealed unions located, locations of flexible pipe connectors, expansion joints, anchors, and guides, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Indicate actual invert and horizontal locations of underground piping. Record actual locations of storage tanks, fire extinguishing components and equipment, equipment identification markings, conduit and piping routing details.
 2. Equipment locations (exposed and concealed), identification, dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.14 MAINTENANCE DOCUMENTS AND INSTRUCTIONS

- A. Maintenance Training: After placing systems in operation, provide 2 members of Owner's maintenance staff with 40 hours of operation and maintenance training for all systems included in this Section of specifications.
- B. Maintenance Manuals: Operating and Maintenance Manuals shall be prepared by the Contractor and submitted in .pdf format to the Engineer and Owner for approval. Each manual shall contain the following information, data and drawings:
 1. List of contents. Insert under front cover.
 2. Copy of approved submittals, equipment, and materials.
 3. Installation, operating, and maintenance instructions for each item of equipment.
 4. Wiring schematics for each item of equipment.
 5. Manufacturer's list of renewal parts for each item of equipment with recommended stock items and quantities indicated.
 6. Manufacturer's equipment warranties.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION

3.1 ASBESTOS

- A. No asbestos containing materials shall be used in any of the new construction.

3.2 DEMOLITION

- A. General: Provide demolition of existing plumbing work in remodeled areas of the existing building and as described on the drawings. Dispose of removed equipment and materials in a way to maximize recycling content. In addition to work indicated on drawings, demolition includes, but is not necessarily limited to, the following:
 1. Removal of all abandoned piping, supports, equipment, control wiring, etc.
 2. Capping and plugging of piping where demolition begins.
- B. Salvage Equipment and Materials: Existing equipment and materials designated for salvage back to the Owner or reinstallation shall be tested for proper operation prior to removal from its installed location. After removal, salvage equipment found defective shall be removed from the Owner's property at no extra cost to the Owner. Salvage equipment found in good working order shall be turned over to the Owner's agent. Defective equipment designated for reinstallation shall be repaired or replaced per bid alternate pricing for repair/replace of existing equipment. Equipment found in good

working order, or repaired, and scheduled for reinstallation shall be cleaned, serviced, and stored at Contractor's expense until it is again installed in the building.

3.3 ROUGH-IN

- A. Final Locations: Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected. Coordinate plumbing systems, equipment, and materials installation with other building components.
- B. Prepare for Installation: Arrange for chases, slots, and openings in other building components during progress of construction, to allow for plumbing installations. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- C. Deviation From Drawings: Drawings are schematic and show approximate location of equipment and materials, however, the Contractor shall obtain the Engineer's/Architect's approval before deviating from the drawings. Written dimensions shall take precedence over scaled dimensions.

3.4 PLUMBING INSTALLATIONS

- A. General: Installation shall be as specified in individual Division 22 Specification Sections and in accordance with approved manufacturer's installation instructions. Conflict between manufacturer's printed instructions and these specifications shall be brought to the attention of the Engineer/Architect.
- B. Equipment: All equipment installed on this project shall be new and unused unless noted otherwise. The Contractor shall remove all shipping labels, dirt, paint spots, grease, and stains from all equipment. Debris shall be removed as it accumulates. Upon completion of his work, the Contractor shall clean all equipment. No loose parts or scraps of equipment shall be left on the premises.
- C. Installation: Install systems, materials, and equipment to conform to approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
 - 1. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
 - 2. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
 - 3. Coordinate connection of plumbing systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations,

- franchised service companies, and controlling agencies. Provide required connection for each service.
4. Install systems, materials, and equipment level and plumb parallel and perpendicular to other building systems and components, following the building lines, where installed exposed in finished spaces.
5. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
6. Provide access panels or doors where units are concealed behind finished surfaces.
7. Install isolation valves at all cold and hot water piping branch taps.

D. Cleaning: Comply with the following cleaning requirements:

1. Upon completion of installation, piping, ducts, and equipment shall be thoroughly cleared of dirt, grease, rust and oil, primed where necessary, and left ready for painting. Vacuum clean the inside and outside of plenums and equipment cabinets.
2. Clean gages, thermometers, traps, strainers, fittings, and lavatory aerators.

E. Painting and Finishing: Comply with the following finishing requirements:

1. Contractor shall clean, spot prime with zinc chromate and entirely repaint, with original color any factory finished equipment which has rusted or been damaged.
2. Insulation coverings shall be cleaned, sized if necessary, and left ready for service identification.
3. Ferrous metal shall be cleaned and primed, ready for painting.

F. Lubrication and Packing: Comply with the following requirements:

1. Lubricate equipment with correct grade, type, and quantity of lubrication before placing equipment into service. Damages caused by not providing proper lubrication shall be repaired at Contractor's expense.
2. Each shaft or valve stem containing a packing gland shall be checked for condition and examined for proper grade, amount, and type of packing by backing packing gland off.
3. Maintain all lubrication and packing seals during construction, and assure that all are operating properly at the time of final acceptance. Replace worn gaskets and packing.
4. When filling systems initially for hydrostatic pressure tests, adjust valve packing glands to finger tight, and allow packing to absorb water for five minutes prior to tightening packing nuts.
5. All rotating pieces of equipment shall be properly lubricated prior to start-up. Damage to shafts, bearings, seals, etc., caused by lack of proper lubrication or over lubrication shall be repaired by the Contractor at no cost to the Owner.

3.5 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 01 – General Requirements. In addition to the requirements specified in Division 01 Specification Sections, the following requirements apply:

1. In new construction areas, avoid cutting of concrete, masonry, and other finished work by use of sleeves and inserts.
2. Any cutting thru structural members or floors shall first be coordinated with the structural Engineer.
3. Cut holes through concrete, brick, tile, etc., when necessary, by rotary core drilling.
4. During cutting and patching operations, protect adjacent installations.
5. Perform at no expense to the Owner, cutting, fitting, and patching of plumbing equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.
 - c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Engineer, uncover and restore Work to provide for Architect's/Engineer's observation of concealed Work.
6. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
7. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
8. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched. Repaired or patched surface finishes and components will match existing finishes. Use new materials.
9. All new wall and floor penetrations shall be made at 90 degree angles, unless shown otherwise, and shall be sealed fireproof with an approved sealant. All penetrations through fire-rated construction shall be sealed with UL 1479 listed through-penetration firestop systems.
10. All roof penetrations are to comply with Owners roofing Contractors and/or roofing insurance requirements.

3.6 EXCAVATION, TRENCHING AND BACKFILL

A. Excavation (See Divisions 00 and 01 for special requirements related to excavation and trenching.):

1. The Plumbing subcontractors shall perform all excavations of every description, for their particular installations and of whatever substances encountered, to the depths indicated on the Drawings and/or required for the installation of piping, conduit, utility systems, etc. All exterior lines shall be installed with a minimum

cover of 24", unless otherwise indicated. Generally, more cover shall be provided if grade will permit. All excavation materials not required for backfill or fill shall be removed and wasted as acceptable to the Construction Inspector. All excavations shall be made only by open cut. The banks of trenches shall be kept as nearly vertical as possible and where required, shall be properly sheeted and braced. Trenches shall be not less than 12" wider nor more than 16" wider than the outside edges of the pipe to be laid therein, and shall be excavated true to line so that a clear space not less than 6" nor more than 8" in width is provided on each side of the pipe. For sewers, the maximum width of trench specified applies to the width at and below the level may be made as wide as necessary for sheeting and bracing, and the proper installation of the work.

2. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length, except for portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints. Bell holes shall be dug after the trench bottom has been graded. Where inverts are not shown, grading shall be determined by the National Plumbing Code for the service intended and the size used. Bell holes for lead pipe joints shall be 12" in depth below the trench bottom and shall extend from a point 6" back of the face of the bell. Such bell holes shall be of sufficient width to provide ample room for caulking. Bell holes for sewer tile and water pipe shall be excavated only to an extent sufficient to permit accurate work in the making of the joints and to insure that the pipe, for a maximum of its length, will rest upon the prepared bottom of the trench. Depressions for joints other than bell-and-spigot shall be made in accordance with the recommendations of the joint manufacturer for the particular type of joint used. In general, grading for electrical ductbanks and conduits shall be from building to manhole, and from a high point between manholes to each manhole. Special pipe beds shall be provided as specified hereinafter.
3. The lower 4" of the pipe trenches measuring from an overhead line set parallel to the grade line of the sewer shall be excavated only a few feet in advance to the pipe laying, by men especially skilled in this type of work. Where damage is likely to result from withdrawing sheeting, the sheeting shall be left in place. Except at locations where excavation of rock from the bottom of trenches is required, care shall be taken not to excavate below the depths required. Where rock excavation is required, the rock shall be excavated to a minimum overdepth of 6" below the trench depths specified. The overdepth rock excavation and all excess trench excavation shall be backfilled with sand. Whenever wet or otherwise unstable soil is incapable of properly supporting the pipe is encountered in the trench bottom, such soil shall be removed to a depth and for the trench lengths required, and then backfilled to trench bottom grade, as hereinafter specified, with sand.

4. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the job site as directed by the Construction Inspector.
5. All shoring and sheeting required to perform and protect the excavations and to safeguard employees and/or adjacent structures shall be provided.
6. Excavate as required under the building in order that all piping, ductwork, etc., shall clear the ground a minimum of 12" for a distance of 24" on either side. Edges of such excavations shall slope at an angle of not over 45 degrees with the horizontal unless otherwise approved by the Construction Inspector. The bottom of such excavation shall be graded to drain in a manner acceptable to the Construction Inspector.
7. Trenches for cast iron drain, storm water and sewer lines inside the building shall be properly excavated, following, in general, the procedures set out for exterior lines. Where floors are to be poured over these lines, they shall be backfilled, tamped and settled with water. Where no flooring is to cover the lines, they shall be backfilled to form a level grade.
8. All surplus materials removed in these trenching operations becomes the property of the Contractor, and shall be disposed of at the expense of the Contractor, at a legal disposal site, off of the campus.

B. Backfilling:

1. Trenches shall not be backfilled until all required tests are performed and until the piping, utilities systems, etc., as installed are certified by the Owner's inspector to conform to the requirements specified hereinafter. The trenches shall be carefully backfilled with sand to a depth of 12 inches above the top of the pipe. The next layer and subsequent layers of backfill may be excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand and gravel, soft shale, or other approved materials free from large clods of earth or stones larger than 1 1/2" in diameter, flooded until the pipe has cover of not less than one foot. The remainder of the backfill material shall then be thrown into the trenches, moistened, and tamped or flooded in one foot layers. Blasted rock, broken concrete or pavement, and large boulders shall not be used as backfill material. Any trenches improperly backfilled, or where settlement occurs, shall be reopened to the depth required for proper compaction, then refilled and mounded over, and smoothed off.

2. Backfill under concrete slabs-on-fill shall be as specified above, shall be gravel, or shall be other such materials more suitable for the application. Installation and compaction shall be as required for compatibility with adjacent materials.
- C. Opening and Re-closing Pavement and Lawns: Where excavation requires the opening of existing walks, streets, drives, other existing pavement, or lawns, such surfaces shall be cut as required to install new lines and to make new connections to existing lines. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched, using materials to match those cut out. The patches shall thoroughly bond with the original surfaces and shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas.
- D. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5 ft. to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Construction Inspector before they are cut or damaged in any way. The Construction Inspector will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.

3.7 SAMPLE SUBMITTAL FORMS

A. Sample Electrical Coordination Form

SAMPLE
CONTRACTOR COMPANY NAME
HVAC/ELECTRICAL DATA SHEET or PLUMBING/ELECTRICAL DATA SHEET
JOB TITLE
JOB LOCATION

Nameplate Data (Mechanical/Plumbing Contractor to provide this portion)					Electrical Power Distribution (Electrical Contractor to provide this portion)				
Unit Tag	Volts	Phase	Minimum circuit amps, KW, or HP	MOCPD* (maximum over current protective device)	Maximum fuse size (if req'd)	Panel Tag	Circuit Number	Circuit Breaker Amps and Poles**	Integral Disconnect Yes or No

* MOCPD as listed per equipment manufacturer submittal data

** Must comply with equipment manufacturer submittal data

plumbing Contractor Name & Signature: _____

Electrical Contractor Name & Signature: _____

General Contractor Name & Signature: _____

END OF SECTION

SECTION 22 10 00 - PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Pipe and pipe fittings for the following systems:
 - 1. Domestic water piping within 5 feet of building.
 - 2. Sanitary sewer piping within 5 feet of building.
 - 3. Unions and flanges.
 - 4. Underground pipe markers.
 - 5. Bedding and cover materials.
- B. Related Sections:
 - 1. Section 220700 - Plumbing Insulation: Product requirements for piping insulation for placement by this section.
 - 2. Section 310513 - Soils for Earthwork: Soils for backfill in trenches.
 - 3. Section 310516 - Aggregates for Earthwork: Aggregate for backfill in trenches.
 - 4. Section 312316 - Excavation: Product and execution requirements for excavation and backfill required by this section.
 - 5. Section 312317 - Trenching: Execution requirements for trenching for underground piping systems.
 - 6. Section 312323 - Fill: Execution requirements for backfilling required by this section.
 - 7. Section 331116 - Site Water Utility Distribution Piping: Product and execution requirements for domestic water piping outside building.
 - 8. Section 331213 - Water Service Connections: Product and execution requirements for domestic water piping outside of building.
 - 9. Section 333100 - Sanitary Utility Sewerage Piping: Product and execution requirements for sanitary waste piping outside of building.
 - 10. Section 334100 - Storm Utility Drainage Piping: Product and execution requirements for storm water piping outside of building.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
 - 2. ASME B16.3 - Malleable Iron Threaded Fittings.
 - 3. ASME B16.4 - Gray Iron Threaded Fittings.
 - 4. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 5. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 6. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
 - 7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
 - 8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
 - 9. ASME B31.9 - Building Services Piping.
 - 10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.

11. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.

- B. ASTM International:
 1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
 2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
 5. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
 6. ASTM A536 - Standard Specification for Ductile Iron Castings.
 7. ASTM B32 - Standard Specification for Solder Metal.
 8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
 9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
 10. ASTM B75 - Standard Specification for Seamless Copper Tube.
 11. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 12. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
 13. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
 14. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
 15. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
 16. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
 17. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
 18. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 19. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
 20. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 21. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
 22. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 23. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
 24. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameters.
 25. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
 26. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
 27. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
 28. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.

29. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
30. ASTM D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
31. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
32. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.
33. ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
34. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
35. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
36. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
37. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
38. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
39. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
40. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
41. ASTM D2996 - Standard Specification for Filament-Wound Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
42. ASTM D2997 - Standard Specification for Centrifugally Cast Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
43. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
44. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
45. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
46. ASTM D3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
47. ASTM D3517 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe.
48. ASTM D3754 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
49. ASTM D3840 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.
50. ASTM F437 - Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
51. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
52. ASTM F439 - Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
53. ASTM F441/F441M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

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54. ASTM F442/F442M - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
55. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
56. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
57. ASTM F628 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core.
58. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
59. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe.
60. ASTM F1282 - Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
61. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

C. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
2. AWS D1.1 - Structural Welding Code - Steel.

D. American Water Works Association:

1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
7. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.
8. AWWA C950 - Fiberglass Pressure Pipe.

E. Cast Iron Soil Pipe Institute:

1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.

F. National Fire Protection Association:

1. NFPA 99 - Standard for Health Care Facilities.

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1.3 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information.
- D. Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used. Submit sizing methods and calculations.
- E. Welders' Certificate: Include welders' certification of compliance with ASME Section IX.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Perform Work in accordance with State of Texas, and local authority.
- C. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 013000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

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1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 016000 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 013000 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.

PART 2 - PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Tubing: ASTM B88, Type K, annealed.
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Brazed, AWS A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190 to 1480 degrees F.
- B. PVC Pipe: ASTM D1785, Schedule 80 SDR-21 for 200 psig pressure rating, polyvinyl chloride (PVC) material.
 - 1. Fittings: ASTM D2467, Schedule 80, PVC.
 - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- C. PVC Pipe: AWWA C900 Class 150, polyvinyl chloride (PVC) material.
 - 1. Fittings: AWWA C110, ductile iron, standard thickness.
 - 2. Joints: ASTM D3139 compression gasket ring.

2.2 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Soil Pipe: ASTM A74, extra heavy weight, bell and spigot ends.
 - 1. Fittings: Cast iron, ASTM A74.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. ABS Pipe: ASTM D2751, SDR 42, Acrylonitrile-Butadiene-Styrene (ABS) material, bell and spigot style solvent sealed ends.
 - 1. Fittings: ABS, ASTM D2751.
 - 2. Joints: ASTM D2235, solvent weld.
- C. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.

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1. Fittings: PVC, ASTM D2729.
2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

D. PVC Pipe: ASTM D3034 SDR 35, polyvinyl chloride (PVC) material.

1. Fittings: ASTM D3034, PVC.
2. Joints: ASTM F477, elastomeric gaskets.

E. PVC Pipe: ASTM D1785, Schedule 40, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed joint ends.

1. Fittings: ASTM D2466, Schedule 40, PVC
2. Joints: ASTM D2855, solvent weld with ASTM D2564 Solvent cement.

F. Copper Tube: ASTM B306, DWV Type K.

1. Fittings: ASME B16.23, cast bronze, or ASME B16.29 wrought copper.
2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.

2.3 UNIONS AND FLANGES

A. Unions for Pipe 2 inches and Smaller:

1. Ferrous Piping: Class 150, malleable iron, threaded.
2. Copper Piping: Class 150, bronze unions with brazed joints.
3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
4. PVC Piping: PVC.
5. CPVC Piping: CPVC.

B. Flanges for Pipe 2-1/2 inches and Larger:

1. Ferrous Piping: Class 150, forged steel, slip-on flanges.
2. Copper Piping: Class 150, slip-on bronze flanges.
3. PVC Piping: PVC flanges.
4. CPVC Piping: CPVC flanges.
5. Gaskets: 1/16 inch thick preformed neoprene gaskets.

C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

2.4 UNDERGROUND PIPE MARKERS

A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Domestic Water Service, Sewer Service in large letters.

2.5 BEDDING AND COVER MATERIALS

A. Bedding: Fill Type A1, A2, A3, A4 as specified in Section 310516.

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- B. Cover: Fill Type A1, A2, A3, A4 as specified in Section 310516.
- C. Soil Backfill from Above Pipe to Finish Grade: Soil Type S1, S2, as specified in Section 310513. Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify excavations are to required grade, dry, and not over-excavated.
- C. Verify trenches are ready to receive piping.

3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to existing piping system size, location, and invert are as indicated on Drawings.
- B. Establish elevations of buried piping with not less than two ft of cover.
- C. Excavate pipe trench in accordance with Section 312317.
- D. Install pipe to elevation as indicated on Drawings.
- E. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- F. Install pipe on prepared bedding.
- G. Route pipe in straight line.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.

- I. Install plastic ribbon tape continuous over top of pipe buried 6 inches below finish grade, above pipe line; coordinate with Section 312323, 312317. Refer to Section 220553.
- J. Pipe Cover and Backfilling:
 1. Backfill trench in accordance with Section [312323.] <_____>.
 2. Maintain optimum moisture content of fill material to attain required compaction density.
 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in [4] [6] inches compacted layers to [6] [12] inches minimum cover over top of jacket. Compact to [95] <_____> percent maximum density.
 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
 5. Do not use wheeled or tracked vehicles for tamping.

3.4 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

- A. Install domestic water piping system in accordance with ASME B31.9.

3.5 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

- A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.
- B. Install bell and spigot pipe with bell end upstream.
- C. Support cast iron drainage piping at every joint.

3.6 FIELD QUALITY CONTROL

- A. Section 014000 - Quality Requirements and 017000 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test domestic water piping system in accordance with applicable code and local authority having jurisdiction.
- C. Test sanitary waste and vent piping system in accordance with applicable code and local authority having jurisdiction.

3.7 CLEANING

- A. Section 017000 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean and disinfect domestic water distribution system in accordance with Section 221100 and 331300.

END OF SECTION 22 10 00

SECTION 26 00 00 - ELECTRICAL GENERAL REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes general electrical work requirements, such as:
 - 1. Summary of Scope of Work
 - 2. Submittal, qualifications, quality assurance, & warranty requirements
 - 3. Storage and handling requirements
 - 4. Coordination requirements
 - 5. Safety requirements
 - 6. Shoring and supporting requirements
 - 7. Temporary construction power and lighting
- B. The scope of work shall include complete provisions for electrical power distribution to all lighting, devices, appliances, and equipment shown on the construction documents.
 - 1. Provisions include, but are not limited to, all supplies, materials, equipment, tools, and labor.
 - 2. Provisions also include all miscellaneous materials required to complete the work shown including, but not limited to, supports, hangers, raceways, boxes, sleeves, seals, equipment pads, wiring connectors, terminals, labels, signs, and markers
 - 3. The construction documents include all plans, elevations, details, diagrams, schedules, and notes on the drawings and the written specifications including any items mentioned in either the specifications or on the drawings but not in the other.
 - 4. Where used on the plans and in the specifications and where not specifically noted otherwise, the term "provide" and the term "install" shall mean furnish, install, connect, and test.
 - 5. Unless explicitly noted "by others" or "existing", all items shown graphically or specified by notes and details on the plans shall be furnished, installed, connected, and tested as needed.
- C. In addition to the general scope described above, the work shall include:
 - 1. Application for temporary and permanent electrical service, Permitting, Inspection, and payment of all associated fees.
 - 2. Testing and Commissioning.
 - 3. Equipment rental.
 - 4. Temporary construction power and lighting. GFCI receptacles shall be used for all construction power.
 - 5. Provisions for maintaining the functionality of existing to remain building communications, fire alarm, security/access control, public address, and bell systems that will be affected by the work.
- D. The intent of the drawings and specifications is to set forth the general requirements and equipment necessary for the functioning of the electrical system. The drawings and specifications do not provide a complete list of materials and work required. All miscellaneous electrical

components required by good practice and workmanship for the complete installation of the electrical system shall be provided by the contractor.

E. The electrical contractor shall be responsible for all controls raceways, where required, and boxes to serve devices and equipment shown or described on the construction documents even where such devices and equipment will be provided by a specialist contractor and/or a contractor working directly for the owner such as communications, fire alarm, HVAC controls, security/access control.

1. Unless noted otherwise, all control wiring shall be by specialist contractor.
2. Electrical contractor shall be responsible for 120 through 480V power required for controls systems such as fire alarm panels and extension panels, server racks, HVAC equipment 120V control and maintenance circuits, etc.

F. Related Sections:

1. This and all other division 26 specifications, the construction drawings, general contract provisions, and division 1 specifications shall be considered collectively as the total general requirements for the electrical equipment and electrical system installation and all special systems shown or described on the electrical or "E series" sheets.

1.2 REFERENCES

A. Materials, equipment, and the work performed shall comply with current requirements, rules and regulations of and, where applicable, be certified by the following standards, codes and organizations:

1. American National Standards Institute (ANSI)
2. American Society for Testing and Materials (ASTM)
3. Americans with Disabilities Act (ADA)
4. ASHRAE/IES 90.1
5. Institute of Electrical and Electronics Engineers (IEEE)
6. IEEE C2(2007; Errata 2007; INT 2008) National Electrical Safety Code
7. IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
8. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms
9. National Electrical Manufacturer's Code (NEMA)
10. NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
11. National Fire Protection Associations (NFPA)
12. NFPA 70 National Electrical Code - 2020 Edition
13. Underwriter's Association (UL)
14. NEC and associated amendments
15. IECC and associated amendments
16. Where discrepancies are found between the requirements of these standards codes, ordinances, regulations and the drawings and specifications, the contractor should notify the engineer prior to installation. Installed work that fails to comply with the requirements of the above shall be replaced at contractor's expense.

1.3 DEFINITIONS

- A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.
- B. The technical sections referred to herein are those specification sections that describe products, installation procedures, and equipment operations and that refer to this section for detailed description of submittal types.
- C. The technical paragraphs referred to herein are those paragraphs in PART 2 - PRODUCTS and PART 3 - EXECUTION of the technical sections that describe products, systems, installation procedures, equipment, and test methods.

1.4 SUBMITTALS

- A. Submittal requirements shown here shall be used in conjunction with the requirements of the other specification sections. Where in conflict, the more stringent requirements shall apply.
- B. Submit the following:
 - 1. Permitting, inspection, and final acceptance certifications from the authority having jurisdiction.
 - 2. A contractor prepared drawing of the electrical rooms showing dimensioned electrical equipment and house keeping pad locations.
 - 3. A contractor prepared drawing of the site indicating the routing of site service conduits for power and special systems as well as feeder conduits over 2" in diameter.
- C. For each product required to be submitted, provide the following
 - 1. Product Data: Submit catalog data showing manufacturer's name and contact information, all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
 - a. Include amperage and voltage ratings, over-current protective device ratings, AIC ratings, etc
 - b. Where multiple sizes are listed, indicate sizes to be used.
 - c. Where multiple products are shown on the same page, indicate which products to be used.
 - 2. Shop Drawings (where applicable): Manufacturer or contractor prepared drawings showing all relevant dimensions, weights, electrical and mechanical connection requirements, conduit entry points, assembly requirements, lifting requirements, lifting points, and required clearances.
 - a. Include dimensioned plan views and elevations.
 - b. Include all relevant electrical diagrams including schematic and interconnection diagrams for power, signal, and control wiring.
- D. Submittals shall be organized by specification section, provided with a table of contents, and a cover page with all pertinent project information including contractor's name and contact information, project name and number, and specification sections submitted.

- E. All submittals shall be submitted in PDF format.
- F. Rejected submittals shall be resubmitted within two weeks of notification of rejection.
- G. Any equipment covered by **division 26** specifications that is installed by the contractor without submittal approval and is not in compliance with the appropriate specifications shall be replaced at the contractor's expense.
- H. As-Built Record Drawings: The Contractor shall maintain a master set of As-Built Record Drawings that show changes and any other deviations from the drawings. The markups must be made as the changes are done. At the conclusion of the job, these As-Built Record Drawings shall be transferred to AutoCAD electronic files, in a format acceptable to the Owner, and shall be complete and delivered to the Owner's Representative prior to final acceptance.

1.5 CLOSEOUT SUBMITTALS

- A. At the end of construction, provide a closeout submittal containing the following information in addition to items specified in other sections.
 - 1. As built drawings showing the actual locations of installed equipment, site raceways and boxes, and feeders rated 100A or more and concealed behind walls or in slabs.
 - 2. Operation and Maintenance data
 - 3. Shop Drawings
 - 4. Test results
 - 5. Actual circuit arrangements at panels and equipment. Provide complete, typed as built of all panel schedules.
- B. Operation and Maintenance Data: At the end of construction, provide the owner with both an 8.5x11 bound manual and an electronic copy of PDF files including the following information:
 - 1. Provide product data as defined under submittals.
 - 2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
 - 3. Spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.
- C. Shop Drawings: At end of construction, provide owner with a final draft, new copy of all shop drawings that were field modified after the original submittal was approved.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products shown on the construction documents with minimum three years documented experience.
 - 1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.
- B. Supplier: Authorized distributor
- C. Installer: A state licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications, required by

code, or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.7 QUALITY ASSURANCE

- A. Inclusion of specific products in these specifications and on the plans, does not mean that said products may be used for all applications in all environments. Products may only be used where approved either in the specification installation requirements sections or on the plans. Where the construction documents do not explicitly state what products are acceptable for an application, the most robust products specified are assumed to be the minimum requirement.
- B. Regulatory Requirements
 - 1. The contractor shall comply with the requirements of all laws, rules, regulations, code and ordinances that have been adopted by the federal, state, and local authorities having jurisdiction (AHJ). All equipment, materials, means and methods shall be acceptable to the AHJ's.
 - 2. Electrical installations shall conform to IEEE C2, NFPA 70, local codes and specified requirements herein. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.
 - 3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. Standard Products
 - 1. Unless otherwise approved, all equipment shall be new, properly designed, from a reputable manufacturer meeting the specification qualifications, in compliance with the specification requirements, and in full working order.
 - 2. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
 - 3. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.
 - 4. Products shall have been in satisfactory commercial or industrial use prior to bid opening. The minimum time of use shall be 2 years. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. Longer periods may be specified for specific products. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
- D. Alternative Qualifications
 - 1. Products having less than a 2-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

- E. Material and Equipment Manufacturing Date
 - 1. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.
- F. All equipment used for testing shall be in full working order and calibrated per the manufacturer's recommendations.

1.8 WARRANTY

- A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.9 COORDINATION

- A. All power outages shall be coordinated in writing with the owner a minimum of one (1) week prior to the outage.
- B. If the owner will occupy any portion of the facility during any period of construction, cooperate fully with the owner or his representative during construction operations to minimize conflicts and to facilitate owner usage so as not to interfere with the owner's operations.
- C. The drawings are diagrammatic. They do not show switches, power and data outlets, special systems components (FA, Access Control, AV, etc), electrical equipment, equipment connections, required raceways, etc. in their exact dimensioned locations. The contractor must carefully review the architectural, structural, mechanical, plumbing, fire protection, and special systems plans to identify conflicts and areas that require coordination.
- D. Coordinate electrical and special systems equipment rough in with millwork, signs, mechanical and plumbing systems, sprinkler systems, architectural and structural elements, and the owner's representative. Minor changes in electrical equipment locations and layout that are required by site conditions or order by the design team prior to performance of work shall be made by the contractor without additional charges to the owner.
- E. Maintain required NEC working space and dedicated equipment spaces around all electrical equipment, control panels, etc that are subject to maintenance, testing, or user interface. Coordinate with other trades prior to installation. If clearance cannot be provided, the contractor shall notify the engineer prior to rough-in.
- F. Coordinate color selections for luminaires and all device plates with architect.
- G. Contractor shall be responsible for field coordinating with other trades.
- H. Coordinate arrangement, mounting, and support of electrical equipment:
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at required slope.

4. So, connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
5. To allow for the appropriate installation of furniture and equipment relative to receptacles and switches.

- I. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- J. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed.
- K. Coordinate sleeve selection and application with architect and structural engineer.
- L. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- M. Determine connection locations and requirements.
- N. Sequence rough-in of electrical connections to coordinate with installation of equipment.
- O. Sequence electrical connections to coordinate with start-up of equipment.

1.10 DELIVERY STORAGE AND HANDLING

- A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.
- B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

1.11 SAFETY

- A. The Contractor shall follow all industry standard safety procedures in addition to the requirements of the owner's Project Safety Manual (PSM).
 1. The Contractors shall be responsible for training all personnel under their employ in areas concerning safe work habits and construction safety. The Contractor shall continually inform personnel of hazards particular to this project and update the information as the project progresses.
 2. The Contractor shall secure all electrical rooms, to limit access, prior to energizing any high voltage switchgear and shall control access during the project after energization. The Contractor shall post and maintain warning and caution signage in areas where work is on going near energized equipment. The Contractor shall cover all energized live parts when work is not being done in the equipment. This includes lunch and breaks.
 3. The Contractor shall strictly enforce OSHA lock out/tag out procedures. Initial infractions shall result in a warning; a second infraction shall result in the removal of the workman and his foreman from the site. Continued infractions shall result in removal of the Contractor from the site.

1.12 SHORING AND EQUIPMENT SUPPORTS

- A. Provide all permanent and temporary bracing, anchoring, supports, and shoring required to firmly stabilize and secure all raceways, boxes, enclosure, equipment, and devices.
- B. Provide free standing racks to support equipment. Racks shall be securely bolted to the floor, wall, and or ceilings. Where secured to only one surface, provide angle bracing so that racks have a minimum of 4 attachment points.
- C. Provide concrete housekeeping pads for floor mounted electrical equipment. Coordinate with flooring contractor for installation.
 - 1. 3000PSI, with rebar reinforcement.
 - 2. Provide dowels for connection to new or existing adjacent slabs
 - 3. Pad shall be 4" thick and protrude a minimum of 1" beyond the edge of equipment.
 - 4. Chamfer top edges of slab

1.13 TEMPORARY CONSTRUCTION POWER AND LIGHTING

- A. Provide temporary power service per utility company specifications
 - 1. Contractor shall be responsible for securing permits and coordinating temporary service with utility provider.
 - 2. Provide temporary power service pole per utility company specifications.
 - 3. Provide service feeder from temporary service point to construction trailers and power distribution assemblies to serve power tools and construction equipment.
- B. Provide panel or assembly containing GFCI receptacles for power tools to be used on site.
- C. Provide temporary power cables neatly trained and protected from damage.
- D. Provide temporary lighting throughout area of construction. Install at ceiling level out of way of construction work.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Equipment to be installed outdoors, in corrosive or hazardous environments shall be rated for the intended use.
- B. Compliance with the requirements of the contract documents shall not relieve the contractor of the responsibility of providing equipment that is new, properly designed, from a reputable manufacturer, and in full working order.
- C. If conflicts occur between the specifications and drawings, the higher quality, price or quantity shall be provided and installed.

- D. If there is any question as to quality, size or quantity necessary, the contractor shall provide a written request for clarification from the Engineer. Contractor shall be responsible for any additional expenses incurred as a result of the contractor's failure to obtain clarification.
- E. Detailed product specifications are included in other specification section and on the plans.

2.2 FINISHES

- A. Electrical equipment shall have factory-applied painting systems which shall, as a minimum, meet the requirements of NEMA 250 corrosion-resistance test.
- B. Raceways, boxes, supports, etc. shall be galvanized: gold, silver, or hot dipped, unless noted otherwise.
 - 1. Do not use pre-galvanized products that are formed, cut, or punched after galvanization.
 - 2. Do not use hot dip galvanized threaded products.

2.3 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time,

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.2 FIELD PROGRAMMING

- A. Electrical contractor shall be responsible for the coordination and payment of programming for all programmable devices and equipment including, but not limited to, lighting controls, circuit breakers, interfaces with building automation system, power monitoring equipment, etc.
- B. Where required, the manufacturer of the product shall be engaged to perform the programming.

3.3 EXAMINATION

- A. If a conflict is found between the specification and plans, notify the Architect or Engineer of the conflict.
- B. Verify equipment is ready for electrical connection, for wiring, and to be energized.
- C. Verify existing conditions are as shown on the plans and that adequate space is available for the equipment for installation.

3.4 INSTALLATION

- A. The installation requirements shown here are general scope requirements. More detailed information is provided for each of these topics in other specifications and on the plans.
- B. No foreign systems such as piping, duct work, etc shall be installed above electrical equipment.
- C. Grounding and Bonding
 - 1. All circuits shall be provided with NEC compliant green ground conductor sized per NEC 250, UNO.
 - 2. All equipment shall be properly bonded.
 - 3. Provide grounding electrodes as specified on plans and as required by code.
- D. Raceways, Boxes and Enclosures
 - 1. Where noted, provide complete raceway systems from source to all loads with dedicated supports for each raceway element.
 - 2. Provide all required back boxes and supports for wiring devices, telecommunications, fire alarm, access control, controls equipment, alarms, sensors, etc.
 - 3. Provide pull box at appropriate locations for all power and special systems raceways whether shown on plans or not.
 - 4. Low voltage cabling may be run without raceways where noted and permitted. All wiring shall be properly supported with J-hooks or other appropriate method. Specialist contractor will be responsible for all supports
- E. Electrical connections and terminations.
 - 1. Make all connections and terminations within the power distribution system and between the distribution system and the equipment served.
 - 2. Make conduit connections to vibrating equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
 - 3. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
 - 4. Provide calibrated torque wrenches and screwdrivers and tighten terminals, lugs and bus joints using it.
- F. Equipment wiring requirements
 - 1. Install disconnect switches, controllers, control stations, and control devices as required for equipment.
 - 2. Install terminal block jumpers to complete equipment wiring requirements.
 - 3. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
 - 4. Install control wiring to interlocks, sensors, and remote operator interfaces provided with equipment such as generators, roll-up doors, dock levelers, etc
- G. Identification
 - 1. Provide appropriate labels for all equipment, wiring devices, conductors, cables, box, and enclosures
 - 2. Provide warning signs for electrical equipment and buried circuits.

H. Code and manufacturer requirement compliance

1. Install work in compliance with the latest edition of the NEC, City and Owner design criteria manuals, and the authority having jurisdiction.
2. Apply, install, connect, erect, use, clean, adjust, and condition materials and equipment as recommended by the manufacturers in their published literature.
3. All terminals, lugs and bus joints shall be tightened per the manufacturer's torque recommendations.

I. Arrangement and planning

1. Arrange electrical work in neat, well-organized manner.
2. Do not block future connection points of electrical service.
3. Install all electrical work parallel or perpendicular to building lines unless noted otherwise, properly supported with purpose-designed apparatus, in a neat manner.
4. Maintain required NEC working space and dedicated equipment spaces around all electrical equipment subject to maintenance, testing, or user interface. Coordinate with other trades prior to installation.
5. Do not block equipment control panels with lighting, raceways, structural elements or other equipment. Orient equipment so that control panels do not face structural elements or other equipment that will restrict access.
6. Coordinate with engineer before installation if any of the above conditions can not be met due to undiscovered site conditions or if locations shown on plans are field determined to be in conflict with equipment and structures called for on other plans.

J. Cutting and Patching

1. Make opening through masonry and concrete by core drilling in acceptable locations. Restore openings to original condition to match remaining surrounding materials.
2. Provide sleeves for penetrations through floors and walls
3. Seal all openings using appropriate materials
4. Where existing conditions are not documented, perform ground penetrating radar scan of structural element to be cut.

END OF DOCUMENT

SECTION 26 05 00 – BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes general electrical materials and methods. Section covers the following specific items.
 - 1. Power Meters
 - 2. Surge Protection Devices
 - 3. Terminal Blocks
 - 4. Lighting Contactors
 - 5. Relays
 - 6. Phase Monitor Relays
 - 7. Push Buttons and Selector Switches
- B. Related Sections:
 - 1. This and all other division 26 specifications, the construction drawings, general contract provisions, and division 1 specifications shall be considered collectively as the total general requirements for the electrical equipment and electrical system installation and all special systems shown or described on the electrical or “E series” sheets.

1.2 REFERENCES

- A. Materials, equipment, and the work performed shall comply with current requirements, rules and regulations of and, where applicable, be certified by the following standards, codes and organizations:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society for Testing and Materials (ASTM)
 - 3. Americans with Disabilities Act (ADA)
 - 4. ASHRAE/IES 90.1
 - 5. Institute of Electrical and Electronics Engineers (IEEE)
 - 6. IEEE C2 (2007; Errata 2007; INT 2008) National Electrical Safety Code
 - 7. IEEE C57.12.28 (2005) Standard for Pad-Mounted Equipment - Enclosure Integrity
 - 8. IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms
 - 9. National Electrical Manufacturer’s Code (NEMA)
 - 10. NEMA 250 (2008) Enclosures for Electrical Equipment (1000 Volts Maximum)
 - 11. National Fire Protection Associations (NFPA)
 - 12. NFPA 70 National Electrical Code - 2020 Edition
 - 13. Underwriter’s Association (UL)
 - 14. Where discrepancies are found between the requirements of these standards codes, ordinances, regulations and the drawings and specifications, the contractor should notify the engineer prior to installation. Installed work that fails to comply with the requirements of the above shall be replaced at contractor’s expense.

1.3 SUBMITTALS

- A. Submittal requirements shown here shall be used in conjunction with the requirements of the other specification sections. Where in conflict, the more stringent requirements shall apply.
- B. Product Data: Submit catalog data showing manufacturer's name and contact information, all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
 - 1. Include amperage and voltage ratings, over-current protective device ratings, AIC ratings, etc
 - 2. Where multiple sizes are listed, indicate sizes to be used.
 - 3. Where multiple products are shown on the same page, indicate which products to be used.
- C. Rejected submittals shall be resubmitted within two weeks of notification of rejection.
- D. Any equipment covered by division 26 specifications that is installed by the contractor without submittal approval and is not in compliance with the appropriate specifications shall be replaced at the contractor' expense.

1.4 CLOSEOUT SUBMITTALS

- A. At the end of construction, provide a closeout submittal containing the following information in addition to items specified in other sections.
 - 1. Operation and Maintenance data
 - 2. Test results
- B. Operation and Maintenance Data: At the end of construction, provide the owner with an 8.5x11 bound manual including the following information:
 - 1. Provide product data as defined under submittals.
 - 2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
 - 3. Spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products shown on the construction documents with minimum three years documented experience.
- B. Supplier: Authorized distributor
- C. Installer: A state licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications, required by code, or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

- A. Inclusion of specific products in these specifications and on the plans, does not mean that said products may be used for all applications in all environments. Products may only be used where approved either in the specification installation requirements sections or on the plans. Where the construction documents do not explicitly state what products are acceptable for an application, the most robust products specified are assumed to be the minimum requirement.
- B. Regulatory Requirements
 - 1. The contractor shall comply with the requirements of all laws, rules, regulations, code and ordinances that have been adopted by the federal, state, and local authorities having jurisdiction (AHJ). All equipment, materials, means and methods shall be acceptable to the AHJ's.
 - 2. Electrical installations shall conform to IEEE C2, NFPA 70, local codes and specified requirements herein. Equipment, materials, installation, and workmanship shall be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.
 - 3. In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. Standard Products
 - 1. Unless otherwise approved, all equipment shall be new, properly designed, from a reputable manufacturer meeting the specification qualifications, in compliance with the specification requirements, and in full working order.
 - 2. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in the technical section.
 - 3. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.
- D. Material and Equipment Manufacturing Date
 - 1. Products manufactured more than 2 years prior to date of delivery to site shall not be used, unless specified otherwise.
- E. All equipment used for testing shall be in full working order and calibrated per the manufacturer's recommendations.

1.7 WARRANTY

- A. The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

1.8 DELIVERY STORAGE AND HANDLING

- A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.
- B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

PART 2 PRODUCTS

2.1 POWER METERS

- A. Manufacturers:
 1. ABB
 2. Siemens
 3. Square D
 4. Eaton
 5. Substitutions: With engineer approval.
- B. Provide Description: Multi-function power quality meter with the following electrical parameters in addition to those shown on the drawings:
 1. Voltage, phase to phase and phase to neutral.
 2. Current, per phase RMS and 3 phase average.
 3. Demand current, per phase.
 4. Power factor, per phase and 3 phase total.
 5. Real power, 3 phase total.
 6. Reactive power, 3 phase total.
 7. Apparent power, 3 phase total.
 8. Energy (MWH).
 9. Reactive energy (MVARH).
 10. Frequency.
 11. Average demand real power.
 12. Total Harmonic Distortion.
 13. Transient detection and logging, 65us at 60Hz.
- C. Product Features
 1. LCD Display
 2. ANSI 12.20 Class 0.2 and IEC 62053-22 Class 0.5S real energy accuracy meters.
 3. Time of Use metering
 4. Trending
 5. Waveform Recording
 6. Harmonic Distortion Metering
 7. Sag/Swell Detection
 8. Transient Capture
- D. Communications

1. Ethernet port
2. RS-232/RS-485 Port
3. Infrared Data Port.
4. Standard digital and analog I/O

E. Memory Capacity: 800kB min

F. Waveform recording

1. Triggered manually or by alarm.
2. 3-Cycle
3. 256 samples/cycle min on 3 min user configurable channels

G. Current Transformers: ANSI C57.13; 5-ampere secondary, window type with single secondary winding and secondary shorting device, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

H. Voltage Transformers: ANSI C57.13; 120-volt secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as shown on Drawings, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

I. Provide communications cabling to connect meter to BAS and provide all necessary programming of BAS.

J. Provide communications cabling to connect meter to facility manager's office computer and provide all necessary software and programming of computer. Verify with owner which person's computer to be provided with meter software.

2.2 SURGE PROTECTION DEVICES

A. Manufacturers:

1. ABB-Current Technology
2. Siemens
3. Square D
4. Eaton
5. Substitutions: With engineer approval.

B. UL Type 1449 – 4th Edition listed.

C. Product Description: IEEE C62.41, switchboard mounted transient voltage surge suppressor, selected to meet requirements for medium exposure and to coordinate with system circuit voltage.

2.3 TERMINAL BLOCKS

A. Manufacturers:

1. Carlon Electrical Products
2. Hubbell Wiring Devices
3. Reliance Electric
4. Substitutions: With engineer approval.

- B. Terminal Blocks: NEMA ICS 4.
- C. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- D. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.
- E. Furnish ground bus terminal block, with each connector bonded to enclosure.

2.4 LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Automatic Switch Co.
 - 2. Eaton
 - 3. ABB
 - 4. Square D
 - 5. Siemens
 - 6. Substitutions: With engineer approval.
- B. Product Description:
 - 1. NEMA ICS 2, magnetic lighting contactor.
 - 2. Configuration: Electrically held, 2 wire control.
 - 3. Coil Operating Voltage: 24 or 120 volts, 60 Hertz.
 - 4. Poles: To match circuit configuration and control function.
 - 5. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.
- C. Accessories:
 - 1. Cover Mounted Pilot Devices: NEMA ICS 5.
 - 2. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
 - 3. Auxiliary Contacts: one normally open and one normally closed in addition to seal-in contact.
 - 4. Relays: NEMA ICS 2,
 - 5. Control Power Transformers: 120-volt secondary, VA as required, in each enclosed contactor. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- D. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 - 1. Interior Dry Locations: Type 1.
 - 2. Exterior Locations: Type 3R.

2.5 RELAYS

- A. Manufacturers:
 - 1. Allen Bradley
 - 2. Automatic Switch Co.
 - 3. Eaton
 - 4. ABB
 - 5. Siemens
 - 6. Square D

7. Substitutions: With engineer approval.
- B. Product Description: Heavy duty, single-coil momentary contact, mechanically held remote control relays, unless noted otherwise
 1. Contacts: Rated 20 amperes at 120-277 volts. Lower ratings may be used for control circuits with approval.
 2. Line Voltage Connections: Clamp type screw terminals.
- C. Time Delay: Provide where required and/or noted
 1. Solid state timer attachment
 2. Adjustable from 0.2 to 60 seconds (min). Note that longer time ranges may be specified on plans.
 3. Field convertible from ON delay to OFF delay.
- D. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
 1. Interior Dry Locations: Type 1.
 2. Exterior Locations: Type 3R.

2.6 PHASE MONITOR RELAY

- A. Manufacturers:
 1. ABB
 2. Eaton
 3. General Electric
 4. Siemens
 5. Square D
 6. Substitutions: With engineer approval.
- B. Product Description:
 1. Capable of protecting any sized motor
 2. Universal operating voltage and frequency. 120 to 480V, 50 or 60 Hz
 3. DPDT Isolated 10A output relay contacts
 4. Restart delay
 5. Wall or din rail mountable
 6. Adjustable time delay
- C. Protection Requirements
 1. Phase Loss (single phasing)
 2. Phase reversal
 3. Under-voltage, Over-voltage, and Unbalanced Voltage
 4. Under-frequency and Over-frequency
- D. Relay and control circuit design shall prohibit motor starting throughout the duration of the fault.

2.7 PUSH BUTTONS AND SELECTOR SWITCHES

- A. Manufacturers:
 1. Allen Bradley

2. Eaton
3. ABB
4. Siemens
5. Square D
6. Substitutions: With engineer approval.

B. Product Description: Heavy duty, oil tight, unless noted otherwise

1. Contacts: Rated 20 amperes at 120-277 volts. Lower ratings may be used for control circuits with approval.
2. Line Voltage Connections: Clamp type screw terminals.
3. Indicator lights: LED type, push to test.
4. Provide black ON or START pushbuttons and switches.
5. Provide red OFF or STOP pushbuttons and switches.
6. Provide engraved plastic label.
7. Provide lock out provisions, shrouds, and manual reset functions as noted on plans.

C. Enclosure: Fabricate enclosure from steel finished with manufacturer's standard gray enamel.

1. Interior Dry Locations: Type 13.
2. Exterior Locations: Type 3R. Provide 4X for corrosive locations.
3. Hazardous Locations: UL listed for the space classification, division, group.

2.8 GENERAL REQUIREMENTS

- A. Equipment to be installed outdoors, in corrosive or hazardous environments shall be rated for the intended use.
- B. Compliance with the requirements of the contract documents shall not relieve the contractor of the responsibility of providing equipment that is new, properly designed, from a reputable manufacturer, and in full working order.
- C. If conflicts occur between the specifications and drawings, the higher quality, price or quantity shall be provided and installed.
- D. If there is any question as to quality, size or quantity necessary, the contractor shall provide a written request for clarification from the Engineer. Contractor shall be responsible for any additional expenses incurred as a result of the contractor's failure to obtain clarification.
- E. Detailed product specifications are included in other specification section and on the plans.

PART 3 EXECUTION

3.1 FIELD APPLIED PAINTING

- A. Paint electrical equipment as required to match finish of adjacent surfaces or to meet the indicated or specified safety criteria.

3.2 FIELD PROGRAMMING

- A. Electrical contractor shall be responsible for the coordination and payment of programming for all programmable devices and equipment including, but not limited to, all power meters and meter monitoring work stations and meter to BAS interfaces, lighting controls, circuit breakers, interfaces with building automation system, power monitoring equipment, etc.
- B. Where required, the manufacturer of the product shall be engaged to perform the programming.

3.3 EXAMINATION

- A. If a conflict is found between the specification and plans, notify the Architect or Engineer of the conflict.
- B. Verify equipment is ready for electrical connection, for wiring, and to be energized.
- C. Verify existing conditions are as shown on the plans and that adequate space is available for the equipment for installation.

3.4 INSTALLATION

- A. The installation requirements shown here are general scope requirements. More detailed information is provided for each of these topics in other specifications and on the plans.
 - 1. All requirements of the NEC and grounding specifications shall apply to the products specified here.
- B. In addition to the applicable installation requirements of the other specification sections and the plans, install all equipment covered under this specification per the following requirements.
 - 1. Install devices plumb and level.
 - 2. Secure to structure and support following all requirements of the NEC, other codes, and the AHJ.
 - 3. Install per manufacturer's recommendations and instructions.
 - 4. Follow all owner requirements, specifications, and design standards.
 - 5. Test and
- C. Identification
 - 1. Provide appropriate labels for all equipment, wiring devices, conductors, cables, box, and enclosures
 - 2. Provide warning signs for electrical equipment and buried circuits.

END OF DOCUMENT

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SECTION 26 05 19 - CONDUCTORS AND CABLES 600V OR LESS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes building
 - 1. wire and cable
 - 2. nonmetallic-sheathed cable
 - 3. direct burial cable
 - 4. service entrance cable
 - 5. metal clad cable
 - 6. armored cable
 - 7. wiring connectors and connections.

1.2 REFERENCES

- A. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- B. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- C. Underwriters Laboratories, Inc.:
 - 1. UL 1277 - Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 SUBMITTALS

- A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
 - 1. Include amperage and voltage ratings.
 - 2. Where multiple sizes are listed, indicate sizes to be used.
 - 3. Where multiple products are shown on the same page, indicate which products to be used.
- B. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and circuits.

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- B. Field Quality-Control Test Reports: Report certified by field testing agent indicating results of performance testing required in Part 3 and/or on plans.
 - 1. Torque log
 - 2. Insulation test results

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.
- C. Testing Agency: An independent agency with the documented experience and properly calibrated, fully functioning equipment to conduct the testing required by the specifications, plans and code, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and is acceptable to the authority having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Provide wiring materials located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with NFPA 262.
- B. Perform Work in accordance with all applicable city, state, and federal requirements.
- C. Maintain one copy of each document on site.
- D. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.
- E. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements are as indicated on Drawings.

1.8 COORDINATION

- A. Where wire and cable destination is indicated and routing is not shown, determine routing and lengths required.
- B. Wire and cable routing indicated is approximate unless dimensioned.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Product Requirements: Provide products as follows:
 1. Solid, insulated conductor in raceway for feeders and branch circuits 10 AWG and smaller.
 2. Stranded, insulated conductors in raceway for feeders and branch circuits 8 AWG and larger
 3. Stranded, insulated conductors for control circuits. Route in raceway, except where otherwise allowed to be run exposed in plenum, in tray, etc.
 4. Conductor not smaller than 12 AWG for power and lighting circuits.
 5. Conductor not smaller than 14 AWG for control circuits.
 6. Increase wire size in branch circuits to limit voltage drop to a maximum of 3 percent.
- B. Wiring Methods: Provide the following wiring methods:
 1. Concealed and Exposed Dry, Wet, or Damp Interior Locations. Use only building wire, Type THHN/THWN insulation, in raceway.
 2. Exterior Locations: Use only building wire, Type THHN/THWN insulation, in raceway.
 3. Underground Locations: Use only building wire, Type XHHW insulation, in raceway.
 4. Cable Tray Locations: Use only Tray cable Type TC.

2.2 BUILDING WIRE

- A. Manufacturers:
 1. AETNA
 2. American Insulated Wire Corp.
 3. Colonial Wire
 4. Encore Wire
 5. General Cable Co.
 6. Republic Wire
 7. Rome Cable
 8. Service Wire Co.
 9. Southwire
 10. Superior Essex
 11. Substitutions: With engineer approval.
- B. Product Description: Single conductor insulated wire.
 1. Conductor: Soft drawn copper, 98% conductivity.
 2. Insulation Voltage Rating: 600 volts.
 3. Insulation Temperature Rating: 90 degrees C.
 4. Insulation Material: Thermoplastic. Type THHN/THWN U.N.O. Use XHHW where install in conduit underground.
- C. Grounding conductors, where insulated, shall be colored solid green or identified with green color as required by the NEC. Conductors intended as a neutral shall be colored solid white, or identified as required by the NEC. All motor or equipment power wiring shall be colored according to Section 26 05 53, Electrical Identification.

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2.3 DIRECT BURIAL CABLE

- A. Manufacturers:
 - 1. Diamond Wire & Cable Co.
 - 2. Essex Group Inc.
 - 3. General Cable Co.
 - 4. Substitutions: With engineer approval.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 90 degrees C.

2.4 ARMORED CABLE

Commented [JW1]: Armored cable should only be used on light commercial type projects as a VE option to MC cable. MC cable is listed for use in many more applications than AC cable.

- A. Manufacturers:
 - 1. Diamond Wire & Cable Co.
 - 2. Essex Group Inc.
 - 3. General Cable Co.
 - 4. Substitutions: With engineer approval.
- B. Conductor: Copper.
- C. Insulation Voltage Rating: 600 volts.
- D. Insulation Temperature Rating: 75 or 90 degrees C.
- E. Insulation Material: Thermoplastic.
- F. Armor Material: Steel.
- G. Armor Design: Interlocked metal tape [Corrugated tube].

2.5 METAL CLAD CABLE

- A. Manufacturers:
 - 1. Diamond Wire & Cable Co.
 - 2. Essex Group Inc.
 - 3. General Cable Co.
 - 4. Substitutions: With engineer approval.
- B. Product Description:
 - 1. Conductor: Soft drawn copper, 98% conductivity.
 - 2. Insulation Voltage Rating: 600 volts.
 - 3. Insulation Temperature Rating: 90 degrees C.
 - 4. Insulation Material: Thermoplastic. Type THHN/THWN U.N.O. Use XHHW where install in conduit underground.

Commented [JW2]: MC cable is fine for a good number of commercial projects. Most institution client specs will not allow MC Cable. When allowed on projects, be sure to clearly note where MC cable will be allowed. Home runs should be in conduit in wire. Refer to section 3.4.F.

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- C. Armor Material: Steel.
- D. Armor Design: Interlocked metal tape
- E. Jacket: Where required.

2.6 TRAY CABLE

- A. Manufacturers:
 - 1. [Rome Cable Company]
 - 2. Substitutions: With engineer approval.
- B. Product Description: Multiconductor power and control cable NFPA 70 Type TC.
- C. Conductor: Copper.
- D. Insulation: Flame-retardant cross-linked polyethylene.
- E. Overall Jacket: Polyvinyl Chlorine (PVC) in accordance with UL 1277.
- F. Insulation Voltage Rating: 600 volts.
- G. Insulation Temperature Rating: 90 degrees C.
- H. Listings: Finished cable UL listed as Type TC, and sunlight resistant.

2.7 WIRING CONNECTORS

- A. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as required by manufacturer of the equipment and the NEC. The following types, classes, kinds and styles should be used only where appropriate and as noted
 - 1. Solderless Pressure Connectors
 - 2. Crimp
 - 3. Threaded
 - 4. Insulated Spring Wire Connectors with plastic caps for 10 AWG and smaller
 - 5. Split bolt parallel connectors
 - 6. Pre-insulated multi-tap connectors
 - 7. Epoxy resin type splicing kits.
- B. Wiring connectors shall be insulated to 600V. Conducting components shall match conducting material of wiring (copper, unless noted otherwise).

2.8 TERMINATIONS

- A. Terminal Lugs for Wires 6 AWG and Smaller: Solderless, compression type copper.
- B. Lugs for Wires 4 AWG and Larger: Color keyed, compression type copper, with insulating sealing collars. Confirm where compression lugs will be required and where mechanical lugs will

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be acceptable on this project. Please note that the switchgear manufacturers limit where compression lugs are available for their electrical equipment.

- C. Control wiring: Use insulated terminals for control wiring. Use flange spade compression terminal for termination of stranded conductors at wiring devices, including grounding connections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify interior of building has been protected from weather.
- B. Verify mechanical work likely to damage wire and cable has been completed.
- C. Verify raceway installation is complete and supported.

3.2 PREPARATION

- A. Completely and thoroughly swab raceway before installing wire.
- B. Clean conductor surfaces before installing lugs and connectors.

3.3 INSTALLATION

- A. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- B. Install electrical cable, wire and connectors as indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and as required to ensure that products serve the intended functions.
- C. Wiring Installation in Raceways
 - 1. Wire and cable shall be pulled into clean dry conduit. Do not exceed manufacturer's recommended values for maximum pulling tension.
 - 2. Do not install the conductors until the raceway system is complete and properly cleaned.
 - 3. Pull conductors together where more than one is being installed in a raceway.
 - 4. Use UL listed pulling compound or lubricant, when necessary; compound must not deteriorate conductor and insulation.
 - 5. Do not use a pulling means, including fish tape, cable or rope, which can damage the raceway.
 - 6. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
 - 7. Place an equal number of conductors for each phase of a circuit in same raceway.
 - 8. Provide separate conduit or raceway for line and load conductors of motor starters, safety disconnect switches, and similar devices. Those devices shall not share the same raceway.

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9. All conduits shall contain a green grounding conductor. Conduit, wireways, or boxes shall not be used as the equipment grounding conductor.

D. Cable :

1. Protect exposed cable from damage.
2. Support cables above accessible ceiling, using spring metal clips or appropriate cable ties to support cables from structure. Do not rest cable on ceiling panels.
3. Use suitable cable fittings and connectors.

E. Direct Burial Cable:

1. Trench and backfill for direct burial cable installation. Install warning tape along entire length of direct burial cable, within 3 inches of grade.
2. Use suitable direct burial cable fittings and connectors.

F. Metal Clad and Metal Armored Cable

1. Metal clad cable shall not be used for homeruns or in exposed locations. Use shall be restricted to locations and conditions explicitly allowed by these specifications and the owner's design guidelines.
2. MC and or AC cable may be used after the first device, or after a junction box located in accessible ceiling space above first wiring device on a 20A circuit where concealed.
3. All switch boxes shall be provided with conduit to junction box above accessible ceiling to allow for future modification.
4. MC cable shall not be used for connections to dedicated receptacles or pieces of equipment.

G. Wiring Connections and Terminations

1. Install splices, taps and terminations, which have equivalent-or-better mechanical strength and insulation as the conductor. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.
2. Keep conductor splices and taps accessible and to a minimum. Splice branch circuits only in accessible junction or outlet boxes. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundled connections, minimum 5 feet at each location, unless noted otherwise on drawings.
3. Splices below grade shall only be in handholes or manholes and shall be made watertight with epoxy resin type splicing kits similar to Scotcheast. 20A branch circuit splices installed below grade may use scotch-lock or other means of making water resistant.
4. Use splice, tap and termination connectors, which are compatible with the conductor material.
5. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
6. Tape un-insulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor and label as spare.
7. Power and Lighting Circuits:
 - a. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and larger.
 - b. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps on lighting and receptacle circuits.
 - c. Use split bolt connectors for copper wire splices and taps, 6 AWG and larger.
8. Controls Circuits

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- a. Control circuit conductors shall terminate at terminal blocks only. Control cable shall never be spliced except the final connection to field devices.
- b. If stranded conductors used for #10 or smaller for controls, FA, security, etc, install crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screws.
9. Connections for all wire sizes in motor terminal boxes where the motor leads are furnished with crimped-on lugs shall be made by installing ring type compression terminals on the motor branch circuit ends and then bolting the proper pairs of lugs together. First one layer of No. 33 scotch tape reversed (sticky side out), then a layer of rubber tape, then two layers of No. 33 half-lapped.
10. Terminate aluminum conductors with tin-plated, aluminum-bodied compression connectors only. Fill with anti-oxidant compound before installing conductor.
11. Install suitable reducing connectors or mechanical connector adaptors for connecting aluminum conductors to copper conductors.

H. Terminal Lugs

1. Install terminal lugs on ends of 600 volt wires unless lugs are furnished on connected device, such as circuit breakers.
2. Size lugs in accordance with manufacturer's recommendations terminating wire sizes. Install 2-hole type lugs to connect wires 4 AWG and larger to copper bus bars.
3. For terminal lugs fastened together such as on motors, transformers, and other apparatus, or when space between studs is small enough that lugs can turn and touch each other, insulate for dielectric strength of 2-1/2 times normal potential of circuit.

I. Voltage Drop

1. No conductor smaller than No. 12 wire shall be used for lighting purposes. In the case of "home runs" over 50' length (100' for 277 volt) no conductor smaller than a No. 10 wire shall be used.
2. Voltage drop on feeders and branch circuits shall not exceed NEC requirement.
3. Voltage drop on control circuits shall not exceed the requirements of the equipment that the wiring serves.

J. Control Wiring

1. Run in separate conduits from building wiring.
2. Departures from the sizes specified in Part 2 shall be made only in those cases in which the National Electrical Code requires the use of larger conductors.
3. The Contractor may, if he deems it necessary or advisable, use larger sized conductors than those shown.

K. Wiring Within an Enclosure:

1. Contractor shall bundle AC and DC wiring separately within an enclosure.
2. The Contractor shall utilize panel wire-ways when they are provided.
3. Where wireways are not provided, the Contractor shall neatly tag and bundle wires and secure to sub-panel at a minimum of every three inches.

L. Separate neutral conductors shall be provided for each single-phase circuit.

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- M. Neutral shall be 200% rated for, heavy computer loads, loads fed from isolated transformers, lab equipment, clinic equipment, and other dedicated circuits where specified, unless noted otherwise on drawings.
- N. Where terminations of cables that are installed under this Section are to be made by others, provide pigtail of adequate length for neat, trained and bundles connections, minimum 5 feet at each location, unless noted otherwise on drawings.
- O. Do not band any conductor either permanently or temporarily during installation to radii less than four times the outer diameter of 600-volt insulated conductors.

3.4 WIRE COLOR

- A. General:
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following for each phase A, B, C, and Neutral:
 - a. Black (A), Red (B) for single phase circuits at 120/240 volts.
 - b. Black (A), Red (B), Blue (C) for circuits at 120/208 volts single or three phase.
 - c. Brown (A), Orange (B), Yellow (C) for circuits at 277/480 volts single or three phase.
 - 2. For wire sizes 8 AWG and larger, identify wire with colored tape at terminals, splices and boxes. Use colors listed above.
- B. General:
 - 1. For wire sizes 10 AWG and smaller, install wire colors in accordance with the following:
 - a. Unique color coding for each phase.
 - b. Separate color coding for 208V and 480V.
 - c. Match the existing building color code system.
 - 2. For wire sizes 8 AWG and larger, use black insulated phase conductors and identify wire with colored tape at terminals, splices and boxes. Colors as above:
- C. Neutral Conductors: White. Use gray for 277/480V neutrals were required by AHJ. When two or more neutrals are located in one conduit, individually identify each with proper circuit number.
- D. Branch Circuit Conductors: Install three or four wire home runs with each phase uniquely color coded.
- E. Feeder Circuit Conductors: Uniquely color code each phase.
- F. Ground Conductors:
 - 1. For 6 AWG and smaller: Green.
 - 2. For 4 AWG and larger: Identify with green tape at both ends and visible points including junction boxes.

Commented [JW3]: NOTE: This is more typical color coding for projects outside Austin.

3.5 FIELD QUALITY CONTROL

- A. Before final acceptance, the Contractor shall make voltage, insulation, and load tests, necessary to demonstrate to the Owner's representative the satisfactory installation and proper performance of all circuits.

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- B. All terminations rated 60A or larger shall be made using a torque wrench and the results recorded in a log to be provided to owner with closeout documents.
- C. Test feeder conductor insulation. Insulation-resistance test shall be conducted per NETA – Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 - 1. Test results below 50 megohms shall be cause for rejection of the wiring installation.
 - 2. Replace and retest all non-compliant conductors.
 - 3. Provide written log of testing results to owner with closeout documents.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Rod electrodes.
 - 2. Active electrodes.
 - 3. Wire.
 - 4. Grounding well components.
 - 5. Mechanical connectors.
 - 6. Exothermic connections.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
 - 2. IEEE 1100 - Recommended Practice for Powering and Grounding Electronic Equipment.
- B. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

- A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
 - 1. Include amperage ratings, voltage, over-current protective device ratings, AIC ratings.
 - 2. Where multiple sizes are listed, indicate sizes to be used.
 - 3. Where multiple products are shown on the same page, indicate which products to be used.
- B. Manufacturer's Installation Instructions: Submit for active electrodes.
- C. Manufacturer's Certificate: Certify, Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of components and grounding electrodes.

- B. Field Quality-Control Test Reports: Report certified by field testing agent indicating results of performance testing required in Part 3 and/or on plans.: Indicate overall resistance to ground.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.
- C. Testing Agency Qualifications: An agency, with the experience and capability to conduct the testing indicated, that is a member of a nationally recognized testing agency and that is acceptable to authorities having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Provide grounding materials conforming to requirements of NEC, IEEE 142, and UL labeled.
- B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.
- C. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.
- D. Maintain one copy of each document on site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- B. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, chemical and mechanical damage, freeze, and where applicable, deterioration from sun light. Store in original packaging where possible.
- C. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.8 COORDINATION

- A. Complete grounding and bonding of building reinforcing steel prior to concrete placement.

PART 2 PRODUCTS

2.1 ROD ELECTRODES

- A. Product Description:
 - 1. Material: Copper.
 - 2. Diameter: 5/8 inch.
 - 3. Length: 10 feet.
- B. Connector: Connector for exothermic welded connection.

2.2 GROUNDING AND BONDING WIRE

- A. Material:
 - 1. Match building wiring material specifications
 - 2. Except where noted bare, match building wiring insulation.
 - 3. Minimum requirement: 600V, stranded copper.
 - 4. Solid copper may be used for #8 AWG and smaller.
- B. Foundation Electrodes: 4 AWG bare, strand copper.
- C. Grounding Electrode Conductor: stranded Copper conductor bare.
- D. Grounding Straps: Tin plated copper braided cable, 1" thick x 0.1" thick (min), #1 awg, with 3/4" one hole connections on both ends (note: other connection types may be noted on plans)

2.3 MECHANICAL CONNECTORS

- A. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.
- B. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.
- C. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

2.4 EXOTHERMIC CONNECTIONS

- A. Product Description: Exothermic welding kits, accessories, and tools for preparing and making permanent field connections between grounding system components.

2.5 GROUND BUS

- A. Rectangular bars of annealed copper, 12-inch-long, 1/4" by 2" in cross section, unless otherwise indicated.
- B. Provide with manufacturer's insulators to stand ground bus off mounting surface.

- C. Requirements for electrical switchgear, switchboards, distribution and branch circuit panel ground buses are covered by the specification section that cover said equipment.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 PREPARATION

- A. Remove paint, rust, mill oils and surface contaminants at connection points.

3.3 SERVICE ENTRANCE GROUNDING ELECTRODE SYSTEM

- A. Install grounding electrode system as required by NEC. At a minimum, a grounding electrode conductors shall be extended to:
 1. The building metal cold water piping, bolted connection.
 2. Structural steel framing, welded connection.
 3. 20 ft. of bare copper encased in concrete, Ufer ground.
 4. 20ft of bare copper conductor buried at 24" or driven ground rods.
 5. Additional electrodes as required to achieve minimum ground impedance as specified below.
- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
 2. Install grounding well pipe with cover at rod locations as indicated on Drawings. Install well pipe top flush with finished grade.
- C. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet of bare copper conductor sized per plans but not smaller than No. 4 AWG
 1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
 2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.
- D. Grounding and Bonding for Piping:
 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed,

- connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect pipe with a bolted connector.
- 3. Bond each above ground portion of gas piping system downstream from equipment shutoff valve.
- E. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.
- F. Install grounding electrode conductor and connect to reinforcing steel in foundation footing.
- G. Additional grounding electrode requirements and grounding electrode conductor sizes are shown on the plans.

3.4 INSTALLATION

- A. General Requirements
 - 1. Install in accordance with IEEE 142, NEC requirements, and manufacturer's recommendations.
 - 2. Install grounding and bonding conductors concealed from view.
 - 3. Routing of grounding electrode, special systems ground conductors, and other grounds not routed in feeders or branch circuit raceways shall be installed in a dedicated metal conduit in all locations subject to physical abuse or environmental deterioration such as exterior mounted, exposed below ceiling, etc.
 - 4. Ground system using separate insulated grounding conductor installed with every feeder and branch circuit conductors in conduits. Terminate each end on suitable lug, bus, or bushing.
 - 5. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes, equipment ground terminal, or metal enclosures of equipment.
 - 6. Raceway systems shall be made continuous from source to load.
 - a. Provide bonding jumpers where raceway system is inherently discontinuous such as where conduits terminate at cable trays.
 - b. Raceway shall be made continuous using mechanical connections that have been securely tightened using the appropriate tool. Hand tight is not acceptable.
 - 7. Permanently attach equipment and grounding conductors prior to energizing equipment.
 - 8. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors
 - 9. Provide grounding bushings for conduit terminations at panels, electrical equipment, enclosures, etc.
- B. Bonding Straps and Jumpers:
 - 1. Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.
 - 2. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 3. Bonding to Equipment Mounted on Vibrations Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

4. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.
5. Bond the following components to the grounding electrode
 - a. System neutral at service entrance and transformer secondaries
 - b. Service equipment enclosures, exposed non-current carrying metal parts of electrical equipment
 - c. Metal raceway systems, cable trays, auxiliary gutters, meter fittings, boxes, cable armor, cable sheath
 - d. Ground bus in electrical rooms and IT rooms
 - e. Lightning protection system. Refer to Section 26 41 00.
 - f. Metal siding not attached to grounded structure; bond to ground.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors
4. Connections to structural Steel: Welded connectors.

3.5 FIELD QUALITY CONTROL

- A. Grounding System Resistance: 5 ohms maximum.
- B. Perform ground resistance testing
 1. Test in accordance with IEEE 142.
 2. Provide additional grounding electrodes as required to achieve resistance listed above.
 3. Testing shall be performed when the soil is dry and there has been no rain in the past 48 hours.
- C. Perform leakage current tests in accordance with NFPA 99.
- D. Perform continuity testing in accordance with IEEE 142.
- E. When improper grounding is found on receptacles, check receptacles in entire project and correct. Perform retest.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nameplates.
 - 2. Labels.
 - 3. Wire markers.
 - 4. Conduit markers.
 - 5. Stencils.
 - 6. Underground Warning Tape.
 - 7. Lockout Devices.
 - 8. Operating Instructions
 - 9. Nameplates
 - 10. Warning Signs

1.2 SUBMITTALS

- A. Product Data:
 - 1. Submit manufacturer's catalog literature for each product required.
 - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
- B. Samples:
 - 1. Submit samples of each type of identification products applicable to project.
 - 2. Submit one sample nameplate illustrating materials and engraving quality.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with federal, state, and local codes
- B. Provide all labeling as required by NFPA 70 and 70E.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

ZIPP FAMILY SPORTS PARK

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Accept identification products on site in original containers. Inspect for damage.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Install labels and nameplates only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Product Description: Laminated three-layer plastic with engraved black letters on white contrasting background color.
- B. Letter Size:
 - 1. 1/4-inch-high (min) letters for identifying individual equipment and loads.
 - 2. 1/4-inch-high (min) letters for identifying grouped equipment and loads.
- C. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

- A. Generic Labels: Embossed adhesive tape, with 3/16 inch white letters on black background.
- B. Finished area Receptacles Cover Labels: Adhesive labels, clear with black text.
- C. Labels for receptacles controlled by motion sensing devices: Embossed adhesive tape, with 3/16 inch white letters on a dark green background.

2.3 WIRE MARKERS

- A. Description: Cloth tape, split sleeve, or tubing type wire markers.
- B. Legend:
 - 1. Power and Lighting Circuits: Panel name and branch circuit or feeder number.
 - 2. Control Circuits: Control wire number as indicated on shop drawings.

2.4 CONDUIT AND RACEWAY MARKERS

- A. Description: Nameplate fastened with adhesive, Labels fastened with adhesive or Stencils.

- B. Color:
 - 1. Medium Voltage System: Black lettering on white background.
 - 2. 480 Volt System: Black lettering on white background.
 - 3. 208 Volt System: Black lettering on white background.
- C. Legend:
 - 1. Medium Voltage System: HIGH VOLTAGE.
 - 2. 480 Volt System: 480 VOLTS.
 - 3. 208 Volt System: 208 VOLTS.

2.5 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. Up to 2 inches Outside Diameter of Raceway: 1/2-inch-high letters.
 - 2. 2-1/2 to 6 inches Outside Diameter of Raceway: 1 inch high letters.

2.6 UNDERGROUND WARNING TAPE

- A. Description: 6-inch-wide plastic tape, detectable type, colored red with suitable warning legend describing buried electrical lines.

2.7 LOCKOUT DEVICES

- A. Lockout Hasps:
 - 1. Anodized aluminum or Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

2.8 POSTED OPERATING INSTRUCTIONS

- A. Provide for each system and principal item of equipment as specified in the technical sections for use by operation and maintenance personnel. The operating instructions shall include the following:
 - 1. Wiring diagrams, control diagrams, and control sequence for each principal system and item of equipment.
 - 2. Start up, proper adjustment, operating, lubrication, and shutdown procedures.
 - 3. Safety precautions.
 - 4. The procedure in the event of equipment failure.
 - 5. Other items of instruction as recommended by the manufacturer of each system or item of equipment.
 - 6. At a minimum, operating instructions shall be provided for fire alarm panels, ATSS, generators, switchgear.
- B. Print or engrave operating instructions and frame under glass or in approved laminated plastic. Post instructions where directed. For operating instructions exposed to the weather, provide weather-resistant materials or weatherproof enclosures. Operating instructions shall not fade when exposed to sunlight and shall be secured to prevent easy removal or peeling.

2.9 MANUFACTURER'S NAMEPLATE

- A. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

2.10 FIELD FABRICATED NAMEPLATES

- A. ASTM D 709. Provide laminated plastic nameplates for each equipment enclosure, relay, switch, and device; as specified in the technical sections or as indicated on the drawings. Each nameplate inscription shall identify the function and, when applicable, the position. Nameplates shall be melamine plastic, 0.125-inch-thick, white with black center core. Surface shall be matte finish. Corners shall be square. Accurately align lettering and engrave into the core. Minimum size of nameplates shall be one by 2.5 inches. Lettering shall be a minimum of 0.25-inch-high normal block style.

2.11 WARNING SIGNS

- A. Provide warning signs for the enclosures of electrical equipment including substations, pad-mounted transformers, pad-mounted switches, generators, and switchgear having a nominal rating exceeding 600 volts.
 - 1. When the enclosure integrity of such equipment is specified to be in accordance with IEEE C57.12.28 or IEEE C57.12.29, such as for pad-mounted transformers, provide self-adhesive warning signs on the outside of the high voltage compartment door(s). Sign shall be a decal and shall have nominal dimensions of 7 by 10 inches with the legend "DANGER HIGH VOLTAGE" printed in two lines of nominal 2-inch-high letters. The word "DANGER" shall be in white letters on a red background and the words "HIGH VOLTAGE" shall be in black letters on a white background. Decal shall be Panduit No. PPSO710D72 or approved equal.

2.12 ARC FLASH HAZARD IDENTIFICATION

- A. Arc Flash Warning Labels: Per ANSI Z535.4, the signal word WARNING appearing in black letters on an orange background, with second line below (Arc Flash and Shock Hazard) in black letters on white background and third line below (Appropriate PPE required) in black letters on white background.
 - 1. Include the following information on the label:
 - a. Equipment name.
 - b. Available bolted current.
 - c. Flash protection boundary distance.
 - d. Incident energy level at 18" expressed in cal/cm².
 - e. Personnel protective equipment (PPE) class.
 - f. Voltage shock hazard.
 - g. Limited shock approach boundary.
 - h. Restricted shock approach boundary.
 - i. Prohibited shock approach boundary.
 - 2. It shall be the Electrical Contractors responsibility to produce the information necessary to complete the above-described warning labels. Provide the services of a qualified engineer if required to calculate these values.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Fire alarm, emergency/critical power, life safety labels, including receptacles, shall be color coded and engraved.
- C. Provide each panel with a manufacturer prepared arc flash hazard warning label.
- D. Provide a typed panel directory for each panel provided or modified for this project. Directory shall identify the circuit number, loads served, and location of loads by room number. Mount on inside of each panel and file with the owner when the work is complete.
- E. Nameplate Installation:
 1. Install nameplate parallel to equipment lines.
 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners, or adhesive.
 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners, or adhesive.
 4. Secure nameplate to equipment front using screws or rivets.
 5. Secure nameplate to inside surface of door on recessed panelboard in finished locations.
 6. Install nameplates for the following:
 - a. Switchboards.
 - b. Panelboards.
 - c. Transformers.
 - d. Disconnects and starters.
 - e. VFDs
 - f. ATSS
 - g. Lighting contactors
 - h. Equipment enclosures
 - i. Controls cabinets and enclosures
- F. Label Installation:
 1. Install label parallel to equipment lines.
 2. Install label for identification of individual control device stations.
 3. Install labels for permanent adhesion and seal with clear lacquer.
 4. Install panel name and circuit number identification labels for the following:
 - a. Junction boxes (permanent marker may be used for junction boxes in mechanical spaces or above lay in ceilings.)
 - b. Receptacle cover plates in areas other than dwelling units.
- G. Wire Marker Installation:

1. Install wire marker for each conductor at panelboards, gutters, pull boxes, at electrical equipment such as contactors and disconnects, and each load connection.
2. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
3. Install labels at data outlets identifying patch panel and port designation.

H. Raceway Marker Installation:

1. Install raceway marker for each raceway longer than 6 feet and rated 100A or more.
2. Raceway Marker Spacing: provide marker in a visible location in each room where raceway passes through walls or floors.
3. Coordinate with architect before labeling raceways in finished spaces

I. Junction and Pull Box Installation

1. Label all junction boxes with the panel, circuit number, and voltage with permanent marker. For boxes exposed in finished spaces, label the inside of the cover.
2. Box for communications, fire alarm, and access control shall be provided with color coded covers. Coordinate color to be used with owner.

J. Underground Warning Tape Installation:

1. Install underground warning tape along length of each underground conduit, raceway, or cable 6 to 8 inches below finished grade, directly above buried conduit, raceway, or cable.

K. Warning Sign Mounting

1. Provide the number of signs required to be readable from each accessible side, but space the signs a maximum of 30 feet apart.

END OF SECTION

SECTION 26 05 73 - OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies to be performed by equipment manufacturer's representative. Protective devices shall be field set by contactor based on results of the protective device coordination study.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUBMITTALS

- A. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form. Provide proposed methodology for approval prior to conducting actual study. Proceed with study upon approval of methodology by Engineer.
 1. Study and Equipment Evaluation Reports.
 2. Coordination-Study Report.
- B. Short circuit analysis shall be performed concurrent with equipment submittal (prior to ordering equipment with overcurrent protective devices) to verify that all equipment had adequate AIC ratings for the available fault current to which it will be subjected.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.
- B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

- A. Comply with IEEE 399.
- B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

- A. Gather and tabulate the following input data to support coordination study:
 - 1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - 2. Impedance of utility service entrance.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and types.
 - b. Relays and associated power and current transformer ratings and ratios.
 - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
 - d. Generator kilovolt amperes, size, voltage, and source impedance.
 - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
 - f. Busway ampacity and impedance.
 - g. Motor horsepower and code letter designation according to NEMA MG 1.
 - 4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Special load considerations, including starting inrush currents and frequent starting and stopping.
 - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

- c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
- d. Generator thermal-damage curve.
- e. Ratings, types, and settings of utility company's overcurrent protective devices.
- f. Special overcurrent protective device settings or types stipulated by utility company.
- g. Time-current-characteristic curves of devices indicated to be coordinated.
- h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 1. Switchgear and switchboard bus.
 2. Medium-voltage controller.
 3. Motor-control center.
 4. Distribution panelboard.
 5. Branch circuit panelboard.
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 IEEE 241 and IEEE 242.
 1. Transformers:
 - a. ANSI C57.12.10.
 - b. ANSI C57.12.22.
 - c. ANSI C57.12.40.
 - d. IEEE C57.12.00.
 - e. IEEE C57.96.
 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
- B. Comply with IEEE 141 IEEE 241 IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
 1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
 - a. Device tag.
 - b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.
 - c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
 - d. Fuse-current rating and type.
 - e. Ground-fault relay-pickup and time-delay settings.
 2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - a. Device tag.

- b. Voltage and current ratio for curves.
- c. Three-phase and single-phase damage points for each transformer.
- d. No damage, melting, and clearing curves for fuses.
- e. Cable damage curves.
- f. Transformer inrush points.
- g. Maximum fault-current cutoff point.

G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 26 05 73

SECTION 26 24 16 - PANELBOARDS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes
 - 1. Distribution panels
 - 2. Branch circuit panelboards,
 - 3. Electronic grade branch circuit panelboards.

1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
 - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
 - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
 - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
 - 3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
 - 4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
 - 5. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
 - 6. NEMA PB 1 - Panelboards.
 - 7. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- C. International Electrical Testing Association:
 - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. National Fire Protection Association:
 - 1. NFPA 70 - National Electrical Code.
- E. Underwriters Laboratories Inc.:
 - 1. UL 67 - Safety for Panelboards.
 - 2. UL 1283 - Electromagnetic Interference Filters.
 - 3. UL 1449 – 4th Edition – Standard for Surge Protective Devices

1.3 SUBMITTALS

- A. Shop Drawings: Manufacturer or contractor prepared drawings showing all relevant dimensions, weights, mounting requirements, and conduit entry points.
 - 1. Include dimensioned plan views and elevations.

- B. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
 - 1. Include amperage ratings, voltage, over-current protective device ratings, AIC ratings.
 - 2. Where multiple sizes are listed, indicate sizes to be used.
 - 3. Where multiple products are shown on the same page, indicate which products to be used.
- C. Source Quality-Control Test Reports
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified factory test report on unit to be shipped for this project showing compliance with all manufacturer tests.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of electrical equipment and record actual circuiting arrangements.
- B. Operation and Maintenance Data:
 - 1. Provide product data as defined under submittals.
 - 2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
 - 3. Submit spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.
- C. Field Quality-Control Test Reports: Report certified by field testing agent indicating results of performance testing required in Part 3 and/or on plans.
- D. Manufacturer's Field Report: Report certified by manufacturer's representative indicating inspections performed, testing observed, findings, and recommendations.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
 - 1. Manufacturer shall maintain or certify an independently operated service center capable of providing training, support, parts, and maintenance services.
- B. Supplier: Authorized distributor
- C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.
- D. Testing Agency: An independent agency with the documented experience and properly calibrated, fully functioning equipment to conduct the testing required by the specifications, plans and code, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL), and is acceptable to the authority having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.
- B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 WARRANTY

- A. Provide manufacturer's standard form clearly stating that manufacturer agrees to repair or replace equipment, materials, and associated auxiliary components that fail or deteriorate within the specified warranty period.
- B. Warranty Period: one (1) year from the date of substantial completion

1.8 DELIVERY STORAGE AND HANDLING

- A. Store in clean, dry space located above grade and protect from dirt, water, construction debris, traffic, freeze, and where applicable, deterioration from sun light.
- B. Maintain factory wrapping or provide additional canvas or plastic cover for all large electrical equipment. Follow all manufacturer recommendations for humidity and max/min temperatures for storing electrical equipment.

1.9 MAINTENANCE MATERIALS

- A. Furnish four of each panelboard key. Panelboards keyed alike.

PART 2 PRODUCTS

2.1 DISTRIBUTION PANELBOARDS

- A. Manufacturers:
 1. Eaton
 2. ABB
 3. Siemens
 4. Square D

5. Substitutions: With engineer approval.
- B. Product Description: NEMA PB 1, circuit breaker type panelboard.
- C. Panelboard Bus:
 1. Aluminum or Copper current carrying components, ratings as indicated on Drawings.
 2. Furnish copper ground bus in each panelboard.

3. Furnish fully rated copper neutral bus in each panelboard.
4. For non-linear load applications subject to harmonics furnish 200 percent rated, plated copper, solid neutral.

D. Minimum integrated short circuit rating: as shown on plans

E. Molded Case Circuit Breakers:

1. NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
2. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
3. Where LSI and/or G are noted adjacent to a circuit breaker on the one line diagram, Long, Short, Instantaneous and/or Ground Fault Trip and Delay functions shall be provided for the indicated circuit breaker.
4. Whether noted on one line or not, provide adjustable instantaneous trip for all breakers rated 600A or more.
5. All circuit breakers rated 1200A or more shall be provided with maintenance mode option.
6. Whether noted on one line or not, for distribution breakers rated 800A or more, provide solid state trip units with the following adjustable trip settings
 - a. Long Time Trip
 - b. Long Time Delay
 - c. Short Time Trip
 - d. Short Time Delay
 - e. Instantaneous Trip
 - f. Ground Fault Trip
 - g. Ground Fault Delay
7. Where the main distribution panel's main circuit breaker is provided with ground fault protection, all circuit breakers in the main distribution panel shall also be provided with ground fault protection.

F. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.

G. Enclosure: NEMA PB 1, Type 1 unless noted otherwise

1. Dimensions shall not be significantly greater than similar panels from the manufacturers listed above.
2. Cover: Flush cabinet front with continuous hinge or bolted cover.
3. Door: Hinged, metal directory frame, and flush latch and lock, all keyed alike.
4. Finish in manufacturer's standard gray enamel except as noted below.
5. For panels on building exteriors in visible locations, paint to match surface to which they are attached.

2.2 BRANCH CIRCUIT PANELBOARDS

A. Manufacturers:

1. Eaton
2. ABB
3. Siemens
4. Square D

5. Substitutions: With engineer approval.

B. Product Description: NEMA PB 1, circuit breaker type, lighting and appliance branch circuit panelboard.

C. Panelboard Bus:

1. Aluminum or Silver tinned plated copper current carrying components, ratings as indicated on Drawings.
2. Furnish copper ground bus in each panelboard.
3. Furnish fully rated copper neutral bus in each panelboard.
4. For non-linear load applications subject to harmonics furnish 200 percent rated, plated copper, solid neutral.

D. Minimum Integrated Short Circuit Rating: 10KAIC unless higher value indicated on Drawings.

E. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as:

1. Type SWD for lighting circuits.
2. Type HACR for air conditioning equipment circuits.
3. Class A ground fault interrupter circuit breakers as indicated on Drawings.
4. UL 1699 compliant arc flash circuit interrupter for all circuits serving receptacles in every room of dwelling units.
5. Do not use tandem circuit breakers.

F. Current Limiting Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size NEMA FU 1, Class RK-5 fuse.

G. Enclosure: NEMA PB 1, Type 1 unless noted otherwise

1. 6 inches deep, 20 inches wide.
2. Cover: Flush cabinet front with screw on cover or continuous hinge.
3. Door: continuous hinge, metal directory frame, and flush lock keyed alike.
4. Finish in manufacturer's standard gray enamel except as noted below.
5. For panels on building exteriors in visible locations, paint to match surface to which they are attached.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install panelboards:

1. In accordance with NEMA PB 1.1.
2. Plumb with adjacent walls and supports.
3. Flush with wall finishes if recessed in wall.
4. By securing all four corners to the adjacent structure using appropriate supports.

5. On concrete pads if floor mounted.
- B. Provide each panel with:
 1. Filler plates for unused spaces in panelboards.
 2. Typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.
 3. Engraved plastic nameplates identifying panel name, source, amperage, and voltage.
- C. Mounting Requirements
 1. Elec/Mech Rms, Warehouses, Industrial Locations, Closets: Surface mount using u-channel supports behind panel to stand panel off wall. In constrained spaces, panels may be secured directly to the wall where required to provide access to equipment, meet egress requirements, or NEC working space requirements.
 2. Finished Corridors, Lobbies, Office Areas: Recess mount panels in wall. Coordinate with general contractor to ensure wall thickness is adequate to flush mount panels. (6" studs, typical).
 3. Where panels are surface mounted in corridors or other egress pathways, provide sheet metal skirt from bottom edge of panel to finished floor for ADA compliance.
 4. Exterior Building Walls: Surface mount using galvanized u-channel supports behind panel to stand panel off wall.
 5. Exterior Free Standing: Mount to galvanized u-channel rack with minimum of two (2) horizontal supports behind panel and one (1) horizontal support below panel to secure conduits. Vertical supports shall be imbedded in concrete foundation or bolted to concrete pad. If bolted to pad, provide 45-degree angle braces attached to vertical support one foot or more above pad.
6. Mounting Height:
 - a. Interior Spaces: 6 feet to top of panelboard.
 - b. Install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
 - c. Exterior: To help shield from view, mount panels as low as practical. Bottom of panel shall be at least 18" AFG unless floor mounted or mounted over concrete, asphalt, etc.
- D. Install spare conduits out of each recessed panelboard to accessible location above ceiling. Minimum spare conduits: 5 empties 1 inch. Identify each as SPARE.
- E. Grounding
 1. Ground and bond panelboard enclosure according to grounding specifications and code.
 2. Connect equipment ground bars of panels in accordance with NFPA 70.
- F. Provide main distribution panel with meter as described above. Provide other panels with meters were noted on plans.

3.2 FIELD QUALITY CONTROL

- A. Tighten all accessible electrical connections to the manufacturer's torque specifications.
- B. Remove all blocks, packing and shipping materials, and foreign materials.
- C. Manually exercise all switches, circuit breakers, and other operating mechanisms to make certain they operate freely.

- D. Check integrity of all electrical and mechanical interlocks and padlocking mechanisms.
- E. Conduct an insulation resistance test phase to ground and phase to phase with the OCPDs in both the open and closed position. Resistance in open position shall be 1 megohm min. Remediate and retest if resistance is less. Verify that any metering or surge protection equipment that could be damaged by this testing has been disconnected and or removed as needed for testing.
- F. Test all ground fault protection systems in accordance with the manufacturer's instructions.

3.3 ADJUSTING

- A. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes
 - 1. Wall switches
 - 2. Wall dimmers
 - 3. Receptacles
 - 4. Floor-boxes
 - 5. Device plates and decorative box covers.
 - 6. Occupancy sensors

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA WD 1 - General Requirements for Wiring Devices.
 - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

1.3 SUBMITTALS

- A. Product Data: Submit catalog data showing all standard features, dimensions, weights, listings and product labels, material types, finishes and clearly indicating which optional features will be provided.
 - 1. Include amperage and voltage ratings.
 - 2. Include color to be used for each wiring device. Architect to select and approve device colors
 - 3. Device and cover plate shall not be ordered until color selections are approved in writing by architect.
 - 4. Where multiple sizes are listed, indicate sizes to be used.
 - 5. Where multiple products are shown on the same page, indicate which products to be used.
- B. Source Quality-Control Test Reports
 - 1. Certified summary of prototype-unit test report.
 - 2. Certified factory test report on unit to be shipped for this project showing compliance with all manufacturer tests.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of each floor box and poke-through fitting.
- B. Operation and Maintenance Data:
 - 1. Provide product data as defined under submittals.

ZIPP FAMILY SPORTS PARK

2. Provide manufacturer's installation and maintenance instructions for normal operation, routine maintenance and testing, and emergency maintenance procedures.
3. Submit spare parts listing; source of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Supplier: Authorized distributor
- C. Installer: A licensed electrician with documented experience installing all equipment specified here in shall directly supervise all work. Where noted in the specifications or required by the manufacturer, installer shall be a manufacturer trained and/or certified installer of the specific product to be installed.

1.6 QUALITY ASSURANCE

- A. Source Limitations: All components required for a complete functioning system as described here in shall be obtained through one source from a single manufacturer.
- B. Listing and Labeling: Where required, all electrical components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for the intended use. Testing agency shall be UL unless noted otherwise or pre-approved by owner and AHJ.

1.7 WARRANTY

- A. Warranty Period: one (1) year from the date of substantial completion

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Wiring device type and color shall be location specific.
 1. In general, use "architectural style" devices in public areas and heavy-duty device in back of house.
 2. Device color shall be selected by architect.
 3. Use white devices if and only if no selection is made by architect.

2.2 WALL SWITCHES

- A. Manufacturers:
 1. Cooper Wiring Devices
 2. Harvey Hubbell, Inc.
 3. Leviton Manufacturing Company.

4. Substitutions: With engineer approval.
- B. Product Description:
 1. NEMA WD 1, General-Duty, commercial grade, AC only general-use snap switch, unless noted otherwise.
 2. NEMA WD 1, General-Duty, Residential grade, AC only general use switches in dwelling units only.
 3. Provide heavy duty industrial grade switches in janitor's closet, mechanical rooms, manufacturing areas, and labs.
 4. One-piece brass integral ground terminal
- C. Ratings:
 1. Voltage: 120-277volts, AC.
 2. Current: 20 amperes.
 3. 1HP-120V, 2HP 240-277V
- D. Body and Handle:
 1. Nylon.
 2. Provide rocker or toggle switches in finished areas.
 3. Provide toggle switches in un-finished areas such as janitor's closet, mechanical rooms, manufacturing areas, and labs.
- E. Indicator Light: Separate pilot strap; red color.
- F. Locator Light: Lighted handle type switch; red color.

2.3 WALL DIMMERS

- A. Manufacturers:
 1. Cooper Wiring Devices
 2. Harvey Hubbell, Inc.
 3. Leviton Manufacturing Company.
 4. Substitutions: With engineer approval.
- B. Product Description:
 1. NEMA WD 1
 2. Semiconductor dimmer for incandescent lamps only.
- C. Body and Handle:
 1. Slide dimmer
 2. Nylon
 3. Push button on off control
- D. Voltage: 120-277 volts.
- E. Power Rating: Match load shown on drawings, 1000W minimum
- F. Accessory Wall Switch: Match dimmer appearance.

2.4 RECEPTACLES

- A. Manufacturers:
 - 1. Cooper Wiring Devices
 - 2. Harvey Hubbell, Inc.
 - 3. Leviton Manufacturing Company.
 - 4. Substitutions: With engineer approval.
- B. Product Description:
 - 1. NEMA WD 1, General-duty, commercial grade receptacle, unless noted otherwise.
 - 2. NEMA WD 1, General-duty, residential-grade in dwelling units only.
 - 3. Provide heavy duty industrial grade receptacles in janitor's closets, mechanical rooms, manufacturing areas, and labs.
 - 4.
 - 5. One-piece brass integral ground straps
 - 6. Ground retention clips
 - 7. Back wired ground terminals
 - 8. Face and body: nylon
- C. Controlled Receptacles
 - 1. Face and body of receptacles that are switched by occupancy sensing device or other means shall have permanent marking indicating which outlet is switched.
 - 2. All Marking shall be manufacturer applied and permanent.
 - 3. Marking shall include universal power symbol adjacent to each switched outlet.
 - 4. Receptacle shall also say "CONTROLLED"
 - 5. Where only one of two receptacles in a duplex are switched, switched outlet shall have permanent manufacturer marking such as color coding or square box around the switched receptacle.
 - a.
- D. Minimum rating: 20A, 125V
- E. Configuration: NEMA WD 6, type as indicated on Drawings.
- F. Convenience Receptacle:
 - 1. Type 5-20, unless noted otherwise
 - 2. 2 pole, 3 wire grounding
- G. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.
- H. USB Charging Receptacles:
 - 1. Each USB/Duplex receptacle combination shall have:
 - a. Two USB 2.0 ports
 - b. 2.0 Amps, 5 Volts DC, Type A.
 - c. USB port shall be rated for at minimum 10,000 insertions and removals

2.5 WALL PLATES

- A. Manufacturers:
 - 1. Provide product by the manufacturer of the wiring device being covered by the wall plate
- B. Decorative Cover Plate: Nylon to match receptacle color. Coordinate color and finish with architect.
- C. Weatherproof Cover Plate: Nylon plate with gasketed device cover. Coordinate color, finish, and/or painting requirements with architect.

2.6 FLOOR BOXES

- A. Manufacturers:
 - 1. Hubbell
 - 2. Wiremold
 - 3. Substitutions: With engineer approval.
- B. Product Description
 - 1. NEMA OS 1
 - 2. Four gang deep boxes,
 - a. Provide two duplex receptacles per receptacle specification above.
 - b. Provide two data mounting plates.
 - c. Power and data shall be on opposite sides of the box, with angled mounting plates and adequate space inside box to completely enclose 4 power plugs and data cables with the cover closed.
 - 3. Flush mounted flanged cover
 - a. Shall meet UL requirements for scrub water exclusion
 - b. Provide with provisions for carpet or tile insert into cover
 - c. Two cable doors within cover, one each for power and data
 - 4. Fully adjustable, field configurable
 - 5. Tamper-Resistant:
 - a. All dwellings, guest rooms and guest suites in hotels/motels, and child care facilities shall be provided with tamper resistant
 - b. All other locations as required by code and or noted on the plans
 - c. Provide at all other locations as noted.
 - 6. GFCI Rated: Unless noted otherwise or provided at circuit breaker, all receptacles at the following locations shall have integral ground fault circuit interrupt units:
 - a. All exterior locations, including roof mounted or under canopies.
 - b. Within 6ft of sinks, hose bibs, or other sources of water.
 - c. Janitor's closets
 - d. All other locations as required by code and or noted on the plans
- C. Material:
 - 1. Use cast or stamped steel.
 - 2. Cover shall be cast aluminum.
- D. Shape: Rectangular

E. Configuration:

1. Two duplexes and two communications outlets in open areas
2. Furniture feed type where installed under system furniture or conference tables that are provided with integral receptacles. Contractor shall verify before ordering floor box.

2.7 POKE-THROUGH FITTINGS

A. Manufacturers:

1. Hubbell
2. Wiremold
3. Substitutions: With engineer approval.

B. Product Description:

1. Assembly comprising service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination
2. Provide one duplex receptacle per receptacle specification above, circuited as noted.
3. Provide one data mounting plate.
4. Power and data shall have separate raceways through poke-through to floor below.

C. Fire Rating: 3 hours.

D. Service Fitting Type: Flush.

E. Housing: Satin aluminum. Coordinate with architect before ordering

F. Device Plate: Stainless steel

G. Configuration:

1. One duplex and one communications outlet in open areas
2. Furniture feed type where installed under system furniture or conference tables that are provided with integral receptacles. Contractor shall verify before ordering poke through.

2.8 OCCUPANCY SENSORS - LINE VOLTAGE

A. Specification for occupancy sensors that are part of a low-voltage controlled system are found in Section 26 09 43 – Network Lighting Controls.

B. Manufacturers:

1. Cooper
2. Douglas Lighting Controls
3. Hubbell
4. Leviton
5. Lutron
6. Watt Stopper
7. Substitutions: With engineer approval.

C. Product Description:

1. Devices shall include both infrared and ultrasonic sensing (elsewhere noted dual technology or multi-technology)

2. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 30 minutes.
3. Operation shall be silent.
4. Integral daylight sensing with automatic shutoff at field adjustable light level.
5. 1000VA at 120V, 2700VA at 277V rated
6. 2000 sq. ft. coverage area.
 - a. 1000 sq. ft. coverage may be used for room 800 sq ft or less, except restrooms and cubicle areas.
 - b. 500 sq. ft. or less coverage devices shall not be used.
 - c. Ceiling mounted sensors
 - d. 360-degree sensing, unless noted 180-degree.
 - e. Ultrasonic sensors on both side of device, unless noted 180-degree.
 - f. Device shall be capable of being wired in parallel with additional occupancy sensors for large spaces.
7. Wall mounted sensors
 - a. Integral on/off pushbutton
 - b. 180-degree sensing

D. Programming

1. Set off delay to 15 minutes minimum.
2. Set off delay to 30 minutes in open office areas and restrooms.
3. Start in the morning and periodically check light levels throughout the day. Set daylight sensing automatic shutoff at the time when and if 40FCs are first measured at 36 inches above floor in the area controlled by the sensor.
4. Set daylight sensing as follows: switch lighting off, temporarily set off-delay to 0, verify adequate foot-candle levels, switch lighting on, and adjust dial until lights switch off
5. Any lighting within the space that is not controlled by the sensor should remain on throughout the programming process.
6. More detail procedures for daylight sensor programming are required when daylight controls are used for selective switching of specific lights within a space that are located near sources of daylight. The procedures described here apply to whole room occupancy sensors only.

E. Dual Relay devices:

1. Where occupancy sensors are indicated on the architectural, mechanical, or electrical plans to control additional equipment (exhaust fans, outside air dampers, etc.), provide sensor with a second dedicated relay with appropriate voltage and power rating for the equipment to be served.
2. Electrical contractor shall coordinate with GC, mechanical contractor, and controls contractors to determine all locations where dual relays are required and insure the appropriate model device is ordered.

F. Corridor and Hallway Sensors:

1. Capable of detecting motion 14 feet wide and 80 feet long with one sensor mounted 10 feet above floor.
2. Capable of detecting motion in warehouse aisle 10 feet wide and 60 feet long or 100 feet long when mounted 22 feet above floor.
3. Device shall be capable of being wired in parallel with additional occupancy sensors

2.9 PHOTOC CELLS (DAYLIGHT SENSORS) – LINE VOLTAGE

- A. Specification for daylight sensors that are part of a low-voltage controlled system are found in Section 26 09 43 – Network Lighting Controls.
- B. Manufacturers:
 - 1. Cooper
 - 2. Douglas Lighting Controls
 - 3. Hubbell
 - 4. Leviton
 - 5. Lutron
 - 6. Watt Stopper
 - 7. Substitutions: With engineer approval.
- C. Product Description:
 - 1. Photoelectric light level sensor
 - 2. Separate sensitivity and time delay adjustments. User adjustable time-delay: 30 seconds to 30 minutes.
 - 3. Operation shall be silent.
 - 4. 1000VA at 120V, 2700VA at 277V rated
 - 5. 2000 sq. ft. coverage area.
 - a. 1000 sq. ft. coverage may be used for room 800 sq. ft. or less, except restrooms and cubicle areas.
 - b. 500 sq. ft. or less coverage devices shall not be used.
 - 6. Device shall be capable of being wired in parallel with additional sensors for large spaces.
- D. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.
 - 1. Exterior Lighting: Hooded sensor, horizontally mounted, employing flat lens, and working range 1-100 foot-candles in 10 percent increments. Entire sensor encased in optically clear epoxy resin.
 - 2. Indoor Lighting: Sensor with Fresnel lens providing for 60-degree cone shaped response area to monitor indoor office lighting levels.
 - 3. Atriums: Sensor with translucent dome with 180-degree field of view and respond in range of 10-1,000 foot-candles.
 - 4. Skylights: Sensor with translucent dome with 180-degree field of view and respond in range of 10-1,000 foot-candles.
- E. Programming for Dimmed Daylight Control
 - 1. Manufacturer to program.
- F. Programming for On/Off Daylight Control
 - 1. Set off delay to 0 for programming, but adjust to 15 minutes after programming to avoid nuisance operation of the device.
 - 2. Any lighting within the space that is not controlled by the sensor should remain on throughout the programming process.

3. At mid-day on a cloudless day, verify with a light meter that the required foot-candle levels are measured at the required location for each space with the lighting to be controlled by the sensor off.
4. If the required light levels are not present, instruct owner in the procedure for setting the device and advise owner to repeat programming effort the following August.
5. If the required light levels are not present, return to site and repeat programming effort the following August. Coordinate visit with owner.
6. If required light levels are present, periodically check light levels on the following day, starting in the early morning, and program sensor when the required light levels first appear.
7. Turn lighting on and adjust dial until lights switch off.
8. Set office and work area sensor as follows
 - a. Offices: 40FC measured at the working surface when the lighting controlled by the sensor is off.
 - b. Open Offices: 40FC measured at the working surface of the cubicle furthest from the source of daylight (i.e. windows) and located between the source of daylight and the first row of lights not controlled by the daylight sensor.
9. Set sensors in other locations by measuring the following levels at floor level along the centerline of the space between the wall transmitting daylight and the outside edge of the first row of lights that will remain on after the daylight sensor controlled lights are switched off.
 - a. Conference Rooms: 30FC
 - b. Corridors: 20FC
 - c. Lobbies: 20 FC
 - d. Classrooms: 50FC
 - e. Dinning: 30 FC
 - f. Restrooms: 20FC

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify outlet boxes are installed at proper height.
- B. Verify wall openings are neatly cut and completely covered by wall plates.
- C. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- D. Verify locations of floor boxes and outlets prior to rough in

3.2 PREPARATION

- A. Clean debris from outlet boxes.

3.3 INSTALLATION

- A. Install devices plumb and level.
- B. Connect wiring device grounding terminal to outlet box with bonding jumper and branch circuit equipment grounding conductor.
- C. Install boxes and fittings to preserve fire resistance rating of slabs and other elements
- D. Connect wiring devices by wrapping solid conductor around screw terminal.
 1. Install stranded conductor for branch circuits 10 AWG and smaller.
 2. When stranded conductors are used in lieu of solid, use crimp on fork terminals for device terminations.
 3. Do not place bare stranded conductors directly under device screws.
- E. Wall Plates
 1. Install wall plates on flush mounted switches, receptacles, and blank outlets.
 2. Install decorative plates with concealed screws on switches, receptacles, and blank outlets in finished areas.
 3. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
 4. Use jumbo size plates for outlets installed in masonry walls.
- F. Switches
 1. Install switches with OFF position down.
 2. Where multiple switches are installed at the same location, switches shall be ganged together.
- G. Dimmers
 1. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
 2. Do not share neutral conductor on load side of dimmers.
 3. Install dimmers on the load side of occupancy sensors and other controls.
- H. Receptacles
 1. Install receptacles with grounding pole on top.
 2. Provide appropriate receptacle type for the application per the requirements listed in part 2 above.
- I. Floor Boxes
 1. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
 2. Set floor boxes level with finished floor. Smooth any edges that protrude above finished floors
 3. Provide a communications conduit with pull string from all floor boxes and poke throughs to the accessible ceiling on the level that the device serves or to the appropriate communications closet as required. Refer to plans for conduit size, 1" minimum.
- J. Occupancy and photo sensors

1. Install ceiling mounted devices in center of area to be covered.
2. Install wall mounted devices at the typical switch location unless gimbal mounted.
3. Install gimbal mounted wall switches at 18" below ceiling.
4. Install 180-degree ceiling mounted devices at locations that are exposed to adjacent spaces from which false on signals could come.
5. Install gimbal mounted and 180-degree ceiling devices at edge of space facing towards the area to be covered and away from adjacent spaces from which false on signals could come

K. Relays

1. Mount relay as indicated on Drawings. Wire numbered relays in panel to control power to each load. Install relays to be accessible. Allow space around relays for ventilation and circulation of air.
2. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.
3. Label each low voltage wire with relay number at each switch or sensor

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes with furniture and equipment.
- B. Install wall switch 48 inches above finished floor.
- C. Install convenience receptacle 18 inches above finished floor.
- D. Install convenience receptacle 6 inches above back splash of counter.
- E. Install dimmer 48 inches above finished floor.

3.5 FIELD QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch and occupancy sensor with circuit energized and verify proper operation.
- C. Verify each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.6 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust floor box flush with finish flooring material

3.7 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.
- B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION

SECTION 26 56 68 – EXTERIOR ATHLETIC LIGHTING

Lighting System with LED Light Source

PART 1 – GENERAL

1.1 SUMMARY

- A. Work covered by this section of the specifications shall conform to the contract documents, engineering plans as well as state and local codes.
- B. The purpose of these specifications is to define the lighting system performance and design standards for Zipp Family Sports Park using an LED Lighting source. The manufacturer / contractor shall supply lighting equipment to meet or exceed the standards set forth in these specifications.
- C. The sports lighting will be for the following venues:
 1. Softball
 2. Baseball
 3. Soccer
 4. Parking Lot
- D. The primary goals of this sports lighting project are:
 1. Guaranteed Light Levels: Selection of appropriate light levels impact the safety of the players and the enjoyment of spectators. Therefore light levels are guaranteed to not drop below specified target values for a period of 25 years.
 2. Environmental Light Control: It is the primary goal of this project to minimize spill light to adjoining properties and glare to the players, spectators and neighbors.
 3. Cost of Ownership: In order to reduce the operating budget, the preferred lighting system shall be energy efficient and cost effective to operate. All maintenance costs shall be eliminated for the duration of the warranty.
 4. Control and Monitoring: To allow for optimized use of labor resources and avoid unneeded operation of the facility, customer requires a remote on/off control system for the lighting system. Fields should be proactively monitored to detect luminaire outages over a 25-year life cycle. All communication and monitoring costs for 25-year period shall be included in the bid.

1.2 LIGHTING PERFORMANCE

- A. Illumination Levels and Design Factors: Playing surfaces shall be lit to an average target illumination level and uniformity as specified in the chart below. Lighting calculations shall be developed and field measurements taken on the grid spacing with the minimum number of grid points specified below. Appropriate light loss factors shall be applied and submitted for the basis of design. Average illumination level shall be measured in accordance with the IESNA LM-5-04 (IESNA Guide for Photometric Measurements of Area and Sports Lighting Installations). Illumination levels shall not to drop below desired target values in accordance to IES RP-6-15, Page 2, Maintained Average Illuminance and shall be guaranteed for the full warranty period.

Area of Lighting	Average Target Illumination Levels	Maximum to Minimum Uniformity Ratio	Grid Points	Grid Spacing
Softball 1 - 4	50fc Infield / 30fc Outfield	2:1 Infield / 2.5:1 Outfield	25 / 181	20' x 20'
1 st Base Bullpens	17fc	4:1	8	10' x 10'
3 rd Base Bullpens	17fc	4:1	8	10' x 10'
Batting Cage	17fc	3:1	15	10' x 10'
Baseball 1, 3 & 4	50fc Infield / 30fc Outfield	2:1 Infield / 2.5:1 Outfield	25 / 91	30' x 30'

Baseball 2	50fc Infield / 30fc Outfield	2:1 Infield / 2.5:1 Outfield	25 / 82	30' x 30'
1 st Base Bullpens	20fc	3:1	7	10' x 10'
3 rd Base Bullpens	20fc	3:1	7	10' x 10'
Batting Cage	20fc	4:1	42	10' x 10'
Soccer 1 – 4	30fc	2.5:1	96	30' x 30'
West Parking Lot	2fc	NA	627	20' x 20'
North Parking Lot	2fc	NA	247	20' x 20'

- B. Future Fixture Accommodations: the lighting poles shall be set up for future soccer fields, where applicable.
- C. Color: The lighting system shall have a minimum color temperature of 5700K and a CRI of 75.
- D. Mounting Heights: To ensure proper aiming angles for reduced glare and to provide better playability, minimum mounting heights shall be as described below. Higher mounting heights may be required based on photometric report and ability to ensure the top of the field angle is a minimum of 10 degrees below horizontal.

# of Poles	Pole Designation	Pole Height
54	P1 – P54	30'
4	A1 – A4	60'
14	A5 – A8, C3 – C8 & C11 – C14	70'
20	B1 – B8, C1 – C2, C9 – C10, C15 – C16, S1, S3 – S4, S6 – S7 & S9	80'
3	S2, S5 & S8	90'

1.3 ENVIRONMENTAL LIGHT CONTROL

- A. Light Control Luminaires: All luminaires shall utilize spill light and glare control devices including, but not limited to, internal shields, louvers and external shields. No symmetrical beam patterns are accepted.
- B. Spill Light and Glare Control: To minimize impact on adjacent properties, spill light and candela values must not exceed the following levels taken at 3 feet above grade.

PROPERTY LINE	Maximum
Specified Spill Line Horizontal Footcandles	0.06 fc
Specified Spill Line Max Vertical Footcandles	0.13 fc
Specified Spill Line Max Candela	55,000 cd

- C. Spill Scans: Spill scans must be submitted indicating the amount of horizontal and vertical footcandles along the specified lines. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights. Illumination level shall be measured in accordance with the IESNA LM-5-04 after 1 hour warm up.
- D. The first page of a photometric report for all luminaire types proposed showing horizontal and vertical axial candle power shall be provided to demonstrate the capability of achieving the specified performance. Reports shall be certified by a qualified testing laboratory with a minimum of five years experience or by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products. A summary of the horizontal and vertical aiming angles for each luminaire shall be included with the photometric report.

1.4 Cost of Ownership

- A. Manufacturer shall submit a 25 year Cost of Ownership summary that includes energy consumption,

anticipated maintenance costs, and control costs. All costs associated with faulty luminaire replacement - equipment rentals, removal and installation labor, and shipping - are to be included in the maintenance costs.

PART 2 – PRODUCT

2.2 SPORTS LIGHTING SYSTEM CONSTRUCTION

- A. Manufacturing Requirements: All components shall be designed and manufactured as a system. All luminaires, wire harnesses, drivers and other enclosures shall be factory assembled, aimed, wired and tested.
- B. Durability: All exposed components shall be constructed of corrosion resistant material and/or coated to help prevent corrosion. All exposed carbon steel shall be hot dip galvanized per ASTM A123. All exposed aluminum shall be powder coated with high performance polyester or anodized. All exterior reflective inserts shall be anodized, coated, and protected from direct environmental exposure to prevent reflective degradation or corrosion. All exposed hardware and fasteners shall be stainless steel, passivated and coated with aluminum-based thermosetting epoxy resin for protection against corrosion and stress corrosion cracking. Structural fasteners may be carbon steel and galvanized meeting ASTM A153 and ISO/EN 1461 (for hot dipped galvanizing), or ASTM B695 (for mechanical galvanizing). All wiring shall be enclosed within the cross-arms, pole, or electrical components enclosure.
- C. System Description: Lighting system shall consist of the following:
 - 1. Galvanized steel poles and cross-arm assembly.
 - 2. Non-approved pole technology:
 - a. Square static cast concrete poles will not be accepted.
 - b. Direct bury steel poles which utilize the extended portion of the steel shaft for their foundation will not be accepted due to potential for internal and external corrosive reaction to the soils and long term performance concerns.
 - 3. Lighting systems shall use concrete foundations. See Section 2.4 for details.
 - a. For a foundation using a pre-stressed concrete base embedded in concrete backfill the concrete shall be air-entrained and have a minimum compressive design strength at 28 days of 3,000 PSI. 3,000 PSI concrete specified for early pole erection, actual required minimum allowable concrete strength is 1,000 PSI. All piers and concrete backfill must bear on and against firm undisturbed soil.
 - b. For anchor bolt foundations or foundations using a pre-stressed concrete base in a suspended pier or re-inforced pier design pole erection may occur after 7 days. Or after a concrete sample from the same batch achieves a certain strength.
 - 4. Manufacturer will supply all drivers and supporting electrical equipment
 - a. Remote drivers and supporting electrical equipment shall be mounted approximately 10 feet above grade in aluminum enclosures. The enclosures shall be touch-safe and include drivers and fusing with indicator lights on fuses to notify when a fuse is to be replaced for each luminaire. Disconnect per circuit for each pole structure will be located in the enclosure. Integral drivers are not allowed.
 - b. Manufacturer shall provide surge protection at the pole equal to or greater than 40 kA for each line to ground (Common Mode) as recommended by IEEE C62.41.2_2002.
 - 5. Wire harness complete with an abrasion protection sleeve, strain relief and plug-in connections for fast, trouble-free installation.
 - 6. All luminaires, visors, and cross-arm assemblies shall withstand 150 mi/h winds and maintain luminaire aiming alignment.
 - 7. Control cabinet to provide remote on-off control, monitoring, and entertainment features of the lighting system. See Section 2.3 for further details.

8. Contactor cabinet to provide on-off control.
9. Manufacturer shall provide lightning grounding as defined by NFPA 780 and be UL Listed per UL 96 and UL 96A.
 - a. Integrated grounding via concrete encased electrode grounding system.
 - b. If grounding is not integrated into the structure, the manufacturer shall supply grounding electrodes, copper down conductors, and exothermic weld kits. Electrodes and conductors shall be sized as required by NFPA 780. The grounding electrode shall be minimum size of 5/8 inch diameter and 8 feet long, with a minimum of 10 feet embedment. Grounding electrode shall be connected to the structure by a grounding electrode conductor with a minimum size of 2 AWG for poles with 75 feet mounting height or less, and 2/0 AWG for poles with more than 75 feet mounting height.

D. Safety: All system components shall be UL listed for the appropriate application.

2.2 ELECTRICAL

- A. Electric Power Requirements for the Sports Lighting Equipment:
 1. Electric power: SEE ELECTRICAL PLANS
 2. Maximum total voltage drop: Voltage drop to the disconnect switch located on the poles shall not exceed three (3) percent of the rated voltage.
- B. Energy Consumption: The kW consumption for the field lighting system shall be \leq 415 kW.

2.3 CONTROL

- A. Instant On/Off Capabilities: System shall provide for instant on/off of luminaires.
- B. Lighting contactor cabinet(s) constructed of NEMA Type 4 aluminum, designed for easy installation with contactors, labeled to match field diagrams and electrical design. Manual off-on-auto selector switches shall be provided.
- C. Dimming: System shall provide for 3-stage dimming (high-medium-low). Dimming will be set via scheduling options (Website, app, phone, fax, email)
- D. Remote Lighting Control System: System shall allow owner and users with a security code to schedule on/off system operation via a web site, phone, fax or email up to ten years in advance. Manufacturer shall provide and maintain a two-way TCP/IP communication link. Trained staff shall be available 24/7 to provide scheduling support and assist with reporting needs.

The owner may assign various security levels to schedulers by function and/or fields. This function must be flexible to allow a range of privileges such as full scheduling capabilities for all fields to only having permission to execute "early off" commands by phone. Scheduling tool shall be capable of setting curfew limits.

Controller shall accept and store 7-day schedules, be protected against memory loss during power outages, and shall reboot once power is regained and execute any commands that would have occurred during outage.

- E. Remote Monitoring System: System shall monitor lighting performance and notify manufacturer if individual luminaire outage is detected so that appropriate maintenance can be scheduled. The controller shall determine switch position (manual or auto) and contactor status (open or closed).
- F. Management Tools: Manufacturer shall provide a web-based database and dashboard tool of actual field usage and provide reports by facility and user group. Dashboard shall also show current status of luminaire outages, control operation and service. Mobile application will be provided suitable for IOS, Android and Blackberry devices.

Hours of Usage: Manufacturer shall provide a means of tracking actual hours of usage for the field lighting system that is readily accessible to the owner.

1. Cumulative hours: shall be tracked to show the total hours used by the facility
2. Report hours saved by using early off and push buttons by users.

- G. Communication Costs: Manufacturer shall include communication costs for operating the control and monitoring system for a period of 25 years.
- H. Communication with luminaire drivers: Control system shall interface with drivers in electrical components enclosures by means of powerline communication.

2.4 STRUCTURAL PARAMETERS

- A. Wind Loads: Wind loads shall be based on the 2015 International Building Code. Wind loads to be calculated using ASCE 7-10, an ultimate design wind speed of 115mph and exposure category C.
- B. Pole Structural Design: The stress analysis and safety factor of the poles shall conform to 2013 AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals (LTS-6).
- C. Foundation Design: The foundation design shall be based on soil parameters as outlined in the geotechnical report. <Enter Geotech Company, Report #, Date, F11> If no geotechnical report is available, the foundation design shall be based on soils that meet or exceed those of a Class 5 material as defined by 2015 IBC Table 1806.2.
- D. Foundation Drawings: Project specific foundation drawings stamped by a registered engineer in the state where the project is located are required. The foundation drawings must list the moment, shear (horizontal) force, and axial (vertical) force at ground level for each pole. These drawings must be submitted at time of bid to allow for accurate pricing.

PART 3 – EXECUTION

3.1 SOIL QUALITY CONTROL

- A. It shall be the Contractor's responsibility to notify the Owner if soil conditions exist other than those on which the foundation design is based, or if the soil cannot be readily excavated. Contractor may issue a change order request / estimate for the Owner's approval / payment for additional costs associated with:
 1. Providing engineered foundation embedment design by a registered engineer in the State of TX for soils other than specified soil conditions;
 2. Additional materials required to achieve alternate foundation;
 3. Excavation and removal of materials other than normal soils, such as rock, caliche, etc.

3.2 DELIVERY TIMING

- A. Delivery Timing Equipment On-Site: The equipment must be on-site in approximately 6 weeks from receipt of approved submittals and receipt of complete order information.

3.3 FIELD QUALITY CONTROL

- A. Illumination Measurements: Upon substantial completion of the project and in the presence of the Contractor, Project Engineer, Owner's Representative, and Manufacturer's Representative, illumination measurements shall be taken and verified. The illumination measurements shall be conducted in accordance with IESNA LM-5-04.
- B. Field Light Level Accountability
 1. Light levels are guaranteed not to fall below the target maintained light levels for the entire warranty period of 25 years. These levels will be specifically stated as "guaranteed" on the illumination summary provided by the manufacturer.
 2. The contractor/manufacturer shall be responsible for conducting initial light level testing and an additional inspection of the system, in the presence of the owner, one year from the date of commissioning of the lighting.
 3. The contractor/manufacturer will be held responsible for any and all changes needed to bring

these fields back to compliance for light levels and uniformities. Contractor/Manufacturer will be held responsible for any damage to the fields during these repairs.

C. Correcting Non-Conformance: If, in the opinion of the Owner or his appointed Representative, the actual performance levels including footcandles and uniformity ratios are not in conformance with the requirements of the performance specifications and submitted information, the Manufacturer shall be required to make adjustments to meet specifications and satisfy Owner.

3.4 WARRANTY AND GUARANTEE

- A. 25-Year Warranty: Each manufacturer shall supply a signed warranty covering the entire system for 25 years from the date of shipment. Warranty shall guarantee specified light levels. Manufacturer shall maintain specifically-funded financial reserves to assure fulfillment of the warranty for the full term. Warranty does not cover weather conditions events such as lightning or hail damage, improper installation, vandalism or abuse, unauthorized repairs or alterations, or product made by other manufacturers.
- B. Maintenance: Manufacturer shall monitor the performance of the lighting system, including on/off status, hours of usage and luminaire outage for 25 years from the date of equipment shipment. Parts and labor shall be covered such that individual luminaire outages will be repaired when the usage of any field is materially impacted. Manufacturer is responsible for removal and replacement of failed luminaires, including all parts, labor, shipping, and equipment rental associated with maintenance. Owner agrees to check fuses in the event of a luminaire outage.

PART 4 – DESIGN APPROVAL

4.0 PRE-BID SUBMITTAL REQUIREMENTS (Non-Musco)

- A. Design Approval: The owner / engineer will review pre-bid submittals per section 4.0.B from all the manufacturers to ensure compliance to the specification 10 days prior to bid. If the design meets the design requirements of the specifications, a letter and/or addendum will be issued to the manufacturer indicating approval for the specific design submitted.
- B. Approved Product: Musco's Light-Structure System™ with TLC for LED™ is the approved product. All substitutions must provide a complete submittal package for approval as outlined in Submittal Information at the end of this section at least 10 days prior to bid. Special manufacturing to meet the standards of this specification may be required. An addendum will be issued prior to bid listing any other approved lighting manufacturers and designs.
- C. All listed manufacturers not pre-approved shall submit the information at the end of this section at least 10 days prior to bid. An addendum will be issued prior to bid; listing approved lighting manufacturers and the design method to be used.
- D. Bidders are required to bid only products that have been approved by this specification or addendum by the owner or owner's representative. Bids received that do not utilize an approved system/design, will be rejected.

REQUIRED SUBMITTAL INFORMATION FOR ALL MANUFACTURERS (NOT PRE-APPROVED) 10 DAYS PRIOR TO BID

All items listed below are mandatory, shall comply with the specification and be submitted according to pre-bid submittal requirements. Complete the Yes/No column to indicate compliance (Y) or noncompliance (N) for each item. Submit checklist below with submittal.

Yes/ No	Tab	Item	Description
	A	Letter/ Checklist	Listing of all information being submitted must be included on the table of contents. List the name of the manufacturer's local representative and his/her phone number. Signed submittal checklist to be included.
	B	Equipment Layout	Drawing(s) showing field layouts with pole locations
	C	On Field Lighting Design	Lighting design drawing(s) showing: <ul style="list-style-type: none"> a. Field Name, date, file number, prepared by b. Outline of field(s) being lighted, as well as pole locations referenced to the center of the field (x & y), Illuminance levels at grid spacing specified c. Pole height, number of fixtures per pole, horizontal and vertical aiming angles, as well as luminaire information including wattage, lumens and optics d. Height of light test meter above field surface. e. Summary table showing the number and spacing of grid points; average, minimum and maximum illuminance levels in foot candles (fc); uniformity including maximum to minimum ratio, coefficient of variance (CV), coefficient of utilization (CU) uniformity gradient; number of luminaires, total kilowatts, average tilt factor; light loss factor.
	D	Off Field Lighting Design	Lighting design drawing showing initial spill light levels along the boundary line (defined on bid drawings) in footcandles. Lighting design showing glare along the boundary line in candela. Light levels shall be taken at 30-foot intervals along the boundary line. Readings shall be taken with the meter orientation at both horizontal and aimed towards the most intense bank of lights.
	E	Photometric Report	Provide first page of photometric report for all luminaire types being proposed showing candela tabulations as defined by IESNA Publication LM-35-02. Photometric data shall be certified by laboratory with current National Voluntary Laboratory Accreditation Program or an independent testing facility with over 5 years experience.
	F	Performance Guarantee	Provide performance guarantee including a written commitment to undertake all corrections required to meet the performance requirements noted in these specifications at no expense to the owner. Light levels must be guaranteed to not fall below target levels for warranty period.
	G	Structural Calculations	Pole structural calculations and foundation design showing foundation shape, depth backfill requirements, rebar and anchor bolts (if required). Pole base reaction forces shall be shown on the foundation drawing along with soil bearing pressures. Design must be stamped by a structural engineer in the state of TX, if required by owner. (May be supplied upon award).
	H	Control & Monitoring System	Manufacturer of the control and monitoring system shall provide written definition and schematics for automated control system. They will also provide ten (10) references of customers currently using proposed system in the state of TX.
	I	Electrical Distribution Plans	Manufacturer bidding an alternate product must include a revised electrical distribution plan including changes to service entrance, panels and wire sizing, signed by a licensed Electrical Engineer in the state of TX.
	J	Warranty	Provide written warranty information including all terms and conditions. Provide ten (10) references of customers currently under specified warranty in the state of TX.
	K	Project References	Manufacturer to provide a list of projects where the technology and specific fixture proposed for this project has been installed in the state of TX. Reference list will include project name, project city, installation date, and if requested, contact name and contact phone number.
	L	Product Information	Complete bill of material and current brochures/cut sheets for all product being provided.

	M	Delivery	Manufacturer shall supply an expected delivery timeframe from receipt of approved submittals and complete order information.
	N	Non-Compliance	Manufacturer shall list all items that do not comply with the specifications. If in full compliance, tab may be omitted.
	O	Cost of Ownership	Document cost of ownership as defined in the specification. Identify energy costs for operating the luminaires. Maintenance cost for the system must be included. All costs should be based on 25 Years
	P	Environmental Light Control Design	Environmental glare impact scans must be submitted showing the maximum candela from the field edge on a map of the surrounding area until 35,000 candela or less is achieved.

The information supplied herein shall be used for the purpose of complying with the specifications for Zipp Family Sports Park. By signing below I agree that all requirements of the specifications have been met and that the manufacturer will be responsible for any future costs incurred to bring their equipment into compliance for all items not meeting specifications and not listed in the Non-Compliance section.

Manufacturer: _____ **Signature:** _____

Contact Name: _____ **Date:** _____ / _____ / _____

Contractor: _____ **Signature:** _____

SECTION 31 05 13 - TOPSOIL

PART 1 GENERAL

1.1 SUMMARY

- A. Description: This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the Drawings or as directed by the Engineer.
- B. Section Includes:
 - 1. Topsoil materials.
- C. Related Sections:
 - 1. Section 31 10 00 – Site Clearing: Excavating topsoil.
 - 2. Section 31 23 10 – Structural Excavation and Backfill: Building excavation.
 - 3. Section 31 23 17 – Trenching: Trenching and backfilling for utilities.
 - 4. Section 31 23 23 – Fill: General building area backfilling.
 - 5. Section 32 91 19 – Landscape Grading: Finish grading with topsoil to contours.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures
- B. Samples: Submit, in air-tight containers, 10 lb sample of each type of fill to testing laboratory.
- C. Materials Source: Submit name of imported materials source.

1.3 QUALITY ASSURANCE

- A. Furnish topsoil material from single source throughout the Work, unless directed otherwise by Engineer.

PART 2 PRODUCTS

2.1 TOPSOIL MATERIALS

- A. Topsoil:
 - 1. This material shall consist of approved topsoil material and shall be clean, friable, loamy soil capable of supporting plant life
 - 2. This material can be excavated and reused material from on-site sources or imported from an approved off-site source.
 - 3. Reasonably free of roots, rocks larger than 2 inches, subsoil, debris, weeds, and foreign matter.
 - 4. Acidity range (pH) of 5.5 to 7.5.
 - 5. Containing minimum of 4 percent and maximum of 25 percent organic matter.

6. Conforming to ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System). Group Symbol OH or PT.
7. Limit decaying matter to 10 percent of total content by volume.

2.2 SOURCE QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. When tests and/or observations indicate materials do not meet specified requirements, change material and retest.
- D. Furnish materials of each type from same source throughout the Work, unless otherwise approved by Engineer. Off-site borrow sources shall be approved by the Engineer.

PART 3 EXECUTION

3.1 EXCAVATION

- A. Perform as specified in Section 31 10 00 – Site Clearing

3.2 STOCKPILING

- A. Stockpile materials at locations designated or approved by Engineer.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Stockpile topsoil to only a height which yields safe slope stability.
- E. Prevent intermixing of soil types or contamination.
- F. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.3 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.
- B. When borrow area is indicated, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

3.4 PLACING TOPSOIL

- A. Eliminate uneven areas and low spots.
- B. Remove debris, roots, branches, and stones in excess of 2 inches in size.

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- C. Scarify surface to depth of 4 inches, or as indicated on the Drawings, where topsoil is scheduled.
- D. Place topsoil in areas where seeding and/or sodding is required to nominal depth of four inches (plus or minus $\frac{1}{2}$ inch), or as indicated on the Drawings. For areas that will receive sod, leave topsoil low. Place topsoil during dry weather.
- E. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.
- F. Remove roots, weeds, rocks, and foreign material while spreading.
- G. Manually spread topsoil close to plant material, structures, water and wastewater appurtenances, concrete paving, and curbs to prevent damage.
- H. Lightly roll placed topsoil.
- I. Remove surplus topsoil from site.
- J. Leave stockpile area and site clean and raked, ready to receive seeding or sodding.
- K. Prohibit construction traffic over topsoil.

END OF SECTION

SECTION 31 10 00 – SITE CLEARING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Removing and disposing of surface debris, rubbish, and other objectionable materials.
 - 2. Removing and disposing of designated building slabs, paving, curbs, driveways, miscellaneous stone, brick, concrete, sidewalks, drainage structures, headwalls, safety end treatments, manholes, inlets, and abandoned railroad tracks.
 - 3. Removing and disposing of designated fencing and signage.
 - 4. Removing and disposing of designated trees, shrubs, and other plant life.
 - 5. Removing and disposing of designated abandoned water and wastewater utilities and septic tanks.
 - 6. Herbicide treatment
 - 7. Excavating topsoil.

- B. Related Sections:
 - 1. Section 31 05 13 - Topsoil: Soils for fill.
 - 2. Section 31 22 13 – Rough Grading
 - 3. Section 31 23 16 – Structural Excavation and Backfill: Building excavation.
 - 4. Section 31 23 17 - Trenching: Trenching and backfilling for utilities.
 - 5. Section 31 23 23 - Fill: General building area backfilling.
 - 6. Section 32 91 19 - Landscape Grading: Finish grading with topsoil to contours.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures

- B. Product Data: Submit data for herbicide. Indicate compliance with applicable codes for environmental protection.

1.3 QUALITY ASSURANCE

- A. Conform to applicable code for environmental requirements, disposal of debris, burning debris on site, and use of herbicides.

- B. Herbicide:
 - 1. License Requirements: Possess either a commercial pesticide applicator license from the Texas Department of Agriculture, or a Texas Structural Pest Control Service License. Provide documentation of license before beginning work. Conduct on-site supervision of all mixing, transporting, handling, spraying, and disposal of materials with licensed personnel.
 - 2. Records: Document work in accordance with all Federal, State, and Local regulations. Submit a copy of the herbicide records on the next business day following application. Submit a final copy of all the herbicide application records upon completion of the work.

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PART 2 PRODUCTS

2.1 MATERIALS

- A. Herbicide: Furnish herbicide materials in accordance with Section 15 of the 2017 TxDOT Herbicide Operations Manual.
- B. Pathfinder II, Transline, & Capstone are acceptable products that can be used in conjunction with each other.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify existing plant life designated to remain is tagged or identified.
- C. Identify spoils site for placing removed materials.

3.2 PREPARATION

- A. Call Texas 811 service at 800-344-8377 not less than three working days before performing Work.
 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Prior to commencing this work, erosion control measures shall be in place.

3.3 PROTECTION

- A. Locate, identify, and protect structures and utilities indicated to remain, from damage.
- B. Areas within the construction limits or as indicated shall be cleared of all trees, stumps, brush, etc. as defined above; except trees or shrubs indicated for preservation which shall be carefully trimmed as directed, and shall be protected from scarring, barking or other injuries during construction operations. Exposed ends of pruned limbs or scarred bark shall be pruned, trimmed and treated with an approved asphaltic material within 24 hours of the pruning or injury.
- C. Locate, protect, and maintain benchmarks, monuments, control points, and project engineering reference points. Re-establishment of disturbed or destroyed items shall be by a Registered Professional Land Surveyor (licensed in the state of Texas), at no additional cost to Owner.
- D. Construction equipment shall not be operated within the drip line of trees, unless indicated. Construction materials shall not be stockpiled under the canopies of trees. No excavation or embankment shall be placed within the drip line of trees until tree wells are constructed.

3.4 CLEARING

- A. Strip and remove from construction area all topsoil, organics, and vegetation to a minimum depth of 6 inches below the existing natural ground surface.
- B. Remove trees and shrubs within the construction limits unless noted otherwise in the Drawings. Remove stumps, main root ball, and root system. Holes remaining after the removal of all obstructions, objectionable materials, trees, stumps, etc. shall be backfilled with Structural Fill and compacted in accordance with Section 31 23 23 - Fill.
- C. Clear undergrowth and deadwood, without disturbing subsoil.
- D. Apply herbicide to remaining stumps to inhibit growth.

3.5 REMOVAL

- A. Remove surface debris, rock, and extracted trees, shrubs and other plant life from site, or as indicated on Drawings.
- B. Remove designated building slabs, paving, curbs, driveways, miscellaneous stone, brick, concrete, sidewalks, drainage structures, headwalls, safety end treatments, manholes, inlets, and abandoned railroad tracks as indicated on Drawings. Neatly saw cut edges at right angle to surface.
- C. Remove designated fencing and signage.
- D. Remove abandoned water and wastewater utilities and septic tanks. Indicated removal termination point for underground utilities on Record Documents.
- E. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- F. Do not burn or bury materials on site. Leave site in clean condition.

3.6 HERBICIDE TREATMENT

- A. Season: Spray herbicide during active growing periods unless otherwise approved.
- B. Equipment: Furnish all equipment.
 1. Broadcast application: furnish self-propelled equipment tractor mounted or pulled spray rigs with a low center of gravity that allows safe traverse on a maximum 3:1 slope. Provide equipment capable of making uniform broadcast application calibrated at a rate between 20 and 40 gallons per acre (GPA).
 2. Basal Bark and Cut Tree applications: Furnish sprayers with low volume spray tips (spray system 5500 adjustable spray tip X-1 or X-2, or approved equivalent).
 3. Personal Protection Equipment: Follow the manufacturer's label requirements for personal protection of employees.
- C. Work Methods: Apply approved herbicide in accordance with the manufacturer's label recommendations, as shown on the drawings or as approved. Add surfactant and blue dye

marker at the manufacturer's recommended rate unless otherwise approved. Prepare herbicide solution to the rates shown on the drawing using procedures on the herbicide container label. Dispose of empty containers and unused chemical mixtures in accordance with the label directions and local, state, and federal regulations. Cease spraying operation immediately when wind or other environmental conditions cause off-target spray drift, leaves are wet, or rainfall is imminent. An inspection of the treated areas will be made not less than 14 days and no later than 30 days after the application. Re-treat areas in which the undesirable vegetation has not be controlled for no additional compensation. Repair and replace any damaged desirable vegetation or erosion as a result of negligent applications.

1. Broadcast application: spray undesirable vegetation by broadcasting with spray nozzles at the desired rate. Ensure nozzles spray consistent across the area being covered.
2. Basal Bark treatment: apply herbicide solution with a low-volume, low pressure sprayer which thoroughly wets the lower 12-15 in. of stems on all sides, including the root collar area, but not to the point of run-off. Perform application at any time throughout the year, except when the stumps are wet from rainfall or dew prevents spraying to the base of the plant.
3. Cut-stump treatment: cut plants parallel to the ground, not to exceed 2 in. above the ground line. Apply the herbicide solution with a low-volume, low-pressure sprayer which thoroughly wets the area adjacent to the cambium and bard around the entire circumference of the stump. Thoroughly wet the sides of the stump, but not to the point of run-off. Make the herbicide application within 1 hr. from the time each plant is cut. Dispose of removed materials and debris at appropriate off-site locations in accordance with local, state, and federal requirements.
- D. Engineer reserves the right to pay a partial payment of 50% of the lump sum price bid after the initial application is performed. The final 50% of the lump sum price bid will be paid after the inspection and required re-treatments have been completed and accepted.

3.7 TOPSOIL EXCAVATION

- A. Excavate topsoil from areas to be further excavated, re-landscaped, re-graded, or within the construction limits of a structure without mixing with foreign materials for use in finish grading.
- B. Do not excavate wet topsoil.
- C. Stockpile in area designated on site to a height which yields safe slope stability and protect from erosion.
- D. Remove excess topsoil not intended for reuse, from project.

END OF SECTION

SECTION 31 22 13 - ROUGH GRADING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Excavating topsoil.
 - 2. Excavating subsoil.
 - 3. Cutting, grading, filling, and compacting site for building pads and paved areas.

- B. Related Sections:
 - 1. Section 31 05 13 - Topsoil: Soils for fill.
 - 2. Section 31 10 00 - Site Clearing: Excavating topsoil.
 - 3. Section 31 23 10 – Structural Excavation and Backfill: Building excavation.
 - 4. Section 31 23 16 – Excavation.
 - 5. Section 31 23 17 - Trenching: Trenching and backfilling for utilities.
 - 6. Section 31 23 23 - Fill: General building area backfilling.
 - 7. Section 32 91 19 - Landscape Grading: Finish grading with topsoil to contours.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

- B. ASTM International:
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 3. ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 6. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - 7. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).
 - 8. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 9. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

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- B. Samples: As requested by the Engineer, submit 10-lb samples of each type of fill material to testing laboratory.
- C. Materials Source: Submit name of imported materials suppliers.
- D. Manufacturer's Certificate: Certify fill meets or exceeds specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

PART 2 PRODUCTS – NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify site conditions under provisions of Section 31 23 10: Structural Excavation and Backfill.
- C. Verify survey benchmark and intended elevations for the Work are as indicated on Drawings.

3.2 PREPARATION

- A. Call Texas 811 service at 800-344-8377 not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum.
- C. Notify Pedernales Electric Cooperative to remove and relocate utilities.
- D. Protect utilities indicated to remain from damage.
- E. Protect trees, vegetation, rock outcrops, and other features shown to be protected.
- F. Protect benchmarks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

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3.3 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated or re-graded.
- B. Do not excavate wet subsoil or excavate and process wet material to obtain optimum moisture content.
- C. When excavating through roots of trees shown to be protected, perform Work by hand and cut roots with sharp axe.
- D. Remove excess subsoil from site not intended for reuse.
- E. Stockpile remaining subsoil to be used as fill in area designated on site in accordance with Section 31 05 13: Topsoil.
- F. Benching Slopes: Horizontally bench existing slopes greater than 1: 4 to key placed fill material to slope to provide firm bearing. Bench width shall be not more than five feet.
- G. Stability: Replace damaged or displaced subsoil as specified for fill.

3.4 FILLING

- A. Fill areas to contours and elevations with unfrozen materials.
- B. Place fill material in continuous layers and compact in accordance with the recommendations of Section 31 23 10 – Structural Excavation and Backfill, and Section 31 23 23 - Fill.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.
- D. Slope grade away from building minimum two (2) percent slope for minimum distance of 10 feet, unless noted otherwise.
- E. Make grade changes gradual. Blend slope into level areas.
- F. Repair or replace items indicated to remain damaged by excavation or filling.

3.5 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 foot (0.10') from required elevation.

3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing
- B. Perform laboratory material tests in accordance with ASTM D698 or TEX-114-E.
- C. Perform in place compaction tests in accordance with the recommendations of Section 31 23 10 – Structural Excavation and Backfill, and Section 31 23 23 - Fill.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

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END OF SECTION

FOR 90% REVIEW

Rough Grading
31 22 13 - 4

SECTION 31 23 15 - TRENCH SAFETY SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Furnishing all equipment, materials and labor for a trench safety system meeting appropriate requirements established in Occupational Safety and Health Administration (OSHA) Safety and Health Regulations, 29 CFR Part 1926, OSHA Standards – Excavations; Final Rule, October 31, 1989. In the event of conflict of published and proposed rules, the more stringent requirement shall be used.

1.2 REFERENCES

- A. Federal Occupational Safety and Health Administration (OSHA) Standards – 29 CFR, Part 1926, Subpart P, as amended, including Proposed Rules published in the Federal Register (Vol. 52, No. 72) on April 15, 1987; Sections 1926-650 through 1926-653.
- B. Texas Legislature House Bill No. 662 and House Bill No. 665 with regard to Trench Safety Systems.

1.3 DEFINITIONS

- A. Trench: A trench shall be defined as a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures
- B. Trench Safety Plan: Prior to construction the Contractor shall submit five copies of a trench safety system to the Engineer specifically for the construction of trench excavation. The trench safety system shall be in accordance with OSHA standards governing the presence and activities of individuals working in and around trench excavation. The trench safety system must be designed and sealed by a professional engineer registered in the State of Texas with professional experience in Soil Mechanics. The Contractor is responsible for obtaining borings and soil analysis as required for plan design. After receiving the trench safety system plans, the Engineer will forward a copy of the plan to the project inspector, to the Contractor and keep one file copy. The submittal is only for general conformance review with OSHA safety standards and the review does not relieve the Contractor or design professional of any or all construction means, methods, techniques and procedures. Any property damage, bodily injury or death that arises from use of the trench safety system or from the Owner's failure to note exceptions to the system shall remain the sole responsibility of the Contractor. No trenching in excess of 5 feet below existing grade will be allowed until the plan is submitted. Any changes in the trench safety system after the initiation of construction will not be cause for extension of time or change order and will require the same review process. On some projects, the Owner may elect to provide preliminary soil information to the Contractors for bid purposes only and not as a substitute for required soil data for design use. The Owner assumes no liability nor makes any guarantees by the inclusion of any soil data.

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1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with OSHA Regulations, 29 CFR Part 1926, OSHA Standards.
- B. Maintain one copy of OSHA Standards on site.

1.6 QUALIFICATIONS

- A. Prepare Trench Safety Plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Texas.

PART 2 PRODUCTS

2.1 TIMBER

- A. Trench sheeting materials shall be a minimum of 2 inches in thickness, solid and sound, free from weakening defects such as loose knots and splits. Shoring timber sizes shall not be less than that called for on the Trench Safety Plan.

2.2 STEEL SHEET PILING

- A. Steel sheet piling and steel for stringers and cross braces shall conform to ASTM A36 – Standard Specification for Carbon Structural Steel.

2.3 TRENCH BOXES

- A. Portable trench boxes shall be constructed of steel conforming to ASTM A36 - Standard Specification for Carbon Structural Steel. Connecting bolts shall conform to ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength. Welds shall conform to requirements of AWS Specification D1.1 – Structural Welding-Steel.

PART 3 EXECUTION

3.1 GENERAL

- A. Trench safety systems shall be constructed, installed and maintained in accordance with the design prepared by the Contractor's registered Professional Engineer licensed to practice in the State of Texas to prevent death or injury to personnel or damage to structures in or near these trench excavations. Materials excavated from trench to be stored no closer to the edge of trench than 1/2 the depth of the trench.

3.2 INSTALLATION

- A. Timber Sheeting: Installed in accordance with detail shown on drawings. Drive timber sheeting to a depth below trench bottom as shown on Drawings. Size of uprights, stringers and cross bracing to be in accordance with details shown on Drawings. Place cross braces in true horizontal position, spaced vertically, and secured to prevent sliding, falling or kickouts.

- B. Steel Sheet Piling: Steel sheet piling of equal or greater strength may be substituted for timber trench shoring shown on the drawings. Contractor to provide certification that steel sheet piling substituted provides equal or greater protection than timber trench shoring shown on drawings. Certification of steel sheet piling to be provided by registered Professional Engineer. Drive steel sheet piling to a minimum depth below trench bottom as recommended by Contractor's registered Professional Engineer licensed to practice in Texas providing design. Place cross braces in true horizontal position, spaced vertically and secured to prevent sliding, falling or kickouts.
- C. Trench Boxes: Portable trench box to be substituted for timber trench shoring shown on Drawings shall be designed or the design checked by Contractor's registered Professional Engineer licensed to practice in Texas. Design trench box to provide equal or greater protection than timber trench shoring shown on Drawings. Certification of the design of trench boxes shall be provided by Contractor prior to its use on project. In cases where top of portable trench box will be below to top of trench, the trench must be sloped to an angle greater than the angle of repose for the soil conditions existing on the project. In areas where sloped trench will affect the integrity of existing structures, Contractor to protect structures prior to sloping trench.
- D. Trench Jacks: When trench jacks are used for cross bracing and/or stringers, the Contractor shall provide certification by a registered Professional Engineer licensed to practice in Texas that the trench jacks provide protection greater than or equal to the timber cross bracing shown on Drawings.

3.3 SUPERVISION

- A. Contractor shall provide competent supervisory personnel at each trench while work is in progress to ensure Contractor's methods, procedures, equipment and materials pertaining to the safety systems in this item are sufficient to meet requirements of OSHA Standards.

3.4 MAINTENANCE OF SAFETY SYSTEM

- A. The safety system shall be maintained in the condition as shown on Drawings or as specified by the Contractor's registered Professional Engineer licensed to practice in Texas. The Contractor shall take all necessary precaution to ensure the safety systems are not damaged during their use. If at any time during its use a safety system is damaged, personnel shall be immediately removed from the trench or excavation area and the safety system repaired. The Contractor shall take all necessary precautions to ensure no loads, except those included in the safety system design, are imposed upon the excavation.

3.5 REMOVAL

- A. Bed and backfill pipe to a point at least one foot above top of pipe prior to removal of any portion of trench safety systems. Bedding and backfill shall be in accordance to other applicable specification items. Backfilling removal of trench supports shall progress together from bottom of trench upward. Remove no braces or trench supports until all personnel have evacuated the trench. Backfill trench to within 4 feet of natural ground prior to removal of entire trench safety systems.

3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. Inspection: Contractor shall make daily inspection of trench safety systems to ensure that the systems meet OSHA requirements. Daily inspection shall be made by competent personnel. If evidence of possible cave-ins or slides is apparent, all work in the trench shall cease until necessary precautions have been taken to safeguard personnel entering trench. Contractor shall maintain permanent record of daily inspections.

END OF SECTION

SECTION 31 23 16 - EXCAVATION

PART 1 GENERAL

1.1 SUMMARY

- A. Description: This item shall consist of excavating and properly utilizing or otherwise satisfactorily disposing of all excavated material, of whatever character, within the limits of the work indicated and the constructing, compacting, shaping and finishing of all earthwork on the entire project in accordance with the specification requirements herein outlined and in conformity with the required lines, grades and typical cross sections indicated or as directed by the Engineer. **All excavation shall be unclassified and shall include all materials encountered regardless of their nature or the manner in which they are removed.**
- B. Section Includes:
 - 1. Soil compaction.
 - 2. Excavating for structures and foundations.
 - 3. Excavating for paving, roads, and parking areas.
 - 4. Excavating for slabs-on-grade.
 - 5. Excavating for site structures.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures
- B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.
- C. If an excavation can be defined as a “trench,” then a Trench Safety Plan must be submitted in accordance with Section 31 23 15 – Trench Safety Systems.

PART 2 PRODUCTS – Not Used.

PART 3 EXECUTION

3.1 PREPARATION

- A. Erosion control and tree protection measures shall be in place prior to commencing work.
- B. Construction equipment shall not be operated within the drip line of trees, unless indicated.
- C. Construction materials shall not be stockpiled under the canopies of trees. No excavation or embankment shall be placed within the drip line of trees until tree wells are constructed as indicated on the Drawings.
- D. Call Texas 811 service at 800-344-8377 not less than three working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.
- E. Call Local Municipality(ies) not less than 2 weeks before performing Work.
 1. Request underground utilities to be located and marked within and surrounding construction areas.
- F. Notify utility company(ies) to remove and relocate utilities as indicated on the Drawings.
- G. Protect utilities indicated to remain from damage.
- H. Protect plant life, lawns, rock outcroppings and other features remaining as portion of final landscaping.
- I. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.2 EXCAVATION

- A. All excavation shall be performed as specified herein and shall conform to the established alignment, grades and cross sections.
- B. Suitable excavated “on-site” materials (Subsoil Type S3) may be utilized, insofar as practicable and when the material meets the criteria outlined in Section 31 23 23 - Fill in constructing required embankments and “fill” areas.
- C. Materials with a Plasticity Index (PI) greater than the surrounding materials or with a moisture content greater than 2 percent in excess of optimum shall be classified as unsuitable and must be manipulated to meet the above criteria before use or be removed.
- D. Unsuitable excavated materials or excavation in excess of that needed for construction shall be known as “Waste” and shall become the property of the Contractor. It shall become his sole responsibility to dispose of this material off the limits of the right of way in an environmentally sound manner at a permitted disposal site.
- E. When required by the Engineer, the Contractor will set “blue-tops” for the subgrade.
- F. Excavate subsoil to the final subgrade elevation(s) to accommodate structural foundations, slabs-on-grade, paving, site structures, and civil site facilities.
- G. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- H. Trim excavation. Remove loose matter.
- I. Remove lumped subsoil, boulders, and rock up to 1/3 cu yd measured by volume. Remove larger material as specified in Section 31 23 23 - Fill.
- J. Notify Engineer of unexpected subsurface conditions.
- K. Correct areas over excavated with Structural Fill as specified in Section 31 23 23 – Fill.

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- L. Remove excess and unsuitable material from site.
- M. Stockpile subsoil in area designated on site to depth not exceeding 8 feet and protect from erosion.
- N. Repair or replace items indicated to remain damaged by excavation.

3.3 SUBGRADE PREPARATION FOR STRUCTURES AND PAVEMENTS

- A. After final subgrade elevation has been achieved, the exposed subgrade soils (subsoils) shall be scarified to a minimum depth of 6 inches. Compaction of the subsoil shall be to a minimum of 95% and less than 100% of its maximum dry density when determined in accordance with ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort, Method D, Standard Proctor. The subsoil shall be no less than its optimum moisture to no greater than 3 percentage points above its optimum moisture content at the time of testing. The moisture content shall be maintained until subsequent construction activities commence.

3.4 FIELD QUALITY CONTROL

- A. Sections 01 40 00 - Quality Requirements.
- B. Request inspection of excavation, subgrade preparation, and density-controlled fill operations in accordance with Section 31 23 23 - Fill.
- C. Request visual inspection of bearing surfaces by Engineer before installing subsequent work. The Engineer shall be notified not less than three working days prior to the visual inspection.

3.5 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- C. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 17 - TRENCHING

PART 1 GENERAL

1.1 SUMMARY

A. Description: This work shall include the furnishing of all labor, materials, tools, equipment and machinery necessary for clearing and removing from the site of the work wherever located, all obstructions, trees, stumps, brush, vegetation, woods and debris; and all earth, rock and other materials to be excavated; the removal of existing structures except where specifically paid for as separate contract pay items; the replacement of topsoil after backfilling is completed; the installation and operation of all pumping, bailing and draining necessary to keep the excavation free from seepage water, water from sewer, drains, ditches, creeks and other sources, and to provide for the uninterrupted flow of sewers and surface waters during progress of the construction; the satisfactory disposal of excess and unsuitable materials not required or which cannot be used for backfilling; compacting and refilling, after settlement of all excavated areas; the restoration of all streets, alleys, rights-of-way and other lands, private or public, damaged or occupied by the Contractor in the performance of the contract to the same (or improved) condition as they were prior to the beginning of the work.

B. Section Includes:

1. Excavating trenches for utilities.
2. Compacted fill from top of embedment to subgrade elevations.
3. Backfilling and compaction.

C. Related Sections:

1. Section 03 30 00 – Cast-in-Place Concrete
2. Section 31 23 10 – Structural Excavation and Backfill.
3. Section 31 23 23 - Fill.
4. Section 31 23 24 – Flowable Fill.
5. Section 31 63 29 – Concrete Drilled Shaft
6. Section 31 75 10 – Bored Shaft Construction
7. Section 32 05 16 – Aggregates for Civil Site Improvements
8. Section 32 11 23 - Flexible Base.

D. References:

1. Geotechnical Data Report

1.2 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.
- B. Engineer: Owner's representative.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures

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- B. Trench Safety Plan: A Trench Safety Plan, which describes sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property shall be submitted in accordance with Section 31 23 15 – Trench Safety Systems.
- C. Product Data: Submit data for geotextile fabric (when specified) indicating fabric properties and manufacturing data; and construction methods.
- D. Materials Source: Submit name of imported fill materials suppliers

1.4 QUALIFICATIONS

- A. Prepare Trench Safety Plan as per Section 31 23 15 – Trench Safety Systems.

1.5 FIELD MEASUREMENTS

- A. Verify field measurements prior to construction.

1.6 COORDINATION

- A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Embedment Material: The type of embedment to be used for storm sewers, sanitary sewers or water mains shall be Coarse Aggregate Type A4 (Gravel for Trench Backfill) per Section 32 05 16 - Aggregates for Civil Site Improvements.
- B. Concrete Encasement: Concrete encasement shall consist of lean concrete with a compressive strength of 2,000 psi per Section 03 30 00 – Cast-in-Place Concrete.
- C. Trench Backfill:
 1. Backfill above embedment material (outside traffic areas): Excavated backfill material outside of traffic areas shall consist of an excavated material of gravel, fine rock cuttings, sandy loam, or clay having dimensions no greater than 2 inches, and compacted per applicable sections of this specification.
 2. Backfill above embedment material (beneath existing or proposed pavements):
 - a. Coarse Aggregate Type A1 (Flexible Base) per Section 32 11 23 – Flexible Base and compacted as specified herein.

2.2 ACCESSORIES

- A. Geotextile Fabric: Non-biodegradable, woven or non-woven, from the following manufacturers:
 1. U.S. Fabrics, Inc.
 2. Alkzo Nobel Geosynthetic Co.
 3. Huesker, Inc.

4. TC Mirafi.
5. Tenax Corp.
6. Tensar Earth Technologies, Inc.

PART 3 EXECUTION

3.1 LINES AND GRADES

- A. Construct the trenches to lines and grades indicated on Drawings.
 1. Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- B. Use laser-beam instrument with a qualified operator to establish lines and grades.
- C. Submit electronic layout plans from the pipe manufacturer for review and approval at least 30 days in advance of any actual construction of the project. The Engineer will forward all comments of the review to the Contractor for revision. Revisions shall be made and forwarded to the Engineer for his acceptance. Prior to commencement of the Project, reviewed layout plans will be sent to the Contractor marked for construction.
- D. Should the Contractor's procedures not produce a finished pipe placed to grade and alignment, the pipe shall be removed and re-laid, and the Contractor's procedures modified to the satisfaction of the Engineer. No additional compensation shall be paid for the removal and relaying of pipe required above.

3.2 PREPARATION

- A. Call Texas 811 service at 800-344-8377 not less than three working days before performing Work.
 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum locations.
- C. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.
- D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities indicated to remain.
- F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 TRENCHING

- A. Site Preparation: The construction site shall be prepared for construction operations by the removal and disposal of all obstructions and objectionable materials from the designated

construction area. Such obstructions and objectionable materials shall include the removal of designated trees, bushes, grass, miscellaneous stone, brick, concrete, scrap iron and all rubbish and debris whether above or below ground level. It is the intent of this specification to provide for the removal and disposal of all objectionable materials not specifically provided for elsewhere by the Drawings and specifications. The removal of such items shall be accomplished prior to grading and excavation operations. The removal and disposal of such items shall not be measured or paid for as a separate contract pay item. Such items shall be considered as incidental work and the cost thereof shall be included in such contract pay item as provided in the proposal and contract.

B. Maintenance of Streets During Construction:

1. Maintain the surfaces of streets being worked on at all times. The maintenance required shall include the filling of holes, blading or otherwise smoothing of the street surfaces (particularly the trench area), cleaning and removal of surplus excavation material, rubbish, etc., sprinkling of streets with water to abate dust nuisances and the elimination of interference resulting from blocking the street to residents thereon. Any or all such operations shall be performed by the Contractor upon demand by the Engineer, but the Contractor shall not wait for instruction from the Engineer before performing maintenance work obviously in need of being done to meet the requirements of these specifications. All costs of work covered by this paragraph shall be included in the prices bid for the various items of work; and no separate payment shall be made.
2. In the event the Contractor fails or refuses to properly maintain the surfaces of streets on which he is working or has worked, the Engineer, after due notice to the Contractor, shall perform the necessary maintenance. All costs to the Engineer incurred in the performance of such work shall be deducted from any monies due or to become due to the Contractor for work performed, or the Contractor shall be billed for such costs directly as the Engineer shall elect. Notice to the Contractor to be given by the Engineer shall be in writing, and it shall be delivered to the Contractor or his authorized agent. Except in emergency cases, where immediate action is required, the Contractor shall have 24 hours in which to comply with the instructions of the Engineer. Should the Contractor fail to do so, the Engineer shall proceed with the work as set forth above.
3. Where traffic must cross open trenches, such as street intersections and driveways, the Contractor shall provide suitable backfill bridges, protective barricades and such other safety equipment as required. The use of machinery must be so regulated as to preclude any unnecessary interference with traffic, utilities, etc. The Contractor shall abide by all applicable federal, state or local laws governing excavation work.

C. Soil and Rock Borings: Whenever the Engineer has caused certain test borings to be made on the site, or when any information pertaining of the character or depth of materials is found from observations, records or otherwise, such information revealed thereby may be provided to the Contractor. The action of the Engineer in revealing such information shall not, in any manner, be construed as a warranty on the part of the Engineer of the exact nature of the subsurface conditions that shall be encountered during construction of the work. Although the information is shown as accurately as possible, the Engineer does not guarantee that any materials to be encountered at any point or points are even approximately the same, either in character or elevations, as those shown on the Drawings. The information thus furnished by the Engineer is intended only as a guide to the Contractor in making his own investigations preliminary to submitting a bid for the work.

D. Existing Structures:

1. All existing structures, improvements and utilities shall be adequately protected, at the expense of the Contractor, from damage that might otherwise occur due to construction operations. Where construction comes in close proximity to existing structures or utilities, or if it becomes necessary to move services, poles, guy wires, pipe lines or other obstructions, the Contractor shall notify and cooperate with the utility or structure Engineer. The utility lines and other existing structures shown on the Drawings are for information only and are not guaranteed by the Engineer to be complete or accurate as to the location and/or depth. The Contractor shall be liable for damage to any utilities resulting from his operation. During construction, all fire hydrants, valve boxes and other existing utility controls shall be left intact, unobstructed and accessible as noted on the plan.
 - a. Relocation or Replacing Utilities: Unless noted on the Drawings that utilities are to be moved by others, any cost of temporarily or permanently relocating utilities shall be borne by the Contractor. The cost of these replacements shall be included in the Contractor's bid price for the various items of work; and no separate payment shall be made. In case damage to an existing structure or utility occurs, whether such damage results directly or indirectly from the Contractor's operations, the Contractor shall be responsible to restore the structure or utility to its original condition and position without extra compensation. Temporary shut down of water and/or sewer services shall not extend overnight, holidays or weekends. The Engineer shall approve all shut downs and may assist in the shut down operations.
 - b. Sewer Services: All sewer services damaged during construction shall be replaced by the Contractor at his expense. Sewer service reconnections, including necessary adjustments to a sanitary sewer replacement, shall not require the services of a master plumber, if being replaced by a utility Contractor; however, in all cases, repair shall be inspected by the Engineer. It shall be the responsibility of the Contractor to maintain such services throughout the construction process.
 - c. Water Services: Service lines shall not be removed during excavation; and the Contractor shall provide adequate support for the services across the open ditch.
 - d. Interrupted Service: Cuts or breaks in sewer mains and laterals, or service connections, shall be restored at the earliest practicable moment in order to give the least possible interruption in service. The Contractor shall be responsible for notifying customers of temporary interruption of service.
 - e. Other Utilities: All water mains, water services, sanitary sewers, sanitary sewer house laterals, storm sewers, power conduits, gas mains, gas service laterals and other appurtenances damaged during construction shall be repaired or replaced. Where the exact depth of any utility or obstruction is not shown on a plan, excavation shall be made prior to reaching the obstruction in order to determine adjustments in grade if needed to prevent interference. Redesign to eliminate conflicts may be necessary. Extra compensation shall not be paid for such delays. When it is necessary to remove or adjust another utility, a representative of that utility shall be notified to decide method and work to be done. The Contractor shall make satisfactory arrangements with other utilities for the required cutting or adjustments at the Contractor's own expense. Other than for items that may be provided in the contract for such work. No extra compensation shall be paid due to delays caused by removal of public utility structures.
 - f. Street Sign Posts and Signs: The Contractor shall be responsible for all damage to street sign posts and signs within the limits of his operations that remain in

place or are removed and replaced. In the event that street sign posts and signs are damaged or destroyed by the Contractor's operations, they shall be replaced at the Contractors' expense.

g. Methods of Removal and Disposal: Materials or parts of structures which are to be broken up, dismantled or removed, and which are to be salvaged, shall be removed, loaded, cleaned and unloaded at sites designated by the Engineer. Materials which are not designated to be salvaged shall become property of the Contractor; and he shall dispose of the material at his own cost and expense.

E. Do not advance open trench more than 200 feet ahead of installed pipe, unless pre-approved by Engineer.

F. Trench Width

1. Trenches for pipes less than 20 inches in diameter shall have a minimum width of 10 inches and a maximum width of 1 foot on each side beyond the outside surfaces of the pipe bell or coupling.
2. Trenches for pipes between 21 and 48 inches in diameter shall have a minimum width of 12 inches and a maximum width not to exceed one pipe diameter on each side beyond the outside surfaces of the pipe.
3. Trenches for pipes 54 inches in diameter and larger shall have a minimum width of 15 inches and a maximum width of one pipe diameter beyond the outside surfaces of the pipe.
4. If trench width within the pipe zone exceeds this maximum, the entire pipe zone shall be refilled with approved backfill material, thoroughly compacted to a minimum of 95 percent of maximum density and then re-excavated to the proper grade and dimensions. Excavation along curves and bends shall be so oriented that the trench and pipe are approximately centered on the centerline of the curve, using short links for pipe and/or bend fillings if necessary.
5. For all utilities to be constructed in fill above natural ground, the embankment shall first be constructed to an elevation not less than 1 foot above the top of the utility after which excavation for the utility shall be made as indicated.

G. Alternative Trench Width for Use with Free-Flowing Granular Embedment Material

1. Based upon preapproval by Engineer, Contractor may use the alternative trench widths in conjunction with free-flowing granular embedment material. Free-flowing granular material includes Coarse Aggregate Type A1 (Flexible Base) per Section 32 11 23 – Flexible Base; or Coarse Aggregate Type A3 (Gravel Base Course) or Fine Aggregate Type A5 (Sand) per Section 32 05 16 - Aggregates for Civil Site Improvements. The minimum and maximum alternative trench widths are specified below; however, in most instances the minimum trench width shall be that width which is sufficient to insure working space between the outside surface of the pipe and the trench wall to safely place trench safety equipment and to properly place and compact the embedment materials.
 - a. Trenches for pipes less than 18 inches in diameter shall have a minimum width of 8 inches and a maximum width of 24 inches on each side beyond the outside surfaces of the pipe bell or coupling.
 - b. Trenches for pipes 18 inches in diameter or greater shall have a minimum width of 6 inches and a maximum width not to exceed one pipe diameter on each side beyond the outside surfaces of the pipe.

H. Trench Depth and Depth of Cover

1. All pipe and in-line appurtenances shall be laid to the grades indicated. The depth of cover shall be measured from the established finish grade, natural ground surface, subgrade for staged construction, street or other permanent surface to the top or uppermost projection of the pipe.
 - a. Where not otherwise indicated, all water piping shall be laid to the following minimum depths:
 - 1) Water piping installed in undisturbed ground in easements of undeveloped areas which are not within existing or planned streets, roads or other traffic areas shall be laid with at least 42 inches of cover.
 - 2) Water piping installed in existing streets, roads or other traffic areas shall be laid with at least 42 inches of cover below finish grade.
2. Provide uniform and continuous bearing and support for bedding material and pipe.

I. Classification of Excavation: Excavation will not be considered or paid for as a separate item of work, so excavated material will not be classified as to type or measured as to quantity. Full payment for all excavation required for the construction shall be included in the various unit or lump sum contract prices for the various items of work installed, complete in place. No extra compensation, special treatment or other consideration will be allowed due to rock, pavement, caving, sheeting and bracing, falling or rising water, working under and in the proximity of trees or any other handicaps to excavation.

J. Dewatering Excavation: Underground piped utilities shall not be constructed or the pipe laid in the presence of water. All water shall be removed from the excavation prior to the pipe placing operation to insure a dry firm granular bed on which to place the underground piped utilities and shall be maintained in such un-watered condition until all concrete and mortar is set. Removal of water may be accomplished by bailing, pumping or by a well-point installation as conditions warrant.

In the event that the excavation cannot be dewatered to the point where the pipe bedding is free of mud, a seal shall be used in the bottom of the excavation. Such seal shall consist of lean concrete with a minimum depth of 3 inches.

K. Trench Conditions:

1. Before attempting to lay pipe, all water, slush, debris, loose material, etc., encountered in the trench must be pumped or bailed out and the trench must be kept clean and dry while the pipe is laid and backfilled. Where needed, sump pits shall be dug adjoining the trench and pumped as necessary to keep the excavation dewatered.
2. Backfilling shall closely follow pipe laying so that no pipe is left exposed and unattended after initial assembly. All open ends, outlets or other openings in the pipe shall be protected from damage and shall be properly plugged and blocked watertight to prevent the entrance of trench water, dirt, etc. The interior of the pipeline shall at all times be kept clean, dry and unobstructed.
3. Where the soil encountered at established footing grade is a quicksand, saturated or unstable material, the following procedure shall be used unless other methods are indicated:
 - a. All unstable soils shall be removed to a depth of 2 feet below bottom of piped utility. Such excavation shall be carried out to the trench widths above.
 - b. All unstable soil so removed shall be replaced with concrete seal foundation rock for the entire trench width or coarse aggregate materials placed in

uniform layers not to exceed 6 inches, loose measure and compacted by mechanical tamping or other means which will provide a stable foundation for the utility.

c. All forms, concrete seals, sheathing and bracing, pumping, additional excavation and backfill required shall be done at the Contractor's expense.

L. Trench sidewalls shall be sloped, or sheeting and/or shoring shall be used in accordance with the Trench Safety Plan in order to provide safety and protection in, and to, the excavation.

M. Trim excavation. Remove loose matter.

N. Correct over excavated areas with compacted backfill as specified for authorized excavation or replace with lean concrete, or Flexible Base as directed by Engineer.

O. Removing Old Structures: When out of service masonry structures or foundations are encountered in the excavation, such obstructions shall be removed for the full width of the trench and to a depth of 1 foot below the bottom of the trench. When abandoned inlets or manholes are encountered and no plan provision is made for adjustment or connection to the new sewers, such manholes and inlets within the construction limits shall be removed completely to a depth of 1 foot below the bottom of the trench. In each instance, the bottom of the trench shall be restored to grade by backfilling and compacting by the methods provided above. Where the trench cuts through storm or wastewater sewers which are known to be abandoned, these sewers shall be cut flush with the sides of the trench and blocked with a concrete plug in a manner satisfactory to the Engineer. When old structures are encountered, which are not visible from the existing surface and are still in service, they shall be protected and adjusted as required to the finished grade.

P. Excess material or material which cannot be made suitable for use in embankments will be declared surplus by the Engineer and shall become the property of the Contractor to dispose of offsite at a permitted fill site, without injury to the City or any individual. Such surplus material shall be removed from the work site promptly following the completion of the portion of the utility involved.

Q. Stockpile subsoil in area designated on site to only a height which yields safe slope stability and protect from erosion.

3.4 SHEETING AND SHORING

A. All excavations for trenches, structures, etc. 5 feet in depth or greater are required to have a Trench Safety Plan prepared and sealed by a Registered Professional Engineer in the State of Texas in accordance with OSHA requirements and Section 31 23 15 – Trench Safety Systems of the specifications.

B. Where excavations extend into rock, provide in-situ support of rock such as rock reinforcement including dowels, bolts, anchors, etc.; or slope rock excavations for safety, or provide adequate protection systems to ensure a safe and stable working environment.

C. Submit Trench Safety Plan prior to any excavation.

- D. When specified in the Drawings, sheeting and shoring to be left in place as part of the completed Work, cut off minimum 18 inches below finished grade. Otherwise, sheeting and shoring shall be removed at completion of excavation work.
- E. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- F. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 PIPE BEDDING AND EMBEDMENT

- A. Where not otherwise provided, all piping shall be installed in a continuous envelope of embedment material meeting the requirement of materials specified herein.
- B. Embedment material shall extend from 6 inches below (bedding) to 12 inches above the outer parts of the pipe (unless indicated otherwise), fittings and accessories for pipe.
- C. All bracing, struts, etc., installed by the pipe manufacturer (or temporary replacements by the Contractor) shall be kept in place in the pipe, undisturbed, until the trench has been backfilled at least to the top of the pipe. When installing mortar lined and mortar coated steel pipe, all bracings, struts, etc., installed by the pipe manufacturer shall be kept in the pipe, undisturbed until the pipe has been backfilled.

3.6 BACKFILLING

- A. Backfill Procedure: Backfill procedure is that procedure required to return trenched or excavated areas to a condition satisfactory to the Engineer. Such backfilling occurs in two general areas. They are 1) areas not subjected to vehicular traffic; and 2) areas subjected to, or influenced by, vehicular traffic.

The methods of backfilling to be used shall vary with the width of trench, the character of the materials excavated, the method of excavation, the type of conduit and the degree of compaction required. The placing of backfill shall not begin until the pipe structure has been properly bedded and jointed.

- 1. Trench backfill material is the material required to fill the trench from the top of the embedment to ground elevation or subgrade of a pavement or structure.
- B. Backfill trenches to contours and elevations with unfrozen fill materials.
- C. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- D. Place geotextile fabric when specified in the Drawings.
- E. Place fill material in continuous layers and compact to the density specified herein.
- F. Employ placement method that does not disturb or damage utilities in trench.
- G. Maintain optimum moisture content of fill materials to attain required compaction density.

H. Do not leave more than 50 feet of trench open at end of working day, unless preapproved by Engineer.

I. Protect open trench to prevent danger to the Engineer, the public, and users of the Project site.

3.7 COMPACTION

A. Compaction of all bedding, embedment, and backfill materials shall be performed in a manner that shall not crack, crush and/or cause the installed pipe to be moved from the established grade and/or alignment, as shown on the Drawings. Satisfactory density shall be obtained at various depths on all backfill material as indicated from random selected test points prior to the required exfiltration or pressure tests that are to be performed on lines being constructed. The required moisture content shall be at not less than 2 percent below nor more than 4 percent above the optimum moisture of the material or as specified by the Engineer.

B. Densities for Bedding and Embedment:

1. Coarse Aggregate Type A1 (Flexible Base) embedment shall be mechanically compacted in 6 inch lifts to a minimum of 95 percent Standard Proctor Density (ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)), unless indicated otherwise on Drawings.
2. Coarse Aggregate Type A2 (Crushed Stone) embedment shall be mechanically compacted in 6 inch lifts to a minimum of 95 percent of Maximum Dry Density in accordance with TEX-113-E – Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials, unless indicated otherwise on Drawings.
3. Coarse Aggregate Type A4 (Gravel Trench Backfill) embedment shall be mechanically compacted in 6 inch lifts to a minimum of 95 percent Standard Proctor Density (ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)), unless indicated otherwise on Drawings.

C. Backfill Densities – Areas Subjected to or Influenced by Vehicular Traffic: The trench backfill shall be mechanically compacted to the top of the subgrade in 6 inch loose lifts to at least 95 percent of maximum density as determined by ASTM D698 -Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³), at, or above, optimum moisture content.

D. Backfill Densities – Areas Not Subjected to or Influenced by Vehicular Traffic: The trench backfill shall be placed in layers not more than 10 inches loose depth and shall be compacted by mechanical means. Compaction methods to at least 95 percent of maximum density as determined by ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³), at, or above, optimum moisture content.

3.8 TOLERANCES

A. Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch (0.08 feet) from required elevations.

B. Top Surface of General Backfilling: Plus or minus 1 inch (0.08 feet) from required elevations.

3.9 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing.
- B. Perform laboratory material tests in accordance with ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
- C. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
 - 2. Moisture Tests: ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods.
- D. Frequency of Tests: The in-place density/moisture content shall be tested and verified at an average frequency of once per 300 linear feet per lift for trenches in traffic areas, and an average of once per 1,000 linear feet per lift for trenches in non-traffic areas.
- E. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

3.10 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 23 23 - FILL

PART 1 GENERAL

1.1 SUMMARY

- A. Description: This item shall consist of the placing and compacting of suitable materials obtained from approved sources for utilization in the construction of civil site improvements.
- B. Section Includes:
 - 1. Fill under structural foundations.
 - 2. Fill for embankment for construction of highways, streets, and pavements.
 - 3. Fill for the construction of earthen embankments, berms, levees, dikes, and structures.
 - 4. Fill for over-excavation.
 - 5. Backfilling of structural foundations, manholes, and utility structures to subgrade elevations.
 - 6. Backfilling site structures to subgrade elevations.
 - 7. Backfilling pipeline trenches.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures
- B. Product Data: Submit data for geotextile fabric indicating fabric and construction.
- C. Samples: Submit, in air-tight containers, 50 lb sample of each type of fill to testing laboratory.
- D. Materials Source: Submit name of imported fill materials suppliers.

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. Subsoil Fill: All subsoil fill shall conform to the following material types:
 - 1. Structural Type S1 (Structural Fill or Structural Borrow): This material shall consist of non-organic on-site granular soils or off-site borrow materials that classify as SM, SC, SP, SW, GC, GM, GP or GW according to ASTM D2487. Fill materials shall not contain particles larger than 3 inches. The fine-grained portion of fill materials shall exhibit Liquid Limit and Plasticity Index values of less than 40 and 15, respectively. Some of the on-site residual soils classify as CL and do not meet these criteria. Therefore, selected excavation to separate the suitable on-site soils will be required if on-site materials are reused.
- B. Structural Fill: Coarse Aggregate Type A1 (Flexible Base) as specified in Section 32 11 23 – Flexible Base.

- C. Coarse Aggregate Fill: Coarse Aggregate Type A2 (Crushed Stone); Coarse Aggregate Type A3 (Gravel Base Course); or Coarse Aggregate Type A4 (Gravel for Trench Backfill), as specified in Section 32 05 16 – Aggregates for Civil Site Improvements.
- D. Concrete: Lean concrete with a minimum compressive strength of 2,000 psi.
- E. Flowable Fill: As specified in Section 31 23 24 – Flowable Fill.

2.2 ACCESSORIES

- A. Geotextile Fabric: Products and execution shall be specified in the drawings. Non-biodegradable, woven or non-woven, from the following manufacturers:
 1. Alkzo Nobel Geosynthetic Co.
 2. Huesker, Inc.
 3. TC Mirafi.
 4. Tenax Corp.
 5. Tensar Earth Technologies, Inc.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION FOR STRUCTURES AND PAVEMENTS

- A. Strip and remove from the construction area any topsoil, organics, and vegetation to a minimum depth of 6 inches below the existing, natural ground surface in accordance with Section 31 10 00 - Clearing.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to the density specified herein.
- C. Compact the subgrade (subsoil) in accordance with Section 31 23 10 – Structural Excavation and Backfill prior to commencing with subsequent “fill” operations.
- D. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.2 EMBANKMENT/FILLING

- A. Prior to placing any embankment (fill), all tree protection, tree wells and erosion control devices shall be in place and all “Clearing” operations shall have been completed on the areas over which the embankment (fill) is to be placed. Stump holes or other small excavations in the limits of the embankments shall be backfilled with suitable material and thoroughly tamped by approved methods before commencing embankment construction. The surface of the ground, including plowed loosened ground or surface roughened by small washes, shall be restored to approximately its original slope and the ground surface thus prepared shall be compacted by sprinkling and rolling.
- B. Construction equipment shall not be operated within the drip line of the trees, unless indicated. Construction materials shall not be stockpiled under the canopies of trees. No excavation or embankment shall be placed within the drip line of trees unless indicated.

- C. Unless otherwise indicated, the surface of the ground of all unpaved areas, other than rock which are to receive embankment (fill), shall be loosened by scarifying or plowing to a depth of not less than 4 inches. The loosened material shall be recompacted with the new embankment as hereinafter specified.
- D. The surface of hillsides to receive embankment (fill) shall be loosened by scarifying or plowing to a depth of not less than 4 inches and benches cut before embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side in partial width layers and increasing the widths as the embankment is raised. Bench width shall not exceed five feet. The material which has been loosened shall be recompacted simultaneously with the embankment material placed at the same elevation.
- E. Where embankments are to be placed adjacent to or over existing roadbeds, the roadbed slopes shall be plowed or scarified to a depth of not less than 6 inches and the embankment built up in successive layers, as hereinafter specified, to the level of the old roadbed before its height is increased. Then, if indicated, the top of the old roadbed shall be scarified and recompacted with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible layer depth.
- F. Trees, stumps, roots, vegetation or other unsuitable materials shall not be placed in embankment (fill).
- G. All embankment shall be constructed in layers approximately parallel to the finished grade and unless otherwise indicated.
- H. The embankment (fill) shall be continuously maintained at its finished section and grade until that portion of the work is accepted. After completion of the embankment to the finished section and grade, the Contractor shall proof roll the subgrade and revegetation procedures must commence immediately to minimize the soil loss and air pollution.
- I. Except as otherwise indicated, embankments (fills) shall be constructed in successive 6 inch layers, loose measure, for the full width of the individual cross section and in such length as are best suited to the sprinkling and compaction methods utilized.
- J. Minor quantities of rocks not larger than 4 inches, encountered in constructing earth embankment may be incorporated in the earth embankment layers, provided such placement of rock is not within 10 feet of any structure.
- K. Each layer of embankment shall be uniform as to material, density and moisture content before beginning compaction. Where layers of unlike materials abut each other, each layer shall be feathered on a slope of 1:20 or the material shall be so mixed as to prevent abrupt changes in soil. No material placed in the embankment by dumping in a pile or windrows shall be incorporated in a layer in that position, but all such piles or windrows shall be moved by blading or similar methods. Clods or lumps of material shall be broken and the embankment material mixed by blading, harrowing, discing or similar methods to the end that a uniform material of uniform density is secured in each layer.
- L. Water required for sprinkling to bring the material to the moisture content necessary for optimum compaction shall be evenly applied and it shall be the responsibility of the

Contractor to secure a uniform moisture content throughout the layer by such methods as may be necessary.

M. All cuts, whether full width or partial width cuts in the side of a hill, which are not required to be excavated below subgrade elevation shall be scarified to a uniform depth of at least 6 inches below grade and the material shall be mixed and reshaped by blading and then sprinkled and rolled in accordance with the requirements outlined above for earth embankments and to the same density as that required for the adjacent embankment.

N. Compaction of embankments (fills) shall be to a minimum of 95% and less than 100% of its maximum dry density when determined in accordance with ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³), Method D, Standard Proctor, unless indicated otherwise on Drawings. The subsoil shall be no less than its optimum moisture to not greater than 3 percentage points above its optimum moisture content at the time of testing. After each layer of earth embankment (fill) is complete, density tests as necessary will be made. If the material fails to meet the density specified, the course shall be reworked as necessary to obtain the specified compaction.

O. Embankment (fill) shall slope away from building minimum 5 percent slope for minimum distance of 10 ft, unless noted otherwise.

P. Grade changes in embankment (fill) shall be made with gradual grade changes. Blend slope into level areas.

Q. Remove surplus fill materials from site.

3.3 BACKFILLING

A. As soon as practicable, all portions of excavation not occupied by the permanent structure shall be backfilled. Backfill material shall comply with "Subsoil Fill" as specified herein.

B. That portion of backfill which will not support any portion of completed structure, roadbed, or embankment shall be placed in layers not more than 10 inches in depth (loose measurement) and shall be compacted in accordance with Paragraph 3.4, "Compaction" for "Subsoil Fill."

C. That portion of the backfill which will support any portion of the structure, roadbed, or embankment shall be placed in uniform layers not more than 8 inches in depth (loose measurement) and shall be compacted in accordance with Paragraph 3.5, "Compaction" for "Subsoil Fill" and shall be compacted to that density by means of mechanical tampers or rammers, except that the use of rolling equipment of the type generally used in compaction embankments will be permitted on portions which are accessible to such equipment. All portions of embankment too close to any portion of a structure to permit compaction by the use of the blading and rolling equipment used on adjoining sections of embankment, shall be placed and compacted in the same manner as specified above for backfill material. Unless otherwise indicated, hand tamping will not be accepted as an alternate for mechanical compaction. As a general rule, material used in filling or backfilling the portions described in this paragraph shall be "Subsoil Fill," free of any appreciable amount of gravel or stone particles larger than 4 inches in greater dimension and of a gradation that permits thorough compaction. When required by the Drawings or by written order of the Engineer, structural fill or coarse aggregate material shall be used for backfilling.

- D. The surface of hillsides to receive embankment (fill) shall be loosened by scarifying or plowing to a depth of not less than 4 inches and benches cut before embankment materials are placed. The embankment shall then be placed in layers, as hereinafter specified, beginning at the low side in partial width layers and increasing the widths as the embankment is raised. Bench width shall not exceed five feet. The material which has been loosened shall be recompacted simultaneously with the embankment material placed at the same elevation.
- E. Where embankments are to be placed adjacent to or over existing roadbeds, the roadbed slopes shall be plowed or scarified to a depth of not less than 6 inches and the embankment built up in successive layers, as hereinafter specified, to the level of the old roadbed before its height is increased. Then, if indicated, the top of the old roadbed shall be scarified and recompacted with the next layer of the new embankment. The total depth of the scarified and added material shall not exceed the permissible layer depth.

3.4 COMPACTION

A. Subsoil Fill:

- 1. Structural Type S1 (Structural Fill, or Structural Borrow): Compaction shall be to a dry density of at least 95 percent Standard Proctor maximum dry density (ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)) and shall be within the range of the materials optimum moisture content to 3 percentage points above the materials optimum moisture content. Placement shall be in lifts not exceeding 8 inches before compaction.

- B. Coarse Aggregate Type A1 (Flexible Base): Flexible Base material used as structural fill beneath foundations and for backfilling structures shall be placed in loose lifts not exceeding 8 inches before compaction, and shall be compacted mechanically to a minimum 98 percent of Standard Proctor dry density (ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)) and within 2 percentage points of the materials optimum moisture content, unless indicated otherwise on Drawings.

C. Coarse Aggregate Fill:

- 1. Coarse Aggregate Type A2 (Crushed Stone): Compaction shall be a minimum of 95 percent of the maximum dry density in accordance with TxDOT Test Method TEX-113-E – Laboratory Compaction Characteristics and Moisture-Density Relationship of Base Materials, unless indicated otherwise on Drawings.
- 2. Coarse Aggregate Type A3 (Gravel Base Course): Gravel Base Course used as structural fill beneath foundations and for backfilling structures shall be placed in loose lifts not exceeding 8 inches before compaction, and shall be compacted mechanically to a minimum 95 percent of Standard Proctor dry density (ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³)) and within 2 percentage points of the materials optimum moisture content, unless indicated otherwise on Drawings.
- 3. Coarse Aggregate Type A4 (Gravel Trench Backfill): Gravel Trench Backfill shall be placed in loose lifts not exceeding 8 inches before compaction, and shall be compacted mechanically to a minimum 95 percent of Standard Proctor dry density (ASTM D698 - Standard Test Method for Laboratory Compaction

Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) and within 2 percentage points of the materials optimum moisture content.

3.5 TOLERANCES

- A. Top Surface of Fill Under Paved Areas: Plus or minus 0.50 inches from required elevations.
- B. Top Surface of General Grading of Fill: Plus or minus 0.10 feet from required elevations.

3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing.
- B. Perform laboratory material tests in accordance with ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
- C. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method, ASTM D2167 – Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method, ASTM D2922 – Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods, or TEX-115-E – Field Method for Determining In-Place Density of Soils and Base Materials as appropriate for the material being tested.
 - 2. Moisture Tests: ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

Proof roll compacted fill surfaces under structural foundations, pavers, paving, and sidewalks. Soft spots shall be removed, replaced, and retested. Quality assurance shall be, as a minimum, as outlined below:

Type of Work	Item	Sample Frequency	Sample Size	Minimum Testing
Structural Fill	Structural Type S1 (Structural Fill or Structural Borrow)	1 per soil Type	50 lbs.	<ul style="list-style-type: none"> - Gradation - P.I. - Moisture-Density Relationship
	Compaction	1 per 5000 sq.ft. per lift (min. of 3 per lift)		- Field Density Tests
Structural Fill	Coarse Aggregate Type A1 (Flexible Base)	1 per type per 1000 cu. yds.	50 lbs.	<ul style="list-style-type: none"> - Sieve - P.I. - Moisture-Density
	Compaction	1 per 2500 sq.ft. per lift (min. of 3 per lift)		- Field Density Tests
Structural Fill	Coarse Aggregate Type A2 (Crushed Stone)	1 per type per 1000 cu. yds.	50 lbs	- Gradation/sieve

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	Compaction	1 per 2500 sq.ft. per lift (min. of 3 per lift)		- Field Density Tests
Structural Fill	Coarse Aggregate Type A3; Coarse Aggregate Type A4	1 per type per 1000 cu. yds.	50 lbs	- Sieve - P.I. - Moisture-Density
	Compaction	1 per 2500 sq.ft. per lift (min. of 3 per lift)		- Field Density Tests

3.7 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic.
- B. Reshape and re-compact fills subjected to erosion.

END OF SECTION

SECTION 31 25 12 – STORM WATER POLLUTION PREVENTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Documentation to be prepared and signed by Contractor before conducting construction operations, in accordance with the Texas Pollutant Discharge Elimination System (TPDES) Construction General Permit Number TXR 150000, latest issue date (the Construction General Permit).
 - 2. Implementation, maintenance inspection, and termination of storm water pollution prevention control measures including, but not limited to, erosion and sediment controls, storm water management plans, waste collection and disposal, off-site vehicle tracking, and other appropriate practices.
 - 3. Review of the Storm Water Pollution Prevention Plan (SWP3) implementation in a meeting with Engineer prior to start of construction.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. Storm Water Pollution Prevention Plan:
 - 1. Basis of Measurement: Lump Sum.
 - 2. Basis of Payment: Payment for Storm Water Pollution Prevention Plan shall be made at the lump sum bid for “Storm Water Pollution Prevention Plan.” Payment for all work prescribed under this item shall be full compensation for the Storm Water Pollution Prevention Plan including all preparation, submittals, notices, updates, and revisions.
- B. Storm Water Pollution Prevention Plan Implementation:
 - 1. Basis of Measurement: Lump Sum.
 - 2. Basis of Payment: Includes all aspects of implementing the SWP3, from Notice of Intent through Notice of Termination.

1.3 REFERENCES

- A. Construction General Permit (TPDES No. TXR 150000).
- B. Clean Water Act.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Submit one copy of the SWP3 to Engineer for record retention purposes only. Engineer will not review or approve the SWP3

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with the SWP3 as per the submission of the Notice of Intent.

- B. Maintain one copy of the SWP3 document on site.

PART 2 PRODUCTS – Not Used.

PART 3 EXECUTION

3.1 SITE SPECIFIC STORM WATER POLLUTION PREVENTION PLAN (SWP3)

- A. Fulfill all TPDES Construction General Permit (TXR 150000) requirements.
- B. Contractor shall fulfill the role of Primary Operator as defined by the TPDES Construction General Permit (TXR 150000) for this project.
- C. Prepare and submit all required documentation and pay all applicable fees to TCEQ required by the TPDES Construction General Permit (TXR 150000). This includes but is not limited to Notice of Intent, Site Notices, Notice of Termination, and Notification of MS4 Operator.
- D. SWP3:
 - 1. Prepare a SWP3 following Part III of the TPDES Construction General Permit (TXR 150000).
 - 2. Update or revise the SWP3 as needed during the construction following Part III, Section E of the TPDES Construction General Permit (TXR 150000).
 - 3. Submit the SWP3 and any updates or revisions to the Engineer for review and address comments prior to commencing, or continuing, construction activities.
 - 4. Conduct inspections in accordance with TPDES Construction General Permit (TXR 150000).
 - 5. Maintain copies of SWP3, inspection reports, and other documentation as required by TPDES Construction General Permit (TXR 150000).

3.2 SWP3 IMPLEMENTATION

- A. Implement SWP3 utilizing state of the art Best Management Practice controls as required by the Construction General Permit, the site specific SWP3, and local government.
- B. Inspect and maintain controls throughout the course of construction per the Construction General Permit requirements.
- C. Remove controls per the Construction General Permit requirements.
- D. On-Site Waste Material Storage:
 - 1. Self-contain on-site waste material storage and satisfy appropriate location, state, and federal rules and regulations.
 - 2. Prepare list of waste material to be stored on-site. Update list as necessary to include up-to-date information. Keep a copy of updated list with the SWP3.
 - 3. Prepare description of controls to reduce pollutants generated from on-site storage. Include storage practices necessary to minimize exposure of materials to storm water, and spill prevention and response measures consistent with best management practices. Keep a copy of the description with the SWP3.

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END OF SECTION

SECTION 31 32 15 - LIME SOIL STABILIZATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Preparing and treating the subgrade, existing subbase or existing base by pulverizing, furnishing and applying lime, mixing and compacting the mixed material to the required density. This item applies to natural ground, embankment or existing pavement structure and shall be constructed as specified herein and in conformity with the typical sections, lines and grades or as indicated.

- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete.
 - 2. Section 31 05 13 - Soils for Earthwork.
 - 3. Section 31 23 16 - Excavation.
 - 4. Section 31 23 17 - Trenching.
 - 5. Section 31 23 23 - Fill.
 - 6. Section 32 05 16 - Aggregates for Civil Site Improvements.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M216 - Standard Specification for Lime for Soil Stabilization.

- B. ASTM International:
 - 1. ASTM C977 - Standard Specification for Quicklime and Hydrated Lime for Soil Stabilization.

- C. National Lime Association:
 - 1. NLA - Lime Stabilization Construction Manual.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

- B. Product Data:
 - 1. Submit mix design and materials mix ratio to achieve specified requirements.
 - 2. Submit data for geotextile fabric indicating fabric and construction.
 - 3. Submit data for curing seal.

- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets and Bridges (latest Edition).

- B. Maintain one copy of Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets and Bridges (latest Edition) on site.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Only use Type B, Commercial Lime Slurry.

PART 2 PRODUCTS

2.1 MIX MATERIALS

- A. Subsoil: Type S3 (Material Excavated from On-Site) as specified in Section 31 05 13.
- B. Existing Subgrade.
- C. Existing Subbase or Base Material.
- D. Lime: Type B (Commercial Lime Slurry) in conformance with TxDOT Standard Specifications Item 260, "Lime Treatment for Materials used as Subgrade."

2.2 EQUIPMENT

- A. The pulverizing, mixing and proof rolling machinery, tools and equipment (capable of excavating subsoil, mixing and placing materials, wetting, consolidation, and compaction of materials), shall be on the project and approved by the Engineer prior to the beginning of construction operations.
- B. All machinery, tools and equipment used shall be maintained in a satisfactory and workmanlike manner.
- C. If lime is furnished in trucks, each truck shall have the weight of lime certified on public scales or the Contractor shall place a set of standard platform truck scales or hopper scales at a location approved by the Engineer.

2.3 SOIL LIME MIX

- A. Mix materials in accordance with TxDOT Standard Specifications Item 260, "Lime Treatment for Materials used as Subgrade."

PART 3 EXECUTION

3.1 GENERAL

- A. The placement of lime shall not adversely impact vegetation, drainageways or waterways, storm water inlets or overflow channels. Structures shall be screened, blocked or protected to prevent lime from entering any structure or waterway.
- B. It is the primary requirement of this specification to secure a completed course of treated material containing a uniform lime mixture at the rate specified, free from loose or segregated areas, of uniform density and moisture content, well bound for its full depth and with a smooth surface suitable for placing subsequent courses. It shall be the responsibility of the Contractor to regulate the sequence of his work, to use the proper amount of lime, maintain the work and rework the courses as necessary to meet the above requirements.
- C. The lime treated surface shall be constructed and shaped to conform to the typical sections, lines and grades as indicated or as established by the Engineer. The material, either before or after lime is added, shall be excavated to the secondary grade (proposed) bottom of lime treatment and removed or windrowed to expose the secondary grade. For pavement construction, the secondary grade shall be blue topped at edge, 1/4 points and along the centerline at not more than 50 foot centers. Any wet or unstable materials below the secondary grade shall be corrected, as directed by the Engineer, by removing the unstable material or by scarifying, adding lime and compacting until it is of uniform stability.

3.2 PREPARATION OF SURFACE

- A. The Contractor shall shape the subgrade or base and proof roll. Any soft areas that this rolling may reveal will be corrected and proof rolled again until approved by the Engineer.

3.3 PREMIXING SURFACE

- A. The surface shall be pulverized so that when all nonslaking aggregates retained on the No. 4 sieve are removed the remainder of the material shall meet the following requirements:
 1. Minimum passing 1 3/4 inch Sieve: 100 percent.
 2. Minimum passing No. 4 Sieve: 60 percent.
- B. Should the material uncovered during the premixing operation reveal properties which differ from the anticipated material, the Engineer shall sample the material to establish a suitable rate of lime application.

3.4 LIME APPLICATION

- A. The application and mixing of lime with the material shall be accomplished by the methods hereinafter described. The minimum rate of lime solids applications shall be six (6) percent by weight, unless otherwise indicated or as directed by the Engineer.
 1. Slurry Placing: The lime shall be mixed with water in a mixer or trucks with approved distributors and applied as a slurry. Application shall be attained by successive passes over a measured section of roadway until the proper moisture and lime content has been

secured. The distributor truck shall be equipped with an agitator which will keep the lime and water in uniform mixture.

3.5 MIXING

- A. The material and lime shall be thoroughly mixed by approved road pulverizer and the mixing continued until a homogeneous, friable mixture of material and lime is obtained, free from all clods or lumps so that when all nonslaking aggregates retained on the No. 4 sieve are removed the remainder of the material shall meet the following requirements:
 1. Minimum passing 1 3/4 inch sieve: 100 percent.
 2. Minimum passing No. 4 sieve: 60 percent.
- B. When treating subgrade material, the Contractor shall use a cutting and pulverizing machine that will remove the subgrade material accurately to the secondary grade and pulverize the material at the same time. He will not be required to expose the secondary grade nor windrow the material. Blue tops must be set at this time. For pavement construction, blue tops will be set at edges, 1/4 points and along the centerline at not more than 50 foot centers. The machine shall be of such design that a visible indication is given at all times that the machine is cutting to the proper depth.
- C. During the interval of time between application and mixing, hydrated lime that has been exposed to the open air for a period of 6 hours or more or to excessive loss due to washing or blowing will not be accepted for payment and the area shall be retreated.

3.6 COMPACTION

- A. Compaction of the mixture shall begin immediately after mixing. The material shall be aerated or sprinkled as necessary to provide the optimum moisture. Compaction shall begin at the bottom and shall continue until the entire depth of mixture is uniformly compacted.
- B. The course shall be sprinkled as required and compacted to the extent necessary to provide the density specified below:
 1. Not less than 95 percent of the optimum density as determined by TxDOT Test Method Tex-121-E, Part II.
 2. Moisture content shall be within the range of 0 to 3 percentage points above the mixture's optimum moisture content.

3.7 FINISHING, CURING AND PREPARATION FOR SURFACING

- A. After the final layer or course of the lime treated subgrade, subbase, or base has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The completed section shall then be finished by rolling with a pneumatic tire or other suitable roller sufficiently light to prevent hair cracking. The Contractor shall set blue tops at edges, 1/4 points and along the centerline at not more than 50 foot spacing. The completed section shall be moist cured for a minimum of 3 days before further courses are added or any through traffic is permitted, unless otherwise directed by the Engineer. In cases where subgrade treatment or subbase sets up sufficiently to prevent objectionable damage from traffic, such layers may be opened to traffic 2 days after compaction. If the Drawings provide for the treated material to be sealed or covered by other courses of material, such seal or

course shall be applied within 14 days after final mixing is completed, unless otherwise directed by the Engineer.

3.8 TOLERANCES

- A. Section 01 40 00 - Quality Requirements: Tolerances.
- B. Top Surface of Subgrade: Plus or minus 0.50 inches from required elevations.

3.9 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Actual amount of lime required shall be confirmed by laboratory tests (ASTM C977, Appendix XI) prior to construction by Contractor.
- C. Thickness of Lime Stabilization.
- D. Density: TxDOT Test Method Tex-115-E.
- E. Atterberg-Limit tests shall be performed to verify the resulting plasticity index of the soil-lime mixture is at, or below 15.
- F. If the material fails to meet the testing requirements, it shall be reworked as necessary to meet these requirements. Throughout this entire operation the shape of the course shall be maintained by blading and the surface upon completion shall be smooth and in conformity with the typical section indicated and to the established lines and grades. Should the material, due to any reason or cause, lose the required stability, density and finish before the next course is placed, it shall be recompacted and refinished at the sole expense of the Contractor.
- G. Frequency of Tests: 1 test, each, per 500 square yards (per lift).

END OF SECTION

SECTION 31 63 29 - DRILLED CONCRETE PIERS AND SHAFTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Dry-installed drilled piers.

1.3 UNIT PRICES

A. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft and diameter may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments are made on net variation of total quantities, based on design dimensions for shafts.

1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, and the diameter of shaft.
2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.

B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed outside dimensions of drilled piers cast against rock. Unit prices for rock excavation include replacement with approved materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site.

1. Review methods and procedures related to drilled piers including, but not limited to, the following:
 - a. Review geotechnical report.
 - b. Discuss existing utilities and subsurface conditions.
 - c. Review coordination with temporary controls and protections.
 - d. Review measurement and payment of unit prices.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternative design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Shop Drawings: For concrete reinforcement, detailing fabricating, bending, supporting, and placing.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and testing agency.
- B. Material Certificates: From manufacturer, for the following:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
- C. Material Test Reports: For each material below, by a qualified testing agency:
 - 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

- A. Record drawings.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.
- B. Testing Agency Qualifications: Qualified according to ASTM C1077, ASTM D3740, and ASTM E329 for testing indicated.

1.9 FIELD CONDITIONS

- A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.

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1. Notify the Structural Engineer when uncharted or incorrectly charted piping or other utilities are encountered during excavation. Protect such utilities and suspend drilling operations until satisfactory arrangements are made with the proper authorities for removal, relocation, abandonment, or tapping of the utility line. The Contractor shall be solely responsible for the repair or replacement of any damage to utilities resulting from drilling operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Drilled-Pier Standard: Comply with ACI 336.1 except as modified in this Section.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C150/C150M, Type I, Type II LA (Low Alkali), or Type I/II LA. Supplement with the following:

- a. Fly Ash: ASTM C618, Class F. Class C fly ash will be permitted only with the approval of the Structural Engineer and provided that the alkali content of the cement is less than 0.6%.

- B. Normal-Weight Aggregate: ASTM C33/C33M, graded, [1 1/2-inch-] nominal maximum coarse-aggregate size.

1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

- C. Water: ASTM C94/C94M and potable.

- D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
 2. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
 3. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
 4. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

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2.4 STEEL CASINGS

- A. Steel Pipe Casings: ASTM A283/A283M, Grade C, or ASTM A36/A36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.

2.5 SLURRY

- A. The use of drilling slurry will not be permitted.

2.6 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 limits.
- C. Limit water-soluble, chloride-ion content in hardened concrete to [0.15] percent by weight of cement.
- D. Proportion normal-weight concrete mixture as follows:
 1. Compressive Strength (28 Days): [3600 psi]
 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 3. Slump Range: Capable of maintaining the a slump range between 6 inches and 8 inches until completion of placement.
 4. Air Content: Do not air entrain concrete.

2.7 REINFORCEMENT FABRICATION

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.
 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.2 EXCAVATION

- A. Drilling: Drill foundations to the elevations or depths to provide the minimum embedment into the bearing strata shown on the drawings, or to an elevation of approved bearing as directed by the Structural Engineer or Testing Agency. Raise or lower the bottom elevations of the foundations as directed by the Structural Engineer or Testing Agency. Foundation reinforcement shall be adjusted as shown on and required by the structural drawings.
- B. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
- C. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
 1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
 2. Remove water from excavated shafts before concreting.
- D. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by the Structural Engineer.
- E. Excavate shafts for closely spaced drilled piers only after adjacent drilled piers are filled with concrete and allowed to set.
- F. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
 1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.
- G. Tolerances: Construct drilled piers to remain within the following tolerances:
 1. Drilled shaft diameter: -1/2", + 2"
 2. Maximum deviation permissible from indicated location: 5% of shaft diameter or 3 inches, whichever is less.
 3. Top of concrete shaft elevation: +1 inch to -3 inches.
 4. Maximum deviation from true vertical alignment for vertical shafts: 1/8" per foot of depth.
- H. When the as-built foundation is not within specified tolerances, the foundation may require modifications, by adding drilled shaft foundations and caps, over drilling or by other methods, to

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properly resist the design forces. Corrective measures must be approved by the Engineer and shall be constructed by the Contractor at no additional cost.

3.3 STEEL REINFORCEMENT INSTALLATION

- A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
- D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.
- E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
- F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.4 CONCRETE PLACEMENT

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified Special Inspector and/or testing agency.
- B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
 1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
 2. Vibrate top 120 inches of concrete.
- C. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 120-inch head of concrete above bottom of casing.
 1. Vibrate top 120 inches of concrete after withdrawal of temporary casing.
- D. Scree concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.
- E. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.

1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.

F. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F.

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform continuous inspections, including the following inspections:

1. Drilled piers.
2. Excavation.
3. Concrete.

B. Concrete Tests and Inspections: ASTM C172/C172M except modified for slump to comply with ASTM C94/C94M.

1. Slump: ASTM C143/C143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
2. Compression Test Specimens: ASTM C31/C31M; one set of five standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens unless field-cured test specimens are required.
3. Compressive-Strength Tests: ASTM C39/C39M; one set for each drilled pier but not more than one set for each truck load. Test one specimen at seven days, test three specimens at 28 days, and retain one specimen in reserve for later testing if required.
4. If frequency of testing provides fewer than five strength tests for a given class of concrete, conduct tests from at least five randomly selected batches or from each batch if fewer than five are used.
5. If strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
6. Strength of each concrete mixture is satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
7. Report test results in writing to Structural Engineer and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.

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8. Additional Tests: Testing and inspecting agency to make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Structural Engineer.
9. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
10. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

C. An excavation, concrete, or a drilled pier will be considered defective if it does not pass inspections.

D. Prepare inspection reports for each drilled pier as follows:

1. Actual top and bottom elevations.
2. Actual drilled-pier diameter.
3. Top of bearing stratum elevation.
4. Description of soil materials.
5. Description, location, and dimensions of obstructions.
6. Final top centerline location and deviations from requirements.
7. Variation of shaft from plumb.
8. Design and tested bearing capacity of bottom.
9. Embedment into bearing strata
10. Levelness of bottom and adequacy of cleanout.
11. Ground-water conditions and water-infiltration rate, depth, and pumping.
12. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
13. Date and time of starting and completing excavation.
14. Inspection report.
15. Condition of reinforcing steel and splices.
16. Concrete testing results.
17. Remarks, unusual conditions encountered, and deviations from requirements.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 316329

SECTION 32 05 16 - AGGREGATES FOR CIVIL SITE IMPROVEMENTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Coarse aggregate materials.
 - 2. Fine aggregate materials.
- B. Related Sections:
 - 1. Section 31 23 17 - Trenching.
 - 2. Section 31 23 23 - Fill.
 - 3. Section 32 11 23 - Flexible Base.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M147 - Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
 - 2. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction
 - 3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 5. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - 6. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Samples: Submit, in air-tight containers, 10 lb samples of each type of fill to testing laboratory.
- C. Materials Source: Submit name of imported materials suppliers.
- D. Manufacturer's Certificate: Certify that aggregates meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Perform Work in accordance with Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets, and Bridges (latest Edition).
- C. Maintain one copy of Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets, and Bridges (latest Edition) document on site.

PART 2 PRODUCTS

2.1 COARSE AGGREGATE MATERIALS

- A. Coarse Aggregate Type A1 (Flexible Base): Conforming to TxDOT's Standard Specifications Item 247, Grade 1 or 2, Type A.
- B. Coarse Aggregate Type A2 (Crushed Stone): washed; free of shale, clay, friable material and debris; graded in accordance with ASTM C136; within the following limits, based on ASTM D448:

Coarse Aggregate Type A2 Grading
Grade No. 2

Sieve Size	Percent Passing
2 inches	100%
1-1/2 inches	95-100%
3/4 inch	40-70%
3/8 inches	10-30%
No. 4	0-5%

OR

**Coarse Aggregate Type A2 Grading
Grade No. 3**

Sieve Size	Percent Passing
1-1/2 inches	95-100%
3/4 inch	60-90%
1/2 inch	25-60%
No. 4	0-5%

C. Coarse Aggregate Type A3 (Gravel Base Course): Durable particles of gravel mixed with approved binding material; and shall be free from thin or elongated pieces, clay lumps, soil loam or vegetable matter. The material may be bank-run; or the binder may be added and incorporated by methods approved by Engineer. Should the material be secured from pits, the overburden or stripping from the site of the pits shall be removed to such a distance that none shall fall or wash into the pit; and it shall be placed so as to divert surface drainage away from the pit site. The pit shall be well drained at all times. The pits shall be opened in such a manner as to expose the vertical faces of all strata of acceptable materials; and, unless otherwise directed by Owner, the materials shall be secured in successive vertical cuts extending through all the exposed strata, in order that a uniformly mixed material shall be secured.

1. Tests: The soil binder shall meet the following requirements:
 - a. The liquid limit shall not exceed 35 when tested in accordance with ASTM D423.
 - b. The plastic limit shall be determined by testing in accordance with ASTM D424.
 - c. The plasticity index shall not exceed 12 nor be less than 4 when calculated in accordance with ASTM D424.
 - d. The preparation of samples for testing according to ASTM D423 and D424 shall be in accordance with the requirements of ASTM D2217.
 - e. The linear shrinkage shall not exceed 6 percent.
2. Gradation: The material when tested by standard laboratory methods shall meet the following percentages by weight:

Passing 1 3/4 in. sieve (45.0 mm)	100%
Passing 3/4 in. sieve (9.5 mm)	40 to 80%
Passing No. 4 sieve (4.75 mm)	25 to 60%
Passing No. 40 sieve (425 µm)	15 to 35%

- a. Material passing the No. 40 sieve (425 µm) shall be known as "soil binder."
- b. Materials containing conglomerate or gravel larger than 2" (50 mm) in any dimension shall be broken up and uniformly mixed with the remainder of the materials. Upgrading by the addition of washed gravel in order to meet the requirements of this section shall be permitted.
- c. If additional binder and/or soil binder are considered necessary by the Owner after gravel materials are spread and shaped, same shall be furnished and applied in the amount directed by the Owner; such additional binder and/or soil binder shall be carefully and evenly

incorporated with the pit materials in place by scarifying, harrowing or other methods approved by the Owner.

3. Rejection: Gravel which fails to meet the requirements of these specifications may be rejected by the Engineer. Such rejection shall incur no cost to the Owner.

D. Coarse Aggregate Type A4 (Gravel for Trench Backfill): Sandy gravel material, free of clay, shale, organic matter; meeting the following requirements:

1. Tests:
 - a. The liquid limit shall not exceed 35 when tested in accordance with ASTM Designation D423.
 - b. The plasticity index shall not exceed 12 nor be less than 4 when calculated in accordance with ASTM Designation D424.
 - c. The linear shrinkage shall not exceed six percent.
2. Gradation: The material when tested by standard laboratory methods shall meet the following percentages by weight:

Passing 2 in. sieve	100%
Passing 1/2 inch sieve	50 to 85%
Passing No. 4 sieve	20 to 65%
Passing No. 100 sieve	0 to 5%

2.2 FINE AGGREGATE MATERIALS

A. Fine Aggregate Type A5 (Sand): Conforming to TxDOT's Standard Specifications Item 421.2(5), "Fine Aggregate."

2.3 SOURCE QUALITY CONTROL

A. Section 01 40 00 – Construction Materials Testing.

A.B. Section 01 45 16 – Contractor Quality Control, Quality Requirements: Testing and inspection services.

B.C. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698.

C.D. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM D698.

D.E. When tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 STOCKPILING

A. Stockpile materials on site at locations designated by Engineer.

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- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate different aggregate materials with dividers or stockpile individually to prevent mixing.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.2 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

SECTION 32 11 23 - FLEXIBLE BASE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Crushed stone foundation course for structural backfill, embedment, trench backfill, surfacing, pavement or other base courses, furnished and installed on a prepared surface. The "Flexible Base" shall be constructed as herein specified in one or more courses in conformity with the typical sections and to the lines and grades as indicated or as established by the Engineer.

B. Related Sections:

1. Section 31 23 17 - Trenching.
2. Section 31 23 23 - Fill.
3. Section 32 05 16 - Aggregates for Civil Site Improvements.
4. Section 32 12 16 - Hot Mix Asphaltic Concrete Paving.
5. Section 32 13 13 - Concrete Paving.
6. Section 32 91 19 - Landscape Grading.

1.2 REFERENCES

A. Texas Department of Transportation's Standard Laboratory Test Procedures:

1. Moisture Content Tex-103-E
2. Liquid Limit Tex-104-E
3. Plasticity Index Tex-106-E
4. Bar Linear Shrinkage Tex-107-E, Part II
5. Sieve Analysis Tex-110-E
6. Moisture-Density Determination Tex-113-E
7. Roadway Density Tex-115-E
8. Wet Ball Mill Tex-116-E
9. Triaxial Tests Tex-117-E
(Part I or II as selected by
the Engineer)
10. Particle Count Tex-460-A, Part I

B. American Association of State Highway and Transportation Officials:

1. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit data for geotextile fabric and herbicide.

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- C. Samples: Submit, in air-tight containers, 10 lb sample of each type of Flexible Base to testing laboratory.
- D. Materials Source: Submit name of aggregate materials suppliers.
- E. Manufacturer's Certificate: Certify Flexible Base meets or exceeds specified requirements outlined herein.

1.4 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Perform Work in accordance with Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets, and Bridges (latest Edition).
- C. Maintain one copy of Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets, and Bridges (latest Edition) on site.

PART 2 PRODUCTS

2.1 FLEXIBLE BASE MATERIAL REQUIREMENTS

- A. Flexible Base: Texas Department of Transportation's Standard Specification Item 247, Grade 1 or 2, Type A.

2.2 ACCESSORIES

- A. Geotextile Fabric: As specified in the Drawings.
- B. Herbicide: As specified in the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify compacted substrate is dry and ready to support paving and imposed loads.
 - 1. Proof roll substrate in accordance with Texas Department of Transportation Standard Specification Item 216, "Rolling (Proof)" to identify soft spots.
 - 2. Remove soft substrate and replace with compacted fill as specified in Section 31 23 23 – Fill.
 - 3. No additional compensation will be made for materials, equipment or labor required for "Proof Rolling," but shall be considered subsidiary to "Flexible Base."

- C. Verify substrate has been inspected, gradients and elevations are correct.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 BASE PLACEMENT

- A. When specified in the Drawings, install geotextile fabric over subgrade in accordance with manufacturer's instructions.
 1. Lap ends and edges minimum 6 inches.
 2. Anchor fabric to subgrade when required to prevent displacement until aggregate is installed.
- B. When the Flexible Base compacted thickness is less than (or equal to) 6 inches, spread base material over prepared substrate to total compacted thickness indicated on Drawings.
- C. When the Flexible Base compacted thickness exceeds 6 inches, place base material equal thickness layers to total compacted thickness indicated on Drawings.
 1. Maximum Layer Compacted Thickness: 6 inches.
 2. Minimum Layer Compacted Thickness: 3 inches.
- D. Roller compact Flexible Base to density indicated in Texas Department of Transportation's Standard Specification Item 247.
- E. Level and contour surfaces to elevations, profiles, and gradients indicated.
- F. Maintain optimum moisture content of base materials to attain specified compaction density.
- G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

- A. Section 01 40 00 - Quality Requirements and Texas Department of Transportation Item 247.3(1)(f), "Tolerances."
- B. Maximum Variation from Flat Surface: 1/4 inch measured with 16 foot straight edge.
- C. Maximum Variation from Thickness: 1/2 inch.
- D. Maximum Variation from Elevation: 1/2 inch.

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3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Compaction testing will be performed in accordance with Texas Department of Transportation's Test Method Tex-113-E.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- D. Frequency of Tests: One test for every 1000 square yards of each course (layer) of compacted base material.

3.6 COMPACTION

- A. Each course of flexible base shall be compacted to not less than 100 percent density when tested in accordance with TxDOT Test Method Tex-113-E. Field density determination shall be made in accordance with TxDOT Test Method Tex-115-E.

END OF SECTION

SECTION 32 12 16 - HOT MIX ASPHALTIC CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Asphalt materials.
 - 2. Aggregate materials.
 - 3. Asphalt paving surface course.
 - 4. Asphalt paving overlay for existing paving.
- B. Related Sections
 - 1. Section 31 23 23 - Fill.
 - 2. Section 32 05 16 - Aggregates for Civil Site Improvements.
 - 3. Section 32 11 23 - Flexible Base.

1.2 REFERENCE STANDARDS

- A. Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets and Bridges (latest Edition):
 - 1. Tex-101-E – Preparing Soil and Flexible Base Materials for Testing
 - 2. Tex-107-E – Determining the Bar Linear Shrinkage of Soils
 - 3. Tex-200-F – Sieve Analysis of Fine and Coarse Aggregates
 - 4. Tex-203-F – Sand Equivalent Test
 - 5. Tex-204-F – Design of Bituminous Mixtures
 - 6. Tex-206-F – Compacting Specimens Using the Texas Gyratory Compactor (TGC)
 - 7. Tex-207-F – Determining Density of Compacted Bituminous Mixtures
 - 8. Tex-210-F – Determining Asphalt Content of Bituminous Mixtures by Extraction
 - 9. Tex-217-F – Determining Deleterious Material and Decantation Test for Coarse Aggregates
 - 10. Tex-227-F – Theoretical Maximum Specific Gravity of Bituminous Mixtures
 - 11. Tex-228-F – Determining Asphalt Content of Bituminous Mixtures by the Nuclear Method
 - 12. Tex-229-F – Combined HMAC Cold-Belt Sampling and Testing Procedure
 - 13. Tex-404-A – Determining Unit Mass (Weight) of Aggregates
 - 14. Tex-410-A – Abrasion of Coarse Aggregate Using the Los Angeles Machine
 - 15. Tex-411-A – Soundness of Aggregate Using Sodium Sulfate or Magnesium Sulfate
 - 16. Tex-431-A – Pressure Slaking Test of Synthetic Coarse Aggregate
 - 17. Tex-432-A – Coarse Aggregate Freeze-Thaw Test
 - 18. Tex-433-A – Absorption and Dry Bulk Specific Gravity of Lightweight Coarse Aggregate
 - 19. Tex-438-A – Accelerated Polish Test for Coarse Aggregate
 - 20. Tex-460-A – Determining Crushed Face Particle Count
- B. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.

2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

C. Asphalt Institute:

1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
2. AI MS-19 - Basic Asphalt Emulsion Manual.
3. AI SP-2 - Superpave Mix Design.

D. ASTM International:

1. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
2. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
3. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
4. ASTM D977 - Standard Specification for Emulsified Asphalt.
5. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
6. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
7. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
8. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
9. ASTM D2041 - Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
10. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
11. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
12. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
13. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
14. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
15. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
16. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

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- B. Product Data:
 - 1. Submit product information for asphalt and aggregate materials.
 - 2. Submit mix design with laboratory test results supporting design.
- C. The Contractor shall designate in writing the source of all materials proposed for use in the mixture. Material certificates signed by the material producer and contractor certifying that each material complies with specification requirements shall be furnished.
- D. Pavement marking plan indicating lane separations and defined parking places. Note dedicated handicapped spaces with international graphics symbol.

1.4 QUALITY ASSURANCE

- A. Mixing Plant: Conform to Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets and Bridges (latest Edition).
- B. Obtain materials from same source throughout.
- C. Perform Work in accordance with Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets and Bridges (latest Edition).
- D. Maintain one copy of Texas Department of Transportation's Standard Specifications for Construction of Highways, Streets and Bridges (latest Edition) on site.

1.5 QUALIFICATIONS

- A. Installer: Company specializing in performing work of this section with minimum 2 years documented experience as approved by Engineer.

1.6 AMBIENT CONDITIONS

- A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.
- B. Do not place asphalt mixture when ambient air temperature is less than 50 degrees F and is falling (or surface is wet or frozen), but it may be placed when the air temperature is above 40 degrees F and is rising.
- C. Place asphalt mixture when temperature is not more than 30 degrees F less than initial mixing temperature.

PART 2 PRODUCTS

2.1 ASPHALT PAVING

- A. Asphalt Materials:
 - 1. Asphalt Cement: Asphalt cement for the paving mixture shall meet the requirements of TxDOT Standard Specifications Item 300, "Asphalts, Oils, and Emulsions."

2. Tack Coat: Asphaltic materials for tack coats, shown on the plans or approved by the Engineer, shall meet the requirements of TxDOT Standard Specifications Item 300, "Asphalts, Oils, and Emulsions."
3. Additives: Additives to facilitate mixing and/or improve the quality of the asphaltic mixture shall be used when noted on the Drawings or may be used with the authorization of the Engineer. The Contractor may choose to use either lime or a liquid anti-stripping agent to reduce the moisture susceptibility of the aggregate. The evaluation and addition of anti-stripping agents will be in accordance with TxDOT Standard Specifications Item 301, "Asphalt Anti-stripping Agents."
4. Aggregate Materials:
5. Coarse Aggregate: ASTM D692; crushed stone or crushed gravel in accordance with TxDOT Standard Specifications Item 340.
6. Fine Aggregate: ASTM D1073; natural sand or sand manufactured from stone, gravel, or blast furnace slag in accordance with TxDOT Standard Specifications Item 340.
7. Mineral Filler: ASTM D242; thoroughly dried stone dust or finely ground mineral particles, free of foreign matter; Portland cement, lime, or fly ash, in accordance with TxDOT Standard Specifications Item 340.

2.2 MIXES

- A. Asphalt Paving Mixtures: Designed in accordance with TxDOT Standard Specifications Item 340 with a maximum 20 percent by weight reclaimed asphalt pavement.
 1. Surface Course: TxDOT Standard Specifications Item 340, Type D "Fine Graded Surface Course" composed of angular crushed limestone. Smooth, uncrushed gravel is not allowed.
 2. Stability: The materials used in the mixture design shall produce a mixture with a stability of at least 35 when tested in accordance with TxDOT Test Method TEX-208-F.

2.3 SOURCE QUALITY CONTROL

- A. Section 01 40 00 — Construction Materials Testing. Quality Requirements: Testing, inspection and analysis requirements.

B.

C.B. Submit proposed mix design for review prior to beginning of Work.

D.C. Test samples in accordance with TxDOT Standard Specifications Item 340.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.
- C. Verify compacted Flexible Base is dry and ready to support paving and imposed loads.
- D. Verify gradients and elevations of base are correct.

E. Verify manhole frames and valve boxes are installed in correct position and elevation.

3.2 INSTALLATION

A. Prime Coat:

1. Apply prime coat in accordance with TxDOT Standard Specifications Item 340.
2. Use clean sand to blot excess primer.

B. Tack Coat:

1. Apply tack coat in accordance with TxDOT Standard Specifications Item 340.
2. Apply tack coat on asphalt and concrete surfaces and over Flexible Base surface at uniform rate.
 - a. New Surfaces: 0.10 gal/sq yd.
 - b. Existing Surfaces: 0.10 gal/sq yd.
3. Apply tack coat to contact surfaces of curbs, gutters and structures.
4. Coat surfaces of manhole and valve box frames with oil to prevent bond with asphalt paving. Do not tack coat these surfaces.

C. Single Course Asphalt Paving:

1. Install Work in accordance with TxDOT Standard Specifications Item 340.
2. Place asphalt within 24 hours of applying primer or tack coat.
3. Place asphalt surface course to thickness indicated on Drawings.
4. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

D. Double Course Asphalt Paving:

1. Place asphalt binder course within 24 hours of applying primer or tack coat.
2. Place binder course to thickness indicated on Drawings.
3. Place surface course within 24 hours of placing and compacting binder course. When binder course is placed more than 24 hours before placing wearing course, clean surface and apply tack coat before placing wearing course.
4. Place surface course to thickness indicated on Drawings.
5. Compact each course by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
6. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

E. Asphalt Paving Overlay

1. Apply tack coat to existing paving surface at rate recommended by Engineer.
2. When indicated on the Drawings, install geotextile fabric in accordance with manufacturer's instructions to permit asphalt saturation of fabric. Lap fabric edge and end joints 4 inches.
3. Place surface course to thickness indicated on Drawings.
4. Compact overlay by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
5. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.3 COMPACTION

- A. Hot Mix Asphaltic Concrete (HMAC) Pavement shall be compacted to between 91 and 96 percent of the maximum theoretical density as measured by ASTM D2041 and in accordance with TxDOT Standard Specifications Item 340, "Hot Mix Asphaltic Concrete Pavement" for Air Void Control.

3.4 TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B.A. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge applied parallel with and at right angles to centerline of paved area.

C.B. Scheduled Compacted Thickness: Within 1/4 inch.

D.C. Variation from Indicated Elevation: Within 1/4 inch.

3.5 FIELD QUALITY CONTROL

- A. Section 01 405-1600 - Contractor Quality ControlQuality Requirements: Requirements for inspecting, testing.
- B. Take samples and perform tests in accordance with TxDOT Standard Specifications Item 340.
- C. Asphalt Paving Mix Temperature: Measure temperature at time of placement.
- D. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1000 square yards compacted paving.
- E. Asphalt Paving Density: Test Method Tex-207-F; test one core sample from every 1000 square yards or 1 per day (minimum) of compacted paving.
- F. Stability: Test Method Tex-208-F; one test per day during production.
- G. Extraction: Test Methods Tex-210-F; Tex-228-F; or Tex-229-F; one test per day during production.

3.6 PROTECTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Immediately after placement, protect paving from mechanical injury until surface temperature is less than 140 degrees F.

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Aggregate base course.
 - 2. Concrete paving for:
 - a. Concrete streets and roads.
 - b. Concrete parking lots.
 - c. Concrete curbs and gutters.
 - d. Concrete median barriers.
 - e. Concrete sidewalks.
 - f. Concrete stair steps.
 - g. Concrete driveways.
- B. Related Requirements:
 - 1. Section 03 11 00 – Concrete Forming.
 - 2. Section 03 21 00 – Reinforcing Steel.
 - 3. Section 03 30 00 – Cast-in-Place Concrete.
 - 4. Section 32 13 15 - Joint Sealer.

1.2 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
- B. American Concrete Institute:
 - 1. ACI 301 - Specifications for Structural Concrete.
 - 2. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- C. ASTM International:
 - 1. ASTM A184/A184M - Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
 - 2. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - 3. ASTM A497/A497M - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 - 4. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 5. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 6. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - 7. ASTM A775/A775M - S Standard Specification for Epoxy-Coated Steel Reinforcing Bars.

8. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
9. ASTM A934/A934M - Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
10. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
11. ASTM C33 - Standard Specification for Concrete Aggregates.
12. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
13. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.
14. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. ASTM C150 - Standard Specification for Portland Cement.
16. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
17. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
18. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
19. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
20. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
21. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
22. ASTM C595 - Standard Specification for Blended Hydraulic Cements.
23. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
24. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
25. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
26. ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
27. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
28. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
29. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
30. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
31. ASTM D1752 - Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
32. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.3 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

- B. Product Data:
 - 1. Submit data on concrete materials, joint filler, admixtures, and curing compounds.
- C. Design Data:
 - 1. Submit concrete mix design for each concrete strength. Submit separate mix designs when admixtures are required for the following:
 - a. Hot and cold weather concrete work.
 - 2. Identify mix ingredients and proportions, including admixtures.
 - 3. Identify chloride content of admixtures and whether or not chloride was added during manufacture.
- D. Source Quality Control Submittals: Indicate results of shop factory tests and inspections.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301 and the requirements of Section 03 11 00, Section 03 21 00, and Section 03 30 00.
- B. Obtain cementitious materials from same source throughout.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 AMBIENT CONDITIONS

- A. Section 01 50 00 - Temporary Facilities and Controls: Ambient conditions control facilities for product storage and installation.
- B. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

PART 2 PRODUCTS

2.1 CONCRETE PAVING

- A. Form Materials:
 - 1. Form Materials: As specified in Section 03 11 00 - Concrete Forming.
 - 2. Joint Sealer: Shall be in accordance with Section 32 13 15 - Joint Sealer.
- B. Reinforcement:
 - 1. Reinforcing Steel: Type specified in Section 03 21 00 - Reinforcing Steel.
 - a. Dowel Bars: Dowel bars shall be plain steel bars conforming to ASTM A615 or ASTM A966 and shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site each dowel bar shall be

painted with one coat of paint conforming to MIL-DTL-24441/20A.SSPC Paint 5 or SSPC Paint 25. Metal or plastic collars (when indicated on Drawings) shall be full circular device supporting the dowel until the epoxy hardens.

The sleeves for dowel bars used in expansion joints shall be translucent of an approved design to cover 2 inches (minimum) of the dowel, with a closed end and with a suitable stop to hold the end of the bar at least 1½ inches from the closed end of the sleeve. Sleeves shall be of such design that they will not collapse during construction.

C. Concrete Materials:

1. Concrete Materials shall be as specified in Section 03 30 00 – Cast in Place Concrete.
2. Cement: ASTM C150, Type I – Normal, Type IA - Air Entraining, Type II – Moderate, Type IIA - Air Entraining, Type III - High Early Strength, or Type IIIA - Air Entraining.
3. Exposed Aggregate: Gravel washed natural mineral aggregate; furnished from single source.
 - a. Minimum Size: 1/4 inch.
 - b. Maximum Size: 1/2 inch.
 - c. Color: As selected.

2.2 FABRICATION

- A. Fabricate reinforcing in accordance with CRSI Manual of Practice.
- B. Form standard hooks for 180 degree bends and 90 degree bends as indicated on the Drawings.

2.3 MIXES

A. Concrete Mix:

1. Mix and deliver concrete in accordance with ASTM C94/C94M, Option a.
2. Select proportions for normal weight concrete in accordance with ACI 301 Method 1.
3. Provide concrete to the following criteria:
 - a. Compressive Strength: 4000 psi at 28 days.
 - b. Slump: 3 inches to ± 1 inch.
 - c. Minimum Cement Content: 564 pounds/cu yd.
 - d. Maximum Water/Cement Ratio: 0.45 (non-air entrained); 0.35 (air entrained).
 - e. Air Entrainment: ASTM C94/C94M; for severe exposure condition; maximum variation of 1.5 percent from required air content.
4. Limit the following cementitious materials to maximum percentage by mass of all cementitious materials:
 - a. Fly Ash: 0 percent. Fly ash shall not be used.
5. Use accelerating admixtures in cold weather only when accepted by the Engineer in writing. Use of admixtures will not relax cold weather placement requirements.
6. Use calcium chloride only when accepted by the Engineer in writing.
7. Use set retarding admixtures during hot weather only when accepted by the Engineer in writing.

2.4 ACCESSORIES

- A. Curing Compound: ASTM C309, Type 2, Class B.
- B. Joint Sealers: Specified in Section 32 13 15.
- C. Premolded Joint Filler: Premolded resilient joint filler for expansion joints shall conform to the requirements of ASTM D1751 and shall be punched to admit the dowels where called for on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to Engineer. Joint filler shall be compatible with joint sealant.

2.5 SOURCE QUALITY CONTROL

- A. Section 03 30 00 – Cast in Place Concrete: Testing.
- B. Submit proposed mix design of each class of concrete to Engineer for review and acceptance prior to commencement of Work.
- C. Tests on cement, aggregates, and mixes will be performed to ensure conformance with specified requirements.
- D. Test samples in accordance with ASTM C94/C94M.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify compacted base or subgrade is dry and ready to support paving and imposed loads.
 - 1. Proof roll subgrade with two perpendicular passes to identify soft spots.
 - 2. Remove soft subgrade or base and replace with Flexible Base.
- C. Verify gradients and elevations of base are correct.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Moisten substrate to minimize absorption of water from fresh concrete.
- C. Coat surfaces of manhole frames with oil to prevent bond with concrete paving.
- D. Notify Engineer minimum 24 hours prior to commencement of concreting operations.

3.3 INSTALLATION

- A. Forms:
 - 1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
 - 2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- B. Reinforcement:
 - 1. Place reinforcing as indicated on Drawings.
 - 2. Interrupt reinforcing at expansion joints.
 - 3. Provide doweled joints as indicated on Drawings. Dowel bars or other load-transfer units of an approved type shall be placed across joints in the manner as shown on Drawings. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment of by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. A dowel expansion cap or sleeve shall be furnished for each dowel bar used with expansion joints. These caps shall be substantial enough to prevent collapse and shall be placed on the ends of the dowels as shown on Drawings. The caps or sleeves shall fit the dowel bar tightly and the closed end shall be watertight. The portion of each dowel painted with rust preventative paint, as required under paragraph 2.1(B) and shown on Drawings to receive a debonding lubricant, shall be thoroughly coated with asphalt MC-70, or an approved lubricant, to prevent the concrete from bonding to that portion of the dowel. If free-sliding plastic-coated or epoxy-coated steel dowels are used, a lubrication bond breaker shall be used except when approved pullout tests indicate it is not necessary. Where butt-type joints with dowels are designated, the exposed end of the dowel shall be oiled.
 - 4. Repair damaged galvanizing and/or epoxy coating to match shop finish.
 - 5. Install tie bars consisting of deformed bars in joints as shown on Drawings. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on Drawings. They shall be held in position parallel to the pavement surface and in the middle of the slab depth. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. These bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed in the female side of the keyed joint provided the installation is made without distorting the keyed dimensions or causing edge slump. If a bent tie bar installation is used, the tie bars shall be inserted through the keyway liner only on the female side of the joint. In no case shall a bent tie bar installation for male keyways be permitted.
- C. Placing Concrete:
 - 1. Place concrete as specified in Section 03 30 00 - Cast in Place Concrete.
 - 2. Ensure reinforcing, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
 - 3. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- D. Joints: Joints shall be constructed as shown on Drawings and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on Drawings. Joints shall not vary more than $\frac{1}{2}$ -inch from their designated position and shall be true to line with not more than $\frac{1}{4}$ -inch

variation in 10 feet. The surface across the joint shall be tested with a 10-foot straightedge as the joints are finished and any irregularities in excess of $\frac{1}{4}$ -inch shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on Drawings.

1. Place expansion joints as indicated on Drawings. Premolded joint filler of the thickness as shown on Drawings shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space for the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint. Align curb, gutter, pavement, and sidewalk joints.
2. Place isolation joints between paving components and building or other structures as indicated on Drawings. Construct isolation joints identically to expansion joints as specified in (1), above. Isolation joints shall not be dowelled.
3. Provide construction joints as indicated on Drawings. Longitudinal construction joints shall be slip-formed or formed against side forms with or without keyways, as shown on Drawings. Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.
4. Install contraction joints at the locations and spacing as shown on Drawings. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Groove or saw cut contraction joints $\frac{1}{4}$ -inch wide at an optimum time as soon as possible after finishing. Cut $\frac{1}{4}$ of depth of slab into the slab. If contraction joint spacing is not indicated on Drawings, maximum contraction joint spacing shall be thirty (30) times the depth of the concrete paving.
5. Seal joints as indicated on Drawings and in accordance with Section 32 13 15.
6. Provide keyways as indicated on Drawings. Form keyways (only female keys permitted) in the plastic concrete by means of side forms or the use of keyway liners that are inserted during the slip-form operations. The keyway shall be formed to a tolerance of $\frac{1}{4}$ inch in any dimension and shall be of sufficient stiffness to support the upper keyway flange without distortion or slumping of the top of the flange. The dimensions of the keyway forms shall not vary more than plus or minus $\frac{1}{4}$ inch from the mid-depth of the pavement. Liners that remain in place permanently and become part of the keyed joint shall be made of galvanized, copper clad, or of similar rust-resistant material compatible with plastic and hardened concrete and shall not interfere with joint reservoir sawing and sealing.

E. Finishing Schedule:

1. Vehicular Paving: Heavy broom finish, burlap drag finish, or saw groove finish.

2. Sidewalk and Curb and Gutter Paving: Light broom finish
3. Inclined Vehicular Ramps: Heavy broom finish perpendicular to slope

F. Curing and Protection

1. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
2. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
3. Cure concrete surfaces as specified in Section 03 30 00 – Cast in Place Concrete.

3.4 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.
- C. Maximum Variation in Thickness: 1/4 inch.

3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. Inspect reinforcing placement for size, spacing, location, support.
- D. Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.
- E. Strength Test Samples:
 1. Sampling Procedures: ASTM C172.
 2. Cylinder Molding and Curing Procedures: ASTM C31/C31M, cylinder specimens, standard cured.
 3. Sample concrete and make one set of three standard cylinders for every 50 cu yds or less of each class of concrete placed each day and for every 2500 sf of surface area paving.
 4. Make one additional cylinder during cold weather concreting, and field cure.
- F. Field Testing:
 1. Slump Test Method: ASTM C143/C143M.
 2. Air Content Test Method: ASTM C173/C173M ASTM C231.
 3. Temperature Test Method: ASTM C1064/C1064M.
 4. Measure slump and temperature for each compressive strength concrete sample.
 5. Measure air content in air entrained concrete for each compressive strength concrete sample.
- G. Cylinder Compressive Strength Testing:
 1. Test Method: ASTM C39/C39M.
 2. Test Acceptance: Average compressive strength of three consecutive test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.

3. Test one cylinder at 7 days.
4. Test one cylinder at 28 days.
5. Retain one cylinder for reserve for testing later when requested by Engineer.
6. Dispose remaining cylinders when testing is not required.

H. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.6 PROTECTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.
- C. Do not permit vehicular traffic over paving for 14 days (minimum) after finishing.

END OF SECTION

SECTION 32 13 15 - JOINT SEALER

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes sealants, joint backer rod, and accessories.
- B. Related Sections:
 - 1. Section 32 13 13 – Concrete Paving: Sealants required in conjunction with concrete paving.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
 - 2. ASTM C1193 - Standard Guide for Use of Joint Sealants.
 - 3. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
 - 4. ASTM D1667 - Standard Specification for Flexible Cellular Materials-Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
 - 5. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Products Data: Submit data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
- C. Samples: Submit two samples illustrating sealant colors for selection.
- D. Manufacturer's Installation Instructions: Submit special procedures, surface preparation, and perimeter conditions requiring special attention.
- E. Warranty: Include coverage for installed sealants and accessories failing to achieve watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with TxDOT Specification 438.
- B. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

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- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 MOCKUP

- A. Section 01 40 00 – Construction Materials Testing: Requirements for mockup.
- B. Construct mockup with specified sealant types and with other components noted.
 1. Determine preparation and priming requirements based on manufacturers recommendations; take action necessary for correction of failure of sealant tests on mockup.
 2. Verify sealants, primers, and other components do not stain adjacent materials.
- C. Locate where directed by Engineer.
- D. Incorporate accepted mockup as part of Work.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work with sections referencing this section.

PART 2 PRODUCTS

2.1 JOINT SEALERS

- A. Manufacturers:
 1. Sonneborne Building Products.
 2. Substitutions: Section 01 60 00 - Product Requirements.
- B. Products Description:
 1. General Purpose Traffic Bearing Sealant (Sealant self-leveling): Polyurethane; ASTM C920, Grade P, Class 25, Use T,M; single component.
 - a. Type: Sonolastic SLI manufactured by Sonneborne.
 - b. Color: Colors as selected.
 - c. Applications: Use for exterior, pedestrian, and vehicular traffic bearing joints.

2.2 ACCESSORIES

- A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

- B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint Backer Rod: Round foam rod compatible with sealant; ASTM D1056, sponge or expanded rubber; D1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
- D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify substrate surfaces and joint openings are ready to receive work.
- C. Verify joint backer rod and release tapes are compatible with sealant.

3.2 PREPARATION

- A. Saw joints in accordance with Drawings.
- B. Immediately after sawing the joint, remove slurry and foreign matter from the joint and adjacent area by flushing with high-pressure water jet, and by use of other tools as necessary.
- C. Immediately before sealing, clean and prime joints. Upon completion of cleaning, the joints shall be blown out with compressed air, free of oil and water. The joint faces shall be surface dry when the sealant is applied.
- D. Perform preparation in accordance with ASTM C1193.
- E. Protect elements surrounding Work of this section from damage or disfiguration.

3.3 INSTALLATION

- A. Perform installation in accordance with ASTM C1193.
- B. Apply joint sealant by means of pressure equipment that will force the sealing material to the bottom of the joint and completely fill the joint without spilling the material on the surface of the pavement. A backing material shall be placed as shown on Drawings and shall be nonreactive and nonadhesive to the concrete or the sealant material. Sealant that does not bond to the concrete surface of the joint walls, contains voids, or fails to set to a tack-free condition will be rejected and replaced by the Contractor at no additional cost. Before sealing the joints, the Contractor shall demonstrate that the equipment and procedures for preparing, mixing, and placing the sealant will produce a satisfactory joint seal. Any sealant spilled on the surface of the pavement, structures and/or adjacent areas shall be removed immediately.
- C. Surface bond area on each side not less than 75 percent of joint width.

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- D. Install bond breaker where joint backing is not used.
- E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
- F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
- G. Tool joints as detailed on Drawings.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean adjacent soiled surfaces.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Protect sealants until cured.

END OF SECTION

SECTION 321823.16

NATURAL TURF PLAYING FIELD SYSTEM

PART 1 - GENERAL

1.1 INFORMATION PROVIDED FROM THE OWNER

- A. The Owner shall provide:
 - 1. Survey of site including but not limited to boundaries, contours and spot elevations, existing structures, and utilities.

1.2 WORK INCLUDED

- A. Provide all equipment and materials and do work necessary to complete the natural turf playing field system, as indicated on the drawings and as specified herein.
 - 1. Earthwork Requirements
 - a. Demolition.
 - b. Excavation, trenching, grading, backfilling, compaction to achieve subgrade.
 - c. Laser grading.
 - d. Disposal of spoil materials.
 - e. Acceptance of Subgrade
 - f. Verification of Subgrade.
 - 2. Playing Field Irrigation System Requirements
 - a. System Piping, heads, valves, controllers, and appurtenances
 - b. Automatic controls
 - 3. Playing Field Requirements
 - a. Soil materials and amendments
 - b. Installation of blended rootzone materials and amendments
 - c. Laser grading
 - d. Grassing and Grow-In
 - 4. Field Equipment
 - a. Field Corner Markers
 - b. Goal Posts, standards, sleeves and footings
 - c. Soccer Goals

1.3 REFERENCE STANDARDS

- A. Comply with applicable requirements of standards relating to the work of this section. Should the standards conflict with other specified requirements; the most restrictive requirement shall govern.
- B. American Society of Testing and Materials (ASTM).
- C. Irrigation System Standards: Comply with all applicable provisions of the latest edition of the following codes:

1. All local and State codes.
2. National Fire Protection Association, (NFPA):
3. The Irrigation Association, (IA).
4. Uniform Plumbing Code (UPC)
5. National Electrical code. (NEC)

D. National Sanitation Foundation, (NSF).

1.4 DEFINITIONS

- A. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal or placement of materials removed.
- B. Unauthorized Excavation: Inadvertent or purposely removing materials beyond indicated subgrade elevations or dimensions without specific direction of the Architect. Unauthorized excavation, as well as remedial work resulting from unauthorized excavation directed by Architect shall be at Contractor's expense.
 1. Unauthorized excavation, including disposition of additional excavated materials and other work resulting from slides, cave-ins or remedial work shall be at Contractor's expense.
- C. Additional Excavation: When excavation has reached required subgrade elevation's, the Architect will be notified and will see of conditions. If Architect determines that bearing materials at required subgrade elevations are unsuitable, excavation shall be continued until suitable bearing materials are encountered and excavated material shall be replaced as directed by the Architect.
 1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- D. Subgrade: The undisturbed earth or the compacted soil layer immediately below proposed playing field soil materials.

1.5 SUBMITTALS

- A. Test reports: Field reports as indicated in PART 3 of this specification.
- B. Supplier List: Submit list of procured and contracted suppliers of all materials required for the Playing Field System.
- C. Material Certifications: Manufacturer's or vendor's certified analysis for:
 1. Soil amendments
 2. Sod.
 3. Fertilizers and chemical amendments
- D. Product Data: Submit manufacturer's product data and samples as noted for the following:
 1. Irrigation system including heads, valves, boxes, fittings, wire connectors, pipe, pump, and appurtenances
 2. Miscellaneous field equipment as noted herein or on drawings.
- E. Rootzone Material Samples:
 1. Submit samples of each of the following materials to establish Baseline specification and ratios for the remainder of the testing process.

- a. Playing Field Sand Material: Provide one-gallon samples of each potential sand source material for testing.
- b. Provide a one-quart sample of each type of organic material to be tested.

F. Live Material Samples:

- 1. Submit prior to construction.
 - a. Sod: Submit a one square foot sample of the proposed sod with minimum of one inch of soil below the thatch layer. Ship in an overnight express package to reduce spoilage.

G. Preliminary Fertility/Chemical Schedule:

- 1. Submit during construction and prior to grow-in. Schedule should include complete grow-in period up to the anticipated Substantial Completion date. This schedule as well as specific applications may be adjusted during the maintenance period as based on Fertility testing results, recommendations from the Fertility Testing Agent, climatic conditions, etc. Changes to the schedule shall be reviewed by the Owner's groundskeeper / representative and agents.

H. Contractor to verify in writing the static pressure and gpm at water connection point for the irrigation system.

I. Shop Drawings: Submit shop drawings for the goal posts, soccer goals, footings and sleeves. Manufacturer to design footings and seal with a registered engineer's stamp.

J. Irrigation Record Drawings:

- 1. The Contractor shall provide and keep up to date a complete set of "As Built" record set of prints which shall be corrected as the work progresses, and show every change from the original drawings and specifications and the actual "As Built" dimensions and kinds of equipment. This set of drawings shall be kept on site and shall be used only as a record set.
- 2. These drawings shall also serve as progress sheets, and the Contractor shall make neat and legible annotations thereon as the work proceeds, showing the work as actually installed. These drawings shall be available at all times for inspection and shall be kept in the Contractor's mobile office on location at all times for inspection.
- 3. Record drawings shall show the location of all sprinklers, valve boxes, valve markers, controllers, pipe, wire trenches, multiple wire splice boxes, sensors and all pertinent material buried and not visible to the eye. Record drawings shall indicate dimensions from two permanent points of easily identifiable nature, if possible, such as sprinkler heads, permanent markers, concrete pads, etc.
- 4. Contractor shall provide Owner a laminated half-size copy of the as-built irrigation plan.

1.6 QUALITY ASSURANCE

- A. All work shall be performed by one (1) Contractor with proven experience in this field. This Contractor shall have successfully installed three similar and successful sand based fields in the last five years.

B. Site work Testing Agents

1. Testing required for this work for items such as subgrade shall be performed utilizing the Owner's agents or the Contractors agents as applicable.

C. Playing Field Testing Agent:

1. The Contractor shall utilize an independent Testing Agent that specializes in the testing required for the scope of work as specified in this document. The Testing Agent shall be A2LA accredited and be insured. The Testing Agent will minimally perform testing of the field system material components, as well as to establish and verify rootzone mix criteria and performance.

D. Fertility Testing Agent:

1. The Playing Field Contractor shall submit soil and tissue tests during the grow-in period to this Agent. Soil and tissue samples shall be submitted for testing every other week after the installation of the sod through Substantial Completion.
2. The Fertility Agent shall specify and make recommendations to the Contractor and Owner for fertilizer ratios and rates of application regarding macro and micronutrients during the maintenance period.

E. Suggested Sampling Collection Procedures for Processed Sand and blended rootzone material:

1. Make a sample collection tube from a 2.5-inch PVC pipe, approximately 4 - 5 foot long with a 45 degree angle on one end of the pipe. It is also useful to have a rubber mallet to tap samples out of the pipe.
2. Push this pipe into the stockpile at 6-8 random locations depending on the size of the stockpile. The material collected at each location shall be placed into a clean bucket. Do this for each stockpile or batch.
3. Thoroughly mix the samples in the bucket and fill a one-gallon labeled zip lock freezer bag with material from the bucket. Repeat the procedure for each stockpile or batch.
4. Note locations of composite samples and what stockpile it corresponds to. Include a transmittal letter to identify the source of samples and sample location. Do not use labels to identify samples. Use a waterproof marker and double bag the sample(s). Send the sample(s) to the Playing Field Testing Agent. Contractor to coordinate all weekend sample deliveries with Testing Agent.

F. Sod Supplier Grow-In Program and Harvest:

1. The Owner has contracted identified a source of sod for this project. The Sod Supplier shall submit to an on-site observation of the area to be used as the sod source. An area of sufficient size to plant the project shall be designated and reserved for the project in the presence of an Owner's Representative. This area should also be where the tested and approved sample was taken. During the grow-in and harvest period, the Owner, Playing Field Designer/Engineer and Owner's Testing Agent shall be allowed to inspect the source at any time.

1.7 QUALITY CONTROL

- A. Submit samples of each of the following during mass production of rootzone and gravel materials for performance testing and prior to shipping.
 - 1. Rootzone Mix:
 - a. A minimum of one-gallon sample for every 500 tons of root zone mix shall be tested by the Owner's Testing Agent for general compliance with the established Baseline specifications.
- B. Live Material Samples
 - 1. Submit during grow-in.
 - a. Grass tissue: Submit in a one-quart bag to the Fertility Testing Agent. Harvest sample immediately after mowing or clipping. Package and ship immediately. Ship in an overnight express package to reduce spoilage.
- C. Pre-bid Materials Inspection and Testing:
 - 1. Bidders are encouraged to:
 - a. Pre-test root zone and gravel drainage materials with an independent Testing Agent prior to submitting a bid. This does not guarantee that the materials or source will be approved for construction.
 - b. Pre-qualify any material deviating from that specified.
 - c. All costs associated with pre-bid testing shall be borne by the bidder.

1.8 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered and stored within the Contractor's work limits or in an area approved by the Owner.
- B. All material shall be stored in strict accordance with the manufacturer's recommendations.
- C. Packaged Materials: Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.
- D. Rootzone Mix:
 - 1. Deliver tested and approved lots in clean, washed and covered trucks to eliminate contamination during transportation. Place directly on playing field. Do not stockpile on site.
- E. Sod: All sod shall be transported to the project site and placed within twenty-four (24) hours after cutting. Sod cutting and shipping shall be coordinated with the Playing Field Contractor and sod installers.
- F. Irrigation Materials:
 - 1. Deliver irrigation system components in manufacturer's original undamaged and unopened containers with labels intact and legible.
 - 2. Deliver plastic piping in bundles, packaged to provide adequate protection of pipe ends.

3. Store and handle materials to prevent damage and deterioration.
4. Provide secure, locked storage for valves, and similar components that cannot be immediately replaced, to prevent installation delays.

1.9 COMPLETION AND ACCEPTANCE

- A. General: Field completion shall be separated into 2 phases, “Preliminary Completion” and “Substantial Completion.”
- B. Preliminary Completion: Scheduled date for preliminary completion shall be at least 15 calendar days before substantial completion. Notify the Owner and Owner’s representative in writing, 3 days prior to this observation meeting. To be considered “Preliminarily Complete” the following items shall be provided:
 1. Rootzone mixture in place, compacted and to grade.
 2. Irrigation system tested, installed and adjusted.
 3. Sod areas laid, joints and seams filled.
 4. One top-dressing application over entire grass surface complete.
- C. Substantial Completion: After “Preliminary Completion” observation, the Engineer/Architect shall prepare and submit to the Contractor, a punch list of items to be completed to achieve “Substantial Completion”. Contractor shall notify the Architect and Owner in writing, 5 days prior to a requested date for a site observation to meet “Substantial Completion.” To be considered “Substantially Complete” or “Playable” the following items shall be provided:
 1. All “Preliminary Completion” punch list items are complete.
 2. Maintenance Log compiled in a loose-leaf 3-ring binder detailing all work done on field from installation through Substantial Completion. Log shall include product information sheets and manufacturers representatives contacted with phone numbers.
 3. Submit five (5) copies of written operating and maintenance instructions. Provide format and contents as directed by the Architect.
 4. Instruct the Team or Owner’s personnel in the operation of the irrigation and other systems.
 5. A minimum of one top dressing performed on total field grass surfaces.
 6. Root depth of 3-1/2 inch averaged over the entire field as determined by 8 core samples equally representative of the field areas.
 7. Absence of all joints and cracks in sod installation as to appear “seamless.
 8. Dense, green, consistent grass void of any bare or patchy areas.
 9. Smooth, level playing surface compacted and level to grading tolerances.
 10. Written warranties/guarantees.
 11. Grass maintained at a height of 2 inches to 2-1/2 inch for bluegrass mowed with reel-type equipment.
 12. Stockpiling of required “attic stock” field materials.
 13. Goal posts, Soccer Goals standards and sleeves.

1.10 WARRANTY / GUARANTEE

- A. General: Warranties / Guarantees specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties/guarantees made by the Contractor under

requirements of the Contract Documents.

- B. Installer Guarantee: Provide a "Full System Guarantee" agreement. The President of the Playing Field Contractor shall sign the guarantee. Provide a guarantee for repair or replacement of the Playing Field System including both materials and workmanship for the following period of time:
 - 1. One year after date of Substantial Completion.
- C. The following are inclusive of the term "Playing Field System" for provisions of the guarantee:
 - 1. Working functions of the irrigation system.
 - 2. Final grade tolerances to one-quarter inch in the length of 25' of finish grade in any direction.
 - 3. All materials and products specified.
 - 4. Rootzone mixture shall be guaranteed to have a percolation rate of 6-8 inches per hour.
 - 5. Grass shall be true of species and type and free from objectionable weeds and/or grasses.

1.11 PLAYING FIELD CONSTRUCTION GROW IN MAINTENANCE

- A. General: Perform all operations necessary to maintain the Playing Field System through the date of Substantial Completion. Playing Field Contractor shall be on site to direct all Playing field subcontractors during this period.
- B. Minimum Requirements: The following list of items represents the minimum operations necessary to maintain the fields during the installation period. Prepare and present to the Owner and Architect in writing a maintenance schedule prior to grow in procedures for consideration and review. Representative schedule items shall include, but not be limited to the following:
 - 1. Mowing: Grass shall be maintained to a neat uniform appearance using only reel-type, clean, sharp, non-contaminated equipment. Grass shall be maintained to a height of 2 inches to 2-1/2 inches through Substantial Completion. Frequency will be dependant on the removal of no more than 1/3 of the grass blade height at any one time to achieve the desired grass height. Remove grass clippings only when an unsightly condition will occur. Mowing pattern to vary with each cut.
 - 2. Rolling: This operation shall only be done after a joint discussion has been held between the Contractor or Owner's Groundskeeper and the Architect. The grass field shall be rolled in two directions on initial planting of the sod. Care shall be taken not to damage irrigation heads. Additional rolling shall be accompanied by additional Aerification operations. One and one half to two ton rollers maximum.
 - 3. Top Dressing: In addition to the initial top dressing during the sod installation to fill in gaps between sod rolls, one lift of 1/4 inch may be required using the same rootzone mix as specified previously. Additional top dressing as required insuring a smooth and safe playing surface may also be required. Broom into sod after application. Care shall be used to avoid smothering sod.
 - 4. Aerification: This operation shall only be done after a joint discussion has been held

between the Contractor or Owner's Groundskeeper and the Architect. Aeration of the field may be required prior to Substantial Completion if determined to be at the appropriate time of year and only after the sod is firmly knitted. Removal of cores is required. Only hollow tine equipment shall be utilized with a 3/8-inch diameter core and a 3-inch x 3-inch grid in one direction or as agreeable.

5. Sod Replacement/Patching: Verified sod of the same type and source shall be used when necessary. All patches shall be a minimum of 12 inches in width and length.
6. Weed and Pest Control: All treatments will comply with local and state codes. Utilize only commercially licensed personnel and applicators to perform these operations. Treatments shall be made according to the needs of the field as determined by the Owner, Owner's Testing Agent, and Architect.
7. Irrigation System: The system shall be adjusted on a continual basis as necessary to maintain specified coverage. Heads shall be adjusted to elevation when necessary. All repairs to lines, valves, heads and field mixes shall be performed in a timely manner repairing to the previous condition and specifications. Heads shall be cleaned as necessary to insure full pop-up and flush lowered positions. Contractor shall use care not to contaminate the rootzone mix when making repairs that require deep excavation below the rootzone layer.
 - a. Controller shall be set for appropriate watering intervals with adequate instructions to the Owner. When possible, Contractor shall demonstrate the operation of the system and its controls in the presence of the Owner's Groundskeeper until they reasonably understand the system
8. Maintenance Log: Record a daily log of all maintenance activities performed on the field through Substantial Completion. These daily records shall be submitted to the Owner and Playing Field Designer/Engineer on a weekly basis through Substantial Completion.
9. Stockpile Materials (Attic Stock): Provide the following additional materials stored as directed by the Owner.

MATERIAL	QUANTITY
Rootzone Mix	100 tons

10. Irrigation Spare Parts (Attic Stock)

QTY	SPARE PART
12	Quick coupler valve keys (1 inch)
12	Hose swivel (1-1/2 inch x 1 inch)
2	Valve stem keys (48 inch)
12	Spare heads of each type specified

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: All fill material, regardless of intended use category, shall be clean and free from organic matter, roots, brush or other vegetation, trash, debris or other detrimental substances, and rocks or unbroken lumps larger than 3 inch, and shall be tested and approved by the soil testing and observation agency prior to placement.
- B. Suitable Material: Soils classified by ASTM as GW, GP, GM, GC, SW or SP, free from organic, frozen, or other deleterious materials. When approved by the Engineer on a case-by-case basis, Select Fill is an acceptable alternate.
- C. Structural Fill: non-plastic, sound, durable, granular particles consisting of sand, gravel, stone or blends with these materials, free from organic, frozen, or other deleterious materials, conforming to the following gradation requirements:

Sieve	Percent Passing
4"	100
No. 40	0-70
No. 200	0-10

- D. Trench Backfill: Existing soils obtained from Playing Field System excavations, excluding broken and pulverized weathered bedrock.
- E. Unacceptable Soil Materials: Existing on-site material or asphalt materials not suitable for fill.

2.2 IRRIGATION SYSTEM MATERIALS

- A. Plastic Pipe: Provide pipe homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, wrinkles, and dents. The pipe and hose are continuously and permanently marked with manufacturer's name, material type, size, and schedule or class and quality control identifications.
 1. Mainline pipe and fittings greater than 3 inches in diameter: Rigid, unplasticized polyvinyl chloride (PVC) PR-200, SDR-26 conforming to ASTM D2241 and D3139, NSF approved pipe, extruded from virgin material, PVC gasketed bell pressure pipe. Uniformly white in color.
 2. Mainline pipe, lateral pipe and fittings less than 3 inches in diameter: Rigid, unplasticized polyvinyl chloride (PVC), SDR-21, Schedule 40, Class 200, conforming to ASTM D2241 and D3139, NSF approved pipe, extruded from virgin material. Use solvent weld pipe and PVC solvent weld fittings. Uniformly white in color.
 3. Sleeves: All new sleeves shall be PVC Schedule 80, with solvent welded joints. The sleeve diameter is to be twice that of the pipe or wiring bundle.

B. Fittings:

1. Fittings for PVC main line piping shall be ductile iron gasketed fittings. The ductile iron fittings shall have deep bell push on joints with gaskets meeting ASTM F-477. These fittings shall be for change of direction and or tapped service tees. These fittings shall be manufactured by Harco Manufacturing or approved equal.
2. Fittings for PVC lateral piping shall be schedule 40 PVC fittings, suitable for solvent weld and threaded connections.

C. Nipples:

1. Plastic: Factory-threaded Schedule 80, Type 1, Grade 1 polyvinyl chloride (PVC) pipe, threaded both ends. Pipe shall be in conformance with ASTM D1784 and D1785, gray color.
2. Metallic: Schedule 40 red brass (35% copper, 15% zinc) pipe, threaded both ends. Pipe shall be in accordance with ASTM B43.

D. Solvents and Sealants:

1. Solvent Cement: Compatible with PVC pipe and of proper consistency conforming to ASTM D2564.
2. Threaded connections: All threaded pipe, fittings, and valve connections excepting the sprinkler body inlet, shall use thread sealant.

E. Swing Joints

1. General:
 - a. Sch-80 PVC prefabricated 0-ring triple elbow swing joints. Product shall not be fabricated on site.
2. Products:
 - a. Dura Plastic Products
 - b. Lasco
 - c. Spears
 - d. Approved equal

F. Irrigation Heads

1. General: All heads shall be as specified on the drawings or approved equal. Nozzle patterns are indicated and shown; however, specific site conditions may require that different nozzle patterns be used. Contractor shall adjust patterns to provide adequate coverage. All heads shown on the drawings shall be installed and have the following minimum characteristics:
 - a. Rotary gear driven.
 - b. Rubber covers affixed to top of head.
 - c. Stainless Steel riser.
2. Products:
 - a. Hunter I-40
 - 1) I-40-ADS-43
 - b. Approved equal.

G. Valve Boxes

1. General:
 - a. Valve boxes shall be of sufficient size to still allow room for maintenance without having to excavate or perform similar operations conforming to ASTM D368 for tensile strength of 18 inch deep and furnished with a non-hinged cover.
2. Products
 - a. Carson
 - b. Ametek
 - c. Brooks Industries
 - d. Approved equal

H. Manual Drain Valves

1. General:
 - a. 3/4"
2. Products:
 - a. Mueller
 - b. Nibco
 - c. Or approved equal

I. Gate Valves:

1. General:
 - a. Non-rising Stem Gate Valves 3 inches and larger: AWWA C500, cast- iron double disc, bronze disc and seat rings or AWWA C509, resilient seated stem, cast-iron body and bonnet, stem nut, 200 psi working pressure, and ends that fit NPS dimension, PVC pipe. Include elastomeric gaskets.
 - b. Bronze, non-rising Stem Gate Valves, 2 inches and Smaller: MSS SP-80, Type 1, solid wedge: non-rising, copper-silicon-alloy stem: Class 125, body and screw bonnet of ASTM B 62 cast bronze, with threaded or solder joint ends. Include polytetraflouoroethylene (PTFE)-impregnated packing, brass packing gland, and malleable-iron hand wheel.
2. Products:
 - a. Kennedy
 - b. Clow
 - c. Waterous
 - d. Or approved equal

J. Ball Valves

1. General:
 - a. Ball valves shall be of the size and type indicated on the plans.
 - b. Shall have a body constructed of cast bronze, stem and cross handle. Ball valves shall have a working pressure of not less than 150 psi and shall conform to AWWA standards.
2. Products:
 - a. Champion
 - b. Approved equal.

K. Quick Coupler

1. General:

- a. One inch
 2. Products
 - a. Hunter HQ-44LRC-R
 - b. Rainbird 44RC
 - c. Approved equal
- L. Quick Coupler Anchor
 1. General
 - a. Ductile Iron Anchor with stainless steel bolt
 2. Products
 - a. Harco
 - b. Approved Equal.
- M. Automatic Control System
 1. General: The automatic controllers shall be commercial type hybrid electromechanical controllers manufactured expressly for control of automatic circuit valves of landscape irrigation systems. Provide dual program clocks with number of circuits as noted on the drawings. Each controller shall have factory installed lightning and surge arrestors.
 2. Controller:
 - a. Hunter ICC-800M
 - b. Toro Controller
 - c. Rainbird Controller
 - d. Approved equal.
 3. Exterior Control Enclosure: Manufacturer's standard weatherproof locking cabinet complying with NFPA 70.
 4. Circuit Control: Each circuit variable from 0-120 minutes. Include switch for manual or automatic operation of each circuit.
 5. Timing Device: Adjustable, 24-hour clock, and 14-day calendar wheel with dual program and electric surge protection. Manual or semiautomatic operation.
 6. Rain Sensor:
 - a. Toro 850-74
 7. Control Wire:
 - a. UF-UL listed color-coded copper conductor direct burial size 14. Use waterproof DBY wire connectors at splices. Provide one color wire for each of the following:
 - 1) Zone control valves
 - 2) Common wire
 - 3) Spare wire
 - 4) Rainstat circuits
 8. Electric Remote Control Valves
 - a. Hunter ICV
 - b. Rainbird PESB
 - c. Toro 252 Series plastic electric remote control valve.
 - d. Or approved equal.
 9. Electric Remote Control Wiring:

- a. General:
 - 1) 24 volt electric control wires from controller to automatic valves shall be 14 gauge for valve control and 12 gauge for common, direct burial wire, Type UF, 600 volt, solid copper only, single conductor wire with PVC insulation and bear UL approval for direct underground feeder cable.
 - 2) Remote control valve wires shall be of a different color than the 110-volt service to controllers. The 24-volt common ground shall be of one continual color (white only) and a different color than the other 24-volt lines and the 110-volt service. Each control wire shall be tagged for zone identification at the controller, valve and where the conduit terminates at the main line loop.
- N. Thrust Blocks: Use 3,000 PSI concrete and 2-mil plastic to wrap fittings and pipe.
- O. Accessories:
 - 1. Drainage fill shall be 1/2" to 3/4" crushed stone.
 - a. Fill shall be clean soil free of stones larger than 2" diameter, foreign matter, organic material and debris.
 - b. Provide imported fill material as required to complete the work. Obtain rights and pay all costs for imported materials.
 - c. Suitable excavated materials removed to accommodate the irrigation system work may be used as fill material subject to the Engineer's review and acceptance.

2.3 ROOTZONE MIX COMPONENTS

- A. Processed Sand
 - 1. Standard:
 - a. ASTM F2396-04 Standard Guide for Construction of High Performance Sand-Based Rootzones for Sports Fields
 - 2. Sand Type:
 - a. Quartz sands shall be used.
 - 3. Sand Shape:
 - a. As classified according to Figure 1 of Test Method ASTM F 1632.
 - 4. Physical Properties: (Test Method F 1815)
 - a. Total Porosity 30-45%
 - b. Bulk Density 1.5 – 1.7
 - c. Air-filled Porosity 15-25%
 - d. Capillary Porosity 15-25%
 - e. Saturated hydraulic conductivity (cm/h) ≥ 25
 - f. (Saturated hydraulic conductivity [in/h]) (≥ 10)
 - 5. Chemical Properties
 - a. pH (Test Method D4972) 5.0 – 7.5
 - b. Calcium carbonate equivalent, preferred <5%
 - c. Calcium carbonate equivalent, marginal 5 to 15%
 - d. Organic Matter (Test Methods F 1647) 0.5 to 2.5%

- e. Nutrient content Adjust locally
- f. Heavy metals, other phytotoxic ions Adjust locally, do not exceed regulated thresholds
- 6. Mechanical Properties
 - a. Friction angle (degrees) (Test method D 3080) 38 to 50
 - b. Or alternatively
 - c. Angle of repose (degrees) (Test Method C 1444) 35 to 45
 - d. CBR (%) (Test Method D 1833) 12 to 25
 - e. Coefficient of Uniformity (CU) of sand 2.5 to 4.5
- 7. Performance Criteria:
 - a. The sand shall be uniform coarse sand screened and washed meeting the following criteria:
 - 1) Gradation Index (D90/D10): Less than 10
 - 2) ASTM F-1815-97 shall be used for the performance testing. Water retention shall be done at [30 cm tension for 12 inch mix design] [25 cm tension for 10 inch mix design] [20 cm tension for 8 inch mix design] [15 cm tension for 6 inch mix design].
 - 3) Infiltration Rate: 8 inches per hour
- 8. Particle Size Distribution of Rootzone Sand (ASTM F 2396)

Size Fraction	U.S. Standard Sieve	Particle Diameter Range	Specified Range (%) % Retained on Sieve
Gravel	4	>4.75 mm	0%
Gravel	6	3.4 to 4.75 mm	<5%
Fine Gravel	10	2.0 to 3.4 mm	<20%
Very Coarse Sand	18	1.0 to 2.0 mm	<20%
Coarse Sand	35	0.50 to 1.0 mm	25 to 50%
Medium Sand	60	0.25 to .50 mm	>25%
Fine Sand	100	0.15 to 0.25 mm	<10%
Very Fine Sand	270	0.05 to 0.15 mm	5% maximum
Silt		0.002 to 0.05 mm	5% maximum
Clay		<0.002	3% maximum

- a. No more than 30% in the combined very coarse sand, fine gravel, and gravel fractions.
- b. At least 60% of the total sand should be in the combined medium sand and coarse sand fractions.
- c. No more than 15% in the combined fraction less than 0.25 mm (fine sand, very fine sand, silt and clay fractions).

d. A Coefficient of Uniformity (CU = D60/D10) value of 2.5 to 4.5.

9. Testing Prior to Blending/Mix Design:

a. The Playing Field Contractor shall submit a one-gallon sample of the proposed sand material to the Playing Field Testing Agent for Testing. This process frequently requires multiple sand source samples to meet the performance specifications. The Playing Field Contractor shall prepare accordingly when scheduling this testing to meet the final construction schedule.

B. Rootzone Amendments

1. Suitability Ratings of Properties of Organic Amendments

Rating/Property	C/N Ratio	Ash Content	pH
Preferred	20:1 to 30:1	<12%	4.5 to 7.0%
Acceptable	30:1 to 50:1	12 to 17%	3.5 to 4.5%
Marginal	50:1 to 80:1	17 to 30%	3.0 to 3.5%
Unacceptable	<20:1 or >80:1	>30	<3.0 or >7.0

2. Processed Peat:

a. Types:

1) Fibric (Moss)
2) Hemic (Reed-sedge)
3) Sapric (Peat Humus)

b. Performance Criteria:

1) If selected shall have a minimum organic matter content of 85% by weight as determined by loss on ignition (ASTM D 2974-87 Method D) and shall be free of sticks, stones, hay, or any other deleterious matter.
2) Fiber content (D 4427)
3) Moisture Content: 40-70%

c. Particle Sizing:

Sieve Criteria	
2.0 mm sieve	0 to 5% retained
1.0 mm sieve	Less than 20% retained

d. Peat Suppliers

1) Pioneer Peat, Inc. (701) 746-4300
2) Oglebay Norton Industrial Sands, Inc. (619) 277-1670

3. Soil:

a. Performance Criteria:

1) If used shall have a minimum sand content of 60%, and a maximum clay content of 5 to 20%.

4. Specialty Additives : [Only at request of client]

- a. Profile/Turface (800) 207-6457
1) www.turface.com
- b. Tufflite, Inc. (602) 931-3681
- c. Western Pozzolan (303) 681-3655
1) www.westernpozzolan.com

5. Testing of Rootzone Amendment Prior to Blending/Mix Design:
 - a. The Playing Field Contractor shall submit a one-quart sample of the proposed amendment to the Owner's Testing Agent for Testing.
 - b. The amendment shall be tested concurrently with the processed sand material to expedite the Final Blend Determination.

2.4 FINAL ROOTZONE MIX

- A. Establishing the Final Rootzone Mix Baseline Specification:
 1. Upon approval of the processed sand and organic amendment, the Playing Field Testing Agent shall blend these components at several ratios as they deem appropriate to meet the performance criteria outlined in these specifications and Contract Documents. Ultimately, the Testing Agent shall recommend a final representative sample with a ratio/blend in general compliance with the specified performance criteria. This final ratio/blend of sand, and organic amendment shall define the baseline specification for all subsequent testing and approvals of the rootzone mix.
- B. Batch Testing, Blending and Verification of Rootzone Mix for Placement
 1. The Playing Field Testing Agent shall evaluate the rootzone mix using the most current ASTM Test Methods for sports fields. (ASTM F 2396 or later)
 2. The Playing Field Contractor shall begin to manufacture the rootzone mix in accordance with the previously recommended baseline mix as described in Paragraph A "Establishing the Final Rootzone Mix Baseline Specification" above.
 - a. The sand and organic matter shall be mixed to a uniform consistency and performed by an experienced blender off-site.
 3. The Playing Field Contractor shall submit to the Playing Field Testing Agent a one-gallon sample of the blended mix for every 500 tons of material. This shall be described as one batch. Physical performance testing shall be performed on each batch. This process shall be repeated throughout the course of manufacturing the rootzone mix.
 - a. Each batch will be released for shipping and placement immediately and only upon the approval of that batch.
- C. Physical Performance Evaluation of Root zone Mix:
 1. ASTM F-1815-97 shall be used for the performance testing. Water retention shall be done at 15 cm tension for 6 inch mix design. Tests shall determine compliance with the specified mixing ratio and provide calibration data for the quality control program. Tests shall comply with the following criteria on a core compacted at 14.3 ft-lb./inches squared.

Test Requirement	Performance
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Infiltration Rate	Greater than 6 inches per hour
Total Porosity	35% to 55%
Aeration Porosity (non capillary)	15% to 30%
Capillary Porosity	15% to 25%
Saturation Percentage	40% to 60%

2. The rootzone mixture shall have an organic matter content of 0.7% to 3% on a dry weight basis, as determine by Method 2 of ASTM F-1647.
3. The sand and organic matter shall be mixed to a uniform consistency and performed by an experienced blender.

2.5 SOD AND GRASS MATERIALS

- A. Bluegrass Sod: Bluegrass blend shall be used.
 1. Sod shall be grown in a sand based soil medium similar to the rootzone mixture specified in this section.
 2. Sod shall be 12-18 months old at time of harvest and machine stripped to a uniform thickness of no more than 3/4" soil below the thatch layer.
 3. No more than 24 hours shall pass from harvest to installation.
 4. Sod shall be free of objectionable grasses and broad leafed weeds.
 5. Sod shall be big roll cut in approximate widths of greater than or equal to 30 inches and minimum lengths of 50 feet.
 6. Sod not displaying the specified soil medium shall be accepted at the sole discretion of the Owner.

2.6 PLAYING FIELD GAME EQUIPMENT

- A. Soccer Goal System
 1. Product
 - a. Pro Premier Interscholastic Goal, Model 2B10 with wheel option, 8'x24
 2. Supplier
 - a. KwikGoal
 - b. Approved Equal
- B. Goal Post and Appurtenances
 1. General:
 - a. Gooseneck Depth 8'-0"
 - b. Crossbar 23'-4" x 6" diameter
 - c. Uprights - 20' high x 4" diameter
 - d. Sleeve and footing - Per the manufacturer, designed by suppliers registered engineer
 - e. Paint: Day-Glo "Saturn Yellow #17"

2. Goal Post Products:
 - a. Triman Tele-Goal (800) 822-6886, Dania, Florida
 - b. Marty Gilman, Inc. (800) 243-0398, Gilman, Connecticut
 - c. Approved equal
3. Goal Post Paint Products
 - a. Day-Glo Color Corp. (216) 391-7070
 - b. Approved equal

C. Field Corner Markers

1. General
 - a. As shown on drawings.
2. Suppliers:
 - a. Missouri Paint

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

- A. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed. Do not proceed with any work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.
- B. Protection of Work: Protect all on-going work, so as not to delay work due to weather or project related construction. This includes but is not limited to the use of tarps, geotextile, plywood and other protective measures.
- C. Protection of Persons and Property: Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.
 1. Protect adjacent construction throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, pavements, and other improvements from damage caused by settlement, lateral movement, undermining and washout.
- D. Unanticipated Conditions: Notify the Architect immediately upon finding evidence of previous structures, filled materials that penetrate below designated excavation levels, or other conditions which are not shown or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Architect's instruction before proceeding with further work in such areas.

3.2 EARTHWORK EXECUTION / SUBGRADE

A. Material Qualification and Testing

1. If found necessary, submit the following test data for each potential borrow source.
 - a. Particle Size Analysis:
 - 1) Method: AASHTO D422.
 - 2) Number of Tests: Three (3) per potential source.
 - 3) Acceptance Criteria: Gradation within specified limits.
 - b. Maximum Density Determination:

- 1) Method: Modified Proctor Test - ASTM D 1557.
- 2) Number of Tests: Three (3) per potential source.
2. Re-establish gradation and maximum density of fill material if source is changed during construction.

B. Preparation

1. Establish required lines, levels, contours and datum. Contractor responsible for work shall coordinate and ensure that the final grade of various materials such as rootzone, warning track, skin materials and sod will result in the final field grades shown on the Contract Drawings when these material sections are installed.
2. Maintain benchmarks and other elevation control points. Re-establish, if disturbed or destroyed, at no additional cost to the Owner.
3. Establish location and extent of utilities before commencement of grading operations.

4. Surface Water Control
 - a. All earthwork operations shall be conducted in a manner to prevent surface water from infiltrating into the subgrade and base. Drainage is to be maintained in all parts of the site to drain surface water without ponding at all times. The Contractor, at his own expense, shall undercut soils saturated by ponding and backfill per this Section at the direction of the Engineer.
5. Erosion Control measures to be in place per local codes.

C. Demolition

1. Sod
 - a. Strip that material necessary to remove sod layer and 8" of soil beneath. Remove sod and excavated material from field area and remove from site or as directed by Owner if allowed to remain on site.
2. Irrigation Heads and Valves
 - a. Remove all existing heads and valves from Field One. These parts are to be returned to the Owner.
3. Irrigation Source
 - a. Protect source connection and existing valves and appurtenances in the area of Work.
4. Existing Drainage System
 - a. Every effort shall be made by the Playing Field Contractor to protect existing systems found. Care shall be made when connecting to the existing system. Display evidence of drainage prior to covering system prior to finish grade work.

D. Excavation

1. Excavation shall consist, in general, of the excavation of whatever substance is encountered to the lines, grades and sections shown on the Drawings, including excavation as necessary for grading and other similar features.
2. During construction, the grading operations shall be executed in such a manner that the excavation will be well drained at all times. All grading shall be finished on neat, regular lines conforming to the sections and contours shown on the Plans.

3. Removal of materials beyond the indicated subgrade elevations, without authorization by the Architect, shall be classified as unauthorized excavation and shall be performed at no additional cost to the Owner.
4. Excavation shall be performed in proper sequence with all other associated operations.
5. Maintain the slopes of excavation in a safe condition until completion of the grading operation.
6. All excavation work shall be reviewed and approved by the Architect before proceeding with construction.
7. Any excess excavation shall be removed from the site to disposal areas at the Contractor's expense.

E. Fill

1. All site fill shall be "Structural Fill" unless otherwise shown on the Drawings, or directed by the Architect. "Structural Fill" shall be placed in lieu of "Suitable Material" where directed by the Architect.
2. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills.
3. Prior to placing fill over undisturbed material, scarify to a minimum depth of eight (8) inches.
4. The original ground or subgrade shall be proof rolled until the underlying soil is thoroughly compacted to the satisfaction of the Engineer. A steel-wheel tandem roller weighing 8 to 10 tons or equipment capable of obtaining the same compactive effort shall be used to obtain a thoroughly compacted subgrade. The subgrade shall be inspected prior to any fill operations or construction of improvements. Remove or re-compact any soft or loose soils as determined by the Engineer prior to filling. Remove any material determined to be unsuitable by the Architect and replace with compacted suitable material.
5. A thoroughly and satisfactorily compacted subgrade is defined as having a minimum dry density of 95 percent of the maximum density of the material used as determined by the Standard Proctor test (ASTM D 698). The sub-grade material shall be compacted at moisture content suitable for obtaining the required density.
 - a. When existing subgrade ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface. Scarify existing subgrade to depth of 8 inch prior to compacting. Moisture condition between 3 percent below and 2 percent above optimum moisture content, and re-compact to at least 95 percent of standard Proctor density (ASTM D698).
6. Place backfill and fill materials in layers not more than six (6") in loose depth. Lift height shall be governed by the ability of the compaction equipment to obtain the required compaction with six (6") as a maximum lift height. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost, ice, ponded water or extraneous debris.
7. When work is suspended during periods of freezing weather, measures shall be taken to prevent fill already in place from freezing. Upon resumption of work after any

inclement weather, prepare the exposed surface by proof rolling to identify any zones of soft/loose soils. Soft/loose materials or frozen soils shall be removed and replaced by compacted select fill.

F. Moisture Control:

1. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill as necessary to provide optimum moisture content. Prevent ponding or other free water on surface subsequent to, or during, compaction operations.
2. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.

G. Grading

1. The finished grade lines are shown on the contract drawings. Upon completion of this work, all debris shall be cleaned out and removed from the premises.
2. All cutting, filling, backfilling and grading necessary shall be done to bring the area to the following grade or subgrade levels:
 - a. The final elevation of the Subgrade shall be within one-half inch on a 25-foot by 25-foot grid of the finished grades indicated on the Contract Drawings. Laser controlled or indicated equipment shall be used for this part of the work.
 - b. The final grade on the subgrade shall mirror the final finish elevation of the field surface regarding slope except where noted on the drawings.
 - c. All surfaces shall be graded to drain to drainage structures with no ponding. Grading tolerances given above do not relieve the Contractor from this requirement.
3. Sufficient grading must be done during the progress of the work so that the entire site shall be well drained and free from water pockets.
4. Finish grading, including dressing swales, disposing of excess material and all other work necessary to prepare the site for final surfacing shall be done after construction of structures is complete.

H. Modifications to existing storm structures/lids

1. Reconfigure existing top of structure elevation to conform to new subgrade elevation as shown on drawings.

I. Compaction Equipment

1. Compaction equipment used for the Work is subject to approval by the Architect. Any equipment not originally manufactured for compaction purposes and equipment which is not in proper working order will not be approved. Furnish manufacturer's specifications covering data not obvious from a visual inspection of the equipment and necessary to determine its classification and performance characteristics.

J. Sub-grade Grade Verification: A certified survey shall be performed at 25-foot centers to verify grade and elevation of the sub-grade – by Owner.

3.3 IRRIGATION INSTALLATION

A. General: Plastic pipe and fittings shall be solvent welded using solvents and methods as recommended by manufacturer of the pipe, except where screwed connections are required. Pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before applying solvent with a non-synthetic bristle brush.

1. Pipe may be assembled and welded on the surface. Snake pipe from side to side of trench bottom to allow for expansion and contraction.
2. Connections between plastic pipe and metal valves shall be made using plastic male adapters and applying the recommended threaded joint compound.
3. All metal screwed joints shall be tightened with tongs or wrenches and employ the specified joint compound. Caulking of any kind will not be permitted.

B. Irrigation System Trenching:

1. Make trenches for main and laterals straight and true with the bottoms graded on uniform slopes to low points. Excavate trenches wide enough to allow a minimum of 4 inch between parallel pipelines, 8 inches from lines of other trades. Do not install lines parallel and directly over one another. Maintain 2-inch vertical clearance between irrigation lines; minimum transverse angle is 45 degrees. A maximum of 2 lines per trench.
2. Backfill for Irrigation Lines:
 - a. Excavated material is generally satisfactory for backfill. Backfill shall be free from rubbish, vegetable matter, frozen materials, and stones larger than 2-inches in maximum dimension. Remove material not suitable for backfill from site. Backfill placed next to pipe shall be free of sharp objects, which may damage the pipe. Backfill material for mainline pipe is to be tamped in 4-inch layers under the pipe and uniformly on both sides of the full width of the trench or as shown, and the full length of the pipe. PVC pipe shall not rest on concrete, rock, wood blocks, or similar items.
 - b. All irrigation pipes shall be immediately backfilled with preliminary backfill sufficient to prevent arching or slipping under pressure. Do not completely backfill trenches until the lines have been tested and reviewed.
3. Trenches shall be made of sufficient depths to provide the minimum cover from finished grade as follows:
 - a. 24 inches over 4 and 6 inch main lines and quick coupling valves.
 - b. 18 inches over main lines less than 4 inches in diameter
 - c. 14 inches over RCV controlled lines (laterals).

C. Sleeving: All lines shall be laid under hard surfaces in a PVC 200 pipe with solvent weld joints. Sleeve diameter shall be equal to twice that of the pipe or wiring bundle or that as shown on the drawings. Depth of sleeves to be determined by the type of line placed in sleeve. In the case of new construction, all sleeves shall be place prior to laying of any hard surface. Extend sleeving 12 inches beyond edge of paved surface.

- D. Pipe Penetrations: Core drill penetrations in a manner approved by the Owner. Provide metal sleeves for all irrigation lines wherever passing through a concrete wall or floor. Provide a water stop or membrane clamp for every pipe or sleeve penetrating an exterior concrete wall or floor, whichever is appropriate to the waterproofing method
- E. Closing: Cap or plug openings in lateral and main lines leaving caps and plugs in place until removal is necessary for completion of installation. Take other precautions as necessary to prevent dirt and debris from entering pipe or equipment.
- F. Automatic Controller: Refer to "Irrigation Controller Installation" in following section.
- G. Flushing: Lines shall be thoroughly flushed out before installing quick coupling valves, sprinklers or emitters.
 - 1. After flushing, main line pipe may be partially backfilled, butt joints, fittings and connections shall remain free and visible.
- H. Manual Drain Valves: Manual drain valve shall be installed at low points on mainlines only.
- I. Gravel Sumps: Gravel sumps shall be located at all manual and automatic drain valves, control valves and gate valves.
- J. Heads: Nozzle patterns are indicated and shown on the drawings, however, specific site conditions may require that different nozzle patterns be used. Contractor shall adjust patterns to provide adequate coverage.
 - 1. Adjustment: Adjust alignment and coverage of all heads. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, make all necessary changes or make arrangements with the manufacturer to have adjustments made, prior to any planting. These changes or adjustments shall be made without additional cost.
 - 2. Placement: Install heads perpendicular to grade. Set top of head 1/2 - inch below finish grade.
- K. Quick Couplers: Locate as shown on plan.
- L. Valve Boxes: Locate boxes the dimension from the field wall as shown on the drawings. Top of box shall be flush with finish grade after installation of artificial grass cover.
- M. Thrust Blocks: Use cast-in-place concrete bearing against undisturbed soil. Size, orientation, and placement shall be as shown on the drawings. Wrap fitting with plastic to protect bolts, joint, and fitting from concrete. Use wherever there is a change in pipe direction, at the end of the line and at all gate valves. Also use on all pipes 3 inches and greater in diameter or any slip joint connected pipe.
- N. Purging and Testing: Immediately prior to hydrostatic testing, all irrigation lines shall be thoroughly purged of all entrapped air. Introduce water into lines to be tested at full operating head pressure. Observe water flow at end of discharge point until determination is made that all air and residual debris has been expelled from the line. Conduct Hydrostatic Testing followed by completing the piping assembly and adjust sprinkler heads for proper distribution.

3.4 IRRIGATION CONTROLLER INSTALLATION

- A. Automatic Controllers: Wall or pedestal mounted in locking cabinets with direct surge protection. Verify power location and type, as well as power connection requirements. The contractor shall be responsible for any temporary controller installation.
 - 1. Contractor shall perform a radio reception survey to determine the best location for the hand held remote control antennae location.
- B. Electrical Control Wires: Installed in the same trench as the main line wherever possible. Wires shall be laid alongside the pipe by “snaking” in to the trench to allow as much slack as possible for contraction and expansion of the wire. All wire connections at remote control valves and at all wire splices shall be left with two feet of wire so that the splice or the valve manifold can be brought to the surface for repairs without disconnecting the wires. Each wire shall have a permanent label affixed to the wire at the controller designating the irrigation section remote control valve that it operates.
 - 1. Bundle control wire where two or more are in the same trench. Install common ground wire and one control wire for each remote control valve. Multiple remote control valves on a single control wire are not allowed. All splices should be made with wire connectors and waterproof sealant, installed per the manufacturer’s instructions. Protect wire not installed with PVC main line pipe with a continuous run of warning tape placed in the backfill above the wiring.
- C. Joint shall be waterproof to prevent leakage of water and corrosion build-up on the connection. All wiring shall be accomplished with as few splices as possible

3.5 ROOTZONE MIX INSTALLATION

- A. Begin placement of rootzone mix only after irrigation system layout and installation have been approved and after verification that the finish grade conforms to the installation tolerances.
 - 1. Footprints, tire tracks or other depressions in the gravel layer shall be removed/re-graded to a smooth surface prior to and during placement of rootzone material.
- B. The tested and approved rootzone material shall be dumped at the edge of the field and systematically worked outward onto the field. Under no circumstances will loaded rubber tired vehicles in excess of 1 ton be allowed on the gravel base prior to or during the spreading of the root zone mix. Equipment used on the rootzone mix/field shall be of a size and weight and shall utilize turf type tires, tracks or tires, which will not damage or overly compact the field installation.
- C. The material shall be spread onto the field in an even depth/layer as shown on the drawings within a tolerance of one-quarter inch. The finish grade slope shall conform exactly to the subgrade slope, (unless indicated otherwise on drawings) when the root zone mix has been spread uniformly over the field and compacted to 85% of the maximum dry density as determined by the standard proctor test. The field shall be compacted, settled and firmed uniformly. Operate the irrigation system as necessary to settle and compact the mix to a final uniform depth.
- D. Finish grades shall be achieved by using a combination of laser-operated equipment, string lines, drag screens, rollers, and hand raking with a tolerance of 1/4 inch in 25 feet.

E. Grade Verification: A survey of the finished spot grades is to be developed by a State licensed surveyor over the entire surface in a 25-foot grid – by Owner.

3.6 GRASS INSTALLATION

A. Pre-sod Fertilization: This may be altered if necessary at the time of planting based on conditions or recommendations of Fertility Testing Agent.

1. Macronutrient package/mix: Immediately prior to laying sod and after compaction of the rootzone mix is complete, incorporate into the upper two inches of the rootzone mix a fertilizer with the following ratios:
 - a. 3.8 pounds N (40% soluble, 60% slow release)
 - b. 6.5 pounds of P2O5
 - c. 6.5 pounds K2O
2. Micronutrient package to include 3.4 pounds of Scott's "Step" per 1000 square feet or equivalent. Verify types and ratio with Testing Agent prior to application.
3. Incorporate Milorganite into the upper two inches of the rootzone at a rate of 32 pounds per thousand square feet prior to sod installation.
4. This fertilization shall only be installed according to the amount of sod to be laid on that day.

B. Sod Installation: The entire area shall be approved by the Architect and the Owner prior to laying sod. Areas to receive sod shall be firm and the irrigation system shall be operational. Lay sod within 24 hours from time of harvesting / stripping. Sod not placed within 24 hours may be rejected at the sole discretion of the Owner and its representatives.

1. Lay sod to form a solid mass with tightly fitted joint, do not overlap. Wherever a break in the big roll occurs, overlap all ends or and trim to tightly fitted joint, removing the excess. Stagger strips to offset joints in adjacent courses. Sod lengths shall be installed so that they outline track areas. Work from boards when necessary to avoid damage to finish grade. Tamp or roll lightly to ensure contact with subgrade. If plastic mesh was used to help harvest big roll sod, this material should be removed prior to field installation and discarded from site. Contractor should take care not to rut or damage big roll sod with tires or tracks from the sod machine.
2. Patching: All patches necessary to fill in undesirable areas shall be a minimum size of 12 inches in length and width to match that of the roll. Patches shall be of the same source and type as the original installation and shall be installed at specified finish grade and watered in firm.
3. Filling Joints: After laying and rolling of sod, fill joints and seams with approved rootzone mixture. Broom or sweep excess material to avoid smothering grass. Sod areas requiring more than 1/4 inch of topdress to meet specified grade shall be lifted. Rootzone mix shall be added below the sod area and thoroughly compacted prior to the re-installation of the sod area. Thoroughly walk all seams to verify that all have been filled and that all low or irregular areas have been brought to specified grade tolerances.
4. Top Dress Sodded Field: Two lifts of 1/8 to 1/4 inch may be required using the same rootzone mix as specified previously. Additional topdressing as required insuring a smooth and safe playing surface may also be required. Care shall be used to avoid

smothering grass.

5. Irrigation of Grass:

- a. General: Begin irrigation as sod is completed in any one section and water to a depth of four inches below the new sod pad. After a short drying period, roll the sod area in two directions to ensure contact with soil mixture and to smooth the area. Water sod areas, as required, through Substantial Completion and until Owner takes possession. Adjust irrigation heads as required for spray pattern and depth to finish grade.

3.7 SPORTS EQUIPMENT INSTALLATION

A. Goal Post / Soccer Goal System

1. Install as per manufacturer's instructions for location, height of crossbar and level.
2. Contractor to submit drawing of footing sealed by a licensed engineer and approved prior to installation of footing or sleeve.

3.8 FIELD LAYOUT INSTALLATION

- A. General: Layout of the field regarding all chalk lines and markings shall be by the Owner following Substantial Completion.
- B. The Contractor shall locate and install field markers at the corners, midpoint and other locations as indicated on the drawings.
- C. The Goal Post shall be located on the centerline of the field and so that the leading edge of the upright is directly above the front edge of the back of the endzone marker. The top edge of the bottom of the crossbar shall be 10 feet above the centerline of the playing field finish grade. The location of the Goal post and sleeve shall be located at the beginning of the playing field construction. The Contractor shall verify that the above conditions can be met at that time.

3.9 FIELD QUALITY CONTROL

A. Subgrade Ground Surface Requirements:

1. Perform density tests in accordance with ASTM A1556, ASTM D2167, or ASTM D2022.
2. Perform moisture tests in accordance with ASTM D3017.
3. Where field-testing is performed using nuclear test methods, verify calibration of both density and moisture gages at the beginning of work, on each different type of material encountered, and additionally as directed by the Owner.

B. Fill and Backfill Materials: Test existing on-site soils and borrow materials proposed for use in filling and backfilling operations as follows. Allow testing services to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

Moisture Content:	ASTM D2216
Maximum Index Density:	ASTM D4253
Moisture Density Relations:	ASTM D698

Plasticity Index:	ASTM D4318
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- C. Subgrade Material: One test for every 2500 square foot of compacted subgrade material, or major fraction thereof, but in no case less than two tests for each day's work.
- D. Acceptance of Grass: At the end of each day, the Playing Field Designer or Owner's Representative shall inspect in place grass for conformance with requirements. Unacceptable grass shall be removed immediately from the site and replaced the following workday. This preliminary acceptance does not guarantee final acceptance at Substantial Completion.
- E. Playing field Contractor to utilize a fertility schedule based on rootzone soil and tissue testing, recommendations by the fertility testing agent and as discussed with the Owner's groundskeeper/representative. This shall occur throughout the grow-in period and up to Substantial Completion.
- F. Grass Root Depth: Grass shall display a minimum average of roots 3-1/2 inch in depth prior to acceptance of Substantial Completion. This requirement shall be evaluated based on conditions leading up Substantial Completion.
- G. Irrigation System Testing: Contractor is to notify the Playing Field Designer and Owner in writing 7 days prior to testing. Owner's Representative shall be on premises for overall check of the system. Pipelines jointed with rubber gaskets or threaded connections may be subjected to a pressure test at any time after partial backfill. Pipelines jointed with solvent-welded PVC joints shall be allowed to cure at least 24 hours before testing.
 - 1. Hydrostatic Pressure Test: Subject all lateral pipe to a hydrostatic pressure equal to the anticipated operating pressure of the system. Backfill to prevent pipe from moving under pressure. Leakage will be detected by visual observation. Replace all defective products. Repeat the test until the pipe passes. Cement or caulking to seal leaks is not allowed.
 - 2. Main Line Testing: Prior to the testing of the mainline pipe, pipe shall be backfilled. Joint areas shall be left exposed. Purge all air from the mainline before the test. Maintain constant pressure by adding water. Subject mainline to a pressure of 100 p.s.i. for one hour without visual evidence of leaks. No pressure loss should occur. If a leak is discovered within this period, the Contractor shall immediately repair the break and the system then retested for the same period. Testing of the laterals shall be done on a zone by zone basis. Replace all defective products and repeat test as necessary to gain a successful result. Cement or caulking to seal leaks is not allowed.
 - 3. Operational Test: Activate each remote control valve in sequence from the controller. The Owner's representative shall visually observe the operation, coverage and leakage. Replace, adjust, or move heads, couplers or other parts of the system as necessary to correct operational, coverage deficiencies or leakage. Repeat testing until each zone passes all tests.
 - 4. Control System Grounding Test: Test for proper grounding of control system per manufacturer's recommendations. Test results must meet or exceed manufacturer's guidelines for acceptance. Replace defective wire, grounding rod or other equipment.

Repeat test until the guidelines are met.

3.10 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from Owner's Property: Remove waste materials, including materials not allowed for fill, backfill or site grading as specified within, trash, and debris, and dispose of it properly off Owner's property at Contractor's expense.

END OF SECTION 32 18 23.16

ZIPP FAMILY SPORTS PARK

SECTION 32 91 19 - LANDSCAPE GRADING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Final grade topsoil for finish landscaping.
- B. Related Sections:
 - 1. Section 31 05 13 - Topsoil.
 - 2. Section 31 22 13 - Rough Grading.
 - 3. Section 31 23 17 - Trenching.
 - 4. Section 31 23 23 - Fill.
 - 5. Section 32 92 19 - Seeding.

1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Materials Source: Submit name of imported materials source.

1.3 QUALITY ASSURANCE

- A. Furnish each topsoil material from single source throughout the Work.

PART 2 PRODUCTS

2.1 MATERIAL

- A. Topsoil: As specified in Section 31 05 13 – Topsoil.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify structural and trench backfilling have been inspected.
- C. Verify substrate base has been contoured and compacted.

3.2 PREPARATION

- A. Protect landscaping and other features remaining as final Work.
- B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

ZIPP FAMILY SPORTS PARK

3.3 SUBSTRATE PREPARATION

- A. Eliminate uneven areas and low spots.
- B. Remove debris, roots, branches, stones, in excess of 2 inches in size. Remove contaminated subsoil.
- C. Scarify surface to depth of 4 inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.4 PLACING TOPSOIL

- A. Place topsoil in areas where seeding and/or sodding is required to nominal depth of four inches, or as indicated on the Drawings. Place topsoil during dry weather.
- B. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade.
- C. Remove roots, weeds, rocks, and foreign material while spreading.
- D. Manually spread topsoil close to plant material, structures, water and wastewater appurtenances, concrete paving, and curbs to prevent damage.
- E. Lightly roll placed topsoil.
- F. Remove surplus subsoil and topsoil from site.
- G. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.5 TOLERANCES

- A. Top of Topsoil: Plus or minus 1/2 inch.

3.6 PROTECTION OF INSTALLED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Prohibit construction traffic over topsoil.

END OF SECTION

SECTION 32 92 19 - SEEDING

PART 1 GENERAL

1.1 SUMMARY

- A. Description: This item shall consist of preparing a seed bed to the lines and grades indicated, sowing of seed, fertilizing, mulching with straw, asphalt, cellulose fiber and other management practices along and across such areas as are indicated or as directed by the Engineer.
- B. Section Includes:
 - 1. Fertilizing.
 - 2. Seeding.
 - 3. Hydroseeding.
 - 4. Mulching.
 - 5. Maintenance.
- C. Related Sections:
 - 1. Section 31 05 13 - Topsoil.
 - 2. Section 32 91 19 - Landscape Grading.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM C602 - Standard Specification for Agricultural Liming Materials.

1.3 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, Brome Grass, or vegetative species other than specified species to be established in given area.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data for seed mix, fertilizer, mulch, stabilizer and other accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Operation and Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; and types, application frequency, and recommended coverage of fertilizer.

1.6 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

1.7 QUALIFICATIONS

- A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
- C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

1.9 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance service.
- B. Maintain seeded areas immediately after placement until grass is well established and exhibits vigorous growing condition.

PART 2 PRODUCTS

2.1 SEED

- A. All seed must meet the requirements of the Texas Seed Law including the labeling requirements for showing pure live seed (PLS), name and type of seed. Seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within nine months of the time of delivery to the project. Each variety of seed shall be furnished and delivered in separate bags or containers. A sample of each variety of seed shall be furnished for analysis and testing when directed by the Engineer. The amount of seed planted per acre shall be of the type specified below.
- B. Substitutions: Section 01 60 00 - Product Requirements.

2.2 ACCESSORIES

- A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable. Straw mulch shall be spread

uniformly over the area indicated or as designated by the Engineer at the rate of 2 to 2 1/2 tons of straw per acre. The actual rate of application will be designated by the Engineer. Straw may be hand or machine placed and adequately secured.

- B. Cellulose Fiber Mulch: Cellulose fiber mulch shall be spread uniformly over the area indicated or as designated by the Engineer at the rate of 45 to 80 lbs per 1000 square feet.
- C. Fertilizer: All fertilizer shall be delivered in bags or containers clearly labeled showing the analysis. The fertilizer is subject to testing by the State Chemist in accordance with the Texas Fertilizer Law. A pelleted or granulated fertilizer shall be used with an analysis indicated below. The figures in the analysis represent the percent of nitrogen, phosphoric acid and potash nutrients, respectively, as determined by the methods of the Association of Official Agricultural Chemists. Fifty percent or greater of the Nitrogen required shall be in the form of Nitrate Nitrogen (NO_3). The remaining Nitrogen required may be in the form of Urea Nitrogen ($\text{CO}(\text{NH}_2)_2$).

In the event it is necessary to substitute a fertilizer of a different analysis, it shall be a pelleted or granulated fertilizer with a lower concentration. The total amount of nutrients furnished and applied per acre shall equal or exceed that specified for each nutrient.

Fertilizer shall be commercial grade; recommended for grass; of proportion necessary to eliminate deficiencies of topsoil to the following proportions: Nitrogen 15 percent, phosphoric acid 15 percent, soluble potash 15 percent.

- D. Lime: ASTM C602, Class T agricultural limestone containing a minimum 80 percent calcium carbonate equivalent.
- E. Water: Clean, fresh and free of industrial wastes and other substances or matter capable of inhibiting vigorous growth of grass.
- F. Soil Retention Blanket: Jute mesh or matting (open weave), or other material used as a soil retention blanket for erosion control purposes.
- G. Herbicide: As specified.
- H. Stakes: Softwood lumber, chisel pointed.
- I. String: Inorganic fiber.

2.3 SOURCE QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- D. Provide recommendation for fertilizer and lime application rates for specified seed mix as result of testing.

- E. Testing is not required when recent tests and certificates are available for imported topsoil. Submit these test results to testing laboratory. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify prepared soil base is ready to receive the Work of this section.

3.2 PREPARING SEED BED

- A. After the designated areas have been rough graded to the lines, grades and typical sections indicated or as provided for in other items of this contract and any other soil area disturbed by the construction, a suitable seed bed shall be prepared. The seed bed shall consist of either 4 inches of approved topsoil or 4 inches of approved salvaged topsoil cultivated and rolled sufficiently to a state of good tilth which could prevent the seed from being covered too deep for optimum germination. The optimum depth for seeding shall be 1/4 inch. Water shall be applied as required to prepare the seed bed. Seeding shall be performed in accordance with the requirements hereinafter described.

3.3 FERTILIZING

- A. Apply lime at application rate recommended by soil analysis. Work lime into top 6 inches of soil.
- B. Apply fertilizer at application rate as indicated below:

Use	Type	Application Rate Pound Per Acre
Broadcast Seeding	Any	400
Hydraulic Seeding	Water Soluble	653
Sodding	Any	300

- C. Apply after smooth raking of topsoil and prior to roller compaction.
- D. Do not apply fertilizer at same time or with same machine used to apply seed.
- E. Mix fertilizer thoroughly into upper 2 inches of topsoil.
- F. Lightly water soil to aid dissipation of fertilizer. Irrigate top level of soil uniformly.

3.4 BROADCAST SEEDING

- A. The seed or seed mixture in the quantity specified shall be uniformly distributed over the prepared seed bed areas indicated or where directed. If the sowing of seed is by hand, rather

than by mechanical methods, the seed shall be sown in two directions at right angles to each other. If mechanical equipment is used, all varieties of seed, as well as fertilizer, may be distributed at the same time, provided that each component is uniformly applied at the specified rate. After planting, the planted area shall be rolled with a corrugated roller of the "Culitpacker" type. All rolling of the slope areas shall be on the contour.

- B. Seed Mixture and Rate of Application for Broadcast Seeding: From September 15 to March 1, seeding shall be with a combination of un-hulled Bermuda Grass at a rate of 2 pounds per 1000 square feet and winter rye at a rate of 7 pounds per 1000 square feet that has a PLS = 0.83. From March 1 to September 15, seeding shall be with hulled Bermuda Grass at a rate of 2 pounds per 1000 square feet with a PLS = 0.83. Fertilizer shall be applied as specified herein.
- C. Do not seed areas in excess of that which can be mulched on same day.
- D. Do not sow immediately following rain, when ground is too dry, or when winds are over 12 mph.
- E. Lightly roll seeded area with roller not exceeding 112 lbs/linear foot.
- F. Immediately following seeding and rolling, apply mulch to thickness of 1/8 inch. Maintain clear of shrubs and trees.
- G. The broadcast seeded areas shall immediately be watered with a minimum of 5 gallons of water per square yard or as needed and in the manner and quantity as directed by the Engineer. Water shall be applied at a minimum rate of 10 gallons per square yard weekly except when rainfall of 1/2 inch or greater occurs on the site, the water can be postponed for one week or as directed, until the grass is uniformly 1 1/2 inches in height.

3.5 HYDRAULIC SEEDING

- A. The seed bed shall be prepared as specified above and hydraulic seeding equipment, which is capable of placing all materials in a single operation, shall be used.

March 1 to September 15: Hydraulic seeding mixture and minimum rate of application per 1000 square feet:

Hulled Bermuda Seed (PLS = 0.83)	Water Soluble Fertilizer	Cellulose Fiber Mulch	Soil Tackifier
1 lb.	15 lbs.	45.9 lbs.	1.4 lbs.

September 15 to March 1: Add 7 pounds per 1000 square feet of winter rye with a PLS = 0.83 to above mixture. Fertilizer shall be applied as specified herein.

- B. Watering: Hydraulically planted seeded area shall be watered weekly, except when rainfall of 1/2 inch or greater occurs on the site, the watering can be postponed for one week, commencing after the tackifier has dried or until the grass is uniformly 1 1/2 inches in height.

The native grass seeded area shall be watered at a minimum rate of 5 gallons per square yard weekly commencing after the tackifier has dried or until the grass is uniformly 1 1/2 inches in height. The watering can be postponed for one week or as directed, when rainfall of 1 1/2 inches or greater occurs on the site.

3.6 SEED PROTECTION

- A. Cover seeded slopes where grade is 3:1 (Horizontal:Vertical) or greater with soil retention blanket. Roll fabric onto slopes without stretching or pulling.
- B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Overlap edges and ends of adjacent rolls minimum 12 inches. Backfill trench and rake smooth, level with adjacent soil.
- C. Secure outside edges and overlaps at 36 inch intervals with stakes.
- D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
- E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.7 MAINTENANCE

- A. Mow grass at regular intervals to maintain at maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at each mowing. Perform first mowing when seedlings are 40 percent higher than desired height.
- B. Neatly trim edges and hand clip where necessary.
- C. Immediately remove clippings after mowing and trimming. Do not let clippings lay in clumps.
- D. Water to prevent grass and soil from drying out.
- E. Lightly roll surface to remove minor depressions or irregularities.
- F. Control growth of weeds. Apply herbicides. Remedy damage resulting from improper use of herbicides.
- G. Immediately reseed areas showing bare spots.
- H. Repair washouts or gullies.
- I. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

SECTION 33 01 30 – FRAMES, GRATES, RINGS AND COVERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Construction of frames, grates, rings and covers.
 - 2. Raising manhole frames and covers.
 - 3. Replacing manhole frames and covers.

- B. Related Sections:
 - 1. Section 03 60 00 - Grouting.
 - 2. Section 33 05 16 - Utility Structures.
 - 3. Section 33 31 00 - Sanitary Utility Sewerage Piping.
 - 4. Section 33 41 13 – Public Storm Utility Drainage Piping

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
 - 2. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale).
 - 3. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
 - 4. ASTM C642 - Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.
 - 5. ASTM C672 - Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
 - 6. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
 - 7. ASTM D395 - Standard Test Method for Rubber Property - Compression Set.
 - 8. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
 - 9. ASTM D573 - Standard Test Method for Rubber-Deterioration in an Air Oven.
 - 10. ASTM D575 - Standard Test Methods for Rubber Properties in Compression.
 - 11. ASTM D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
 - 12. ASTM F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 13. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

- B. Product Data: Submit manhole covers and riser rings construction, features, configuration, dimensions and load ratings.

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- C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual grade adjustment elevation of manhole.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in undamaged, unopened container, bearing manufacturer's original labels. Inspect for damage.
- C. Protect materials from damage by storage in secure location.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Provide schedule of manhole grade adjustment.

PART 2 PRODUCTS

2.1 FRAMES, GRATES, RINGS AND COVERS

- A. Manufacturers:
 1. East Jordan Iron Works (EJ Group, Inc.).
 2. Neenah Foundry (Neenah Enterprises, Inc.).
 3. Substitutions: Section 01 60 00 - Product Requirements.

2.2 MATERIALS

A. Welded Steel:

1. Welded steel grates and frames shall conform to the member, size, dimensions and details indicated and shall be welded into an assembly in accordance with those details. Steel shall conform to the requirements of ASTM A36.

B. Castings:

1. Castings, whether Carbon-Steel, Gray Cast Iron or Ductile Iron shall conform to the shape and dimensions indicated and shall be clean substantial castings, free from sand or blowholes or other defects. Surfaces of the castings shall be free from burnt on sand and shall be reasonably smooth. Runners, risers, fins and other cast on pieces shall be removed from the castings and such areas ground smooth. Bearing surfaces between manhole rings and covers or grates and frames shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact. Pairs of machined castings shall be matchmarked to facilitate subsequent identification at installation.
2. Steel castings shall conform to ASTM A27, "Mild to Medium Strength Carbon Steel Castings for General Application." Grade 70-36 shall be furnished unless otherwise specified.
3. Cast iron castings shall conform to ASTM A48, "Gray Iron Castings," Class 30.
4. Ductile Iron castings shall conform to ASTM A536, "Ductile Iron Castings." Grade 60-40-18 shall be used unless otherwise indicated.

C. Rings:

1. ASTM A536, "Gray Iron Castings."

D. Nuts and Bolts:

1. Hot-dipped galvanized ASTM F1554.

E. Mortar:

1. Mortar for bedding castings shall consist of one part cement and 3 parts sand meeting the requirements of fine aggregate Section 03 30 00 Cast-in-Place Concrete.

F. Accessories:

1. Joint Sealant: ASTM C990.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify and locate manholes requiring grade adjustment.

3.2 CONSTRUCTION METHODS

- A. Frames, grates, rings and covers shall be constructed of the materials as specified and in accordance with the details indicated and shall be placed carefully to the lines or grades indicated or as directed by the Engineer.
- B. All welding shall conform to the requirements of the AWS-D-1-72. Welded frames, grates, rings and covers shall be hot-dipped galvanized (ASTM F1554).
- C. Painting of gray iron castings will not be required, except when used in conjunction with structural steel shapes.

3.3 EXISTING WORK

- A. Saw cut existing paving.
- B. Excavate.
- C. Clean manholes.
- D. Remove existing manhole frames and covers.
- E. Repair waterproofing.

3.4 RAISING MANHOLE FRAMES AND COVERS

- A. Locate and raise manholes to grade as indicated on Drawings.
- B. Use precast concrete manhole rings to achieve elevation indicated for frame and cover.
- C. Do not adjust elevation more than 12 inches with manhole rings.
- D. Seal joints between manhole top, rings, and frame with sealant.
- E. Reinstall removed manhole frame and cover.

3.5 REPLACING MANHOLE FRAMES AND COVERS

- A. Remove existing manhole frames and covers to enable reuse.
- B. Deliver removed manhole frames and covers to Owner as maintenance materials in accordance with Section 01 70 00 - Execution and Closeout Requirements.
- C. Install new frames and covers for manholes as indicated on Drawings. Adjust to match finished grade as indicated on Drawings. Seal joints between manholes and manhole frames.

3.6 PAVING RESTORATION

- A. Restore bituminous paving areas in accordance with Section 32 12 16 – Hot Mix Asphaltic Concrete Paving.

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END OF SECTION

FOR 90% REVIEW

Frames, Grates, Rings, and Covers
33 01 30 - 5

SECTION 33 01 32 - SEWER AND MANHOLE TESTING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Testing Manholes:
 - a. Vacuum Test.
 - b. Exfiltration Test.
 - 2. Testing Gravity Sewer Piping:
 - a. Low-pressure Air Test.
 - b. Infiltration Test.
 - 3. Hydrostatic Testing Pressure Piping.
 - 4. Deflection Testing.
- B. Related Sections:
 - 1. Section 33 01 30 - Frames, Grates, Rings, and Covers.
 - 2. Section 33 31 00 - Sanitary Utility Sewerage Piping.
 - 3. Section 33 41 13 – Public Storm Utility Drainage Piping.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
 - 2. ASTM D2122 - Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Submit the following prior to start of testing:
 - 1. Testing procedures.
 - 2. List of test equipment.
 - 3. Testing sequence schedule.
 - 4. Provisions for disposal of flushing and test water.
 - 5. Certification of test gauge calibration.
 - 6. Deflection mandrel drawings and calculations.
- C. Test Reports: Indicate results of manhole and piping tests.

PART 2 PRODUCTS

2.1 VACUUM TESTING EQUIPMENT

- A. Vacuum pump.

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- B. Vacuum line.
- C. Vacuum tester base with compression band seal and outlet port.
- D. Shut-off valve.
- E. Stop watch.
- F. Plugs.
- G. Vacuum gauge, calibrated to 0.1 inch Hg

2.2 EXFILTRATION TEST EQUIPMENT

- A. Plugs.
- B. Pump.
- C. Measuring device.

2.3 AIR TEST EQUIPMENT

- A. Air compressor.
- B. Air supply line.
- C. Shut-off valves.
- D. Pressure regulator.
- E. Pressure relief valve.
- F. Stop watch.
- G. Plugs.
- H. Pressure gauge, calibrated to 0.1 psi.

2.4 INFILTRATION TEST EQUIPMENT

- A. Weirs.

2.5 HYDROSTATIC TEST EQUIPMENT

- A. Hydro pump.
- B. Pressure hose.
- C. Water meter.
- D. Test connections.

- E. Pressure relief valve.
- F. Pressure gauge, calibrated to 0.1 psi.

2.6 DEFLECTION TEST EQUIPMENT

- A. Go, No-Go mandrels.
- B. Pull/retrieval ropes.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify manholes and piping are ready for testing.
- C. Verify trenches are backfilled.
- D. Verify pressure piping concrete reaction support blocking or mechanical restraint system is installed.

3.2 PIPING PREPARATION

- A. Lamping:
 1. Lamp gravity piping after flushing and cleaning.
 2. Perform lamping operation by shining light at one end of each pipe section between manholes; observe light at other end; reject pipe not installed with uniform line and grade; remove and reinstall rejected pipe sections; re-clean and lamp until pipe section achieves uniform line and grade.
- B. Plug outlets, wye-branches and laterals; brace plugs to resist test pressures.

3.3 FIELD QUALITY CONTROL

- A. Sections 01 40 00 – Construction Materials Testing and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Testing Gravity Sewer Piping:
 1. Low-pressure Air Test:
 - a. Test each section of gravity sewer piping between manholes.
 - b. Introduce air pressure slowly to approximately 4 psig.
 - 1) Determine ground water elevation above spring line of pipe for every foot of ground water above spring line of pipe, increase starting air test pressure by 0.43 psig; do not increase pressure above 10 psig.
 - c. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or increased test pressure as determined above when ground water is present. Start test.

d. Test:

1) Determine test duration for sewer section with single pipe size from the following table. Do not make allowance for laterals.

Nominal Pipe Size, inches	Minimum Test Time, min/ 100 feet
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0

2) Record drop in pressure during test period; when air pressure has dropped more than 1.0 psig during test period, piping has failed; when 1.0 psig air pressure drop has not occurred during test period, discontinue test and piping is accepted.

3) When piping fails, determine source of air leakage, make corrections and retest; test section in incremental stages until leaks are isolated; after leaks are repaired, retest entire section between manholes.

C. Pressure test system in accordance with AWWA C600 and the following:

1. Hydrostatically test each portion of pressure piping, including valved section, at 1.5 times working pressure of piping based on elevation of lowest point in piping corrected to elevation of test gauge.
2. Conduct hydrostatic test for at least two-hour duration.
3. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
4. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
5. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
6. Compute maximum allowable leakage by the following formula:

$L = (SD\sqrt{P})/C$
L = testing allowance, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure during hydrostatic test, in psig
C = 148,000

When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

7. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.

D. Deflection Testing of Plastic Sewer Pipe:

1. Perform vertical ring deflection testing on PVC sewer piping, after backfilling has been in place for at least 30 days.
2. Allowable maximum deflection for installed sewer pipe limited to 5 percent of original vertical internal diameter.
3. Perform deflection testing using properly sized rigid ball or 'Go, No-Go' mandrel.
4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe as determined by ASTM standard to which pipe is manufactured. Measure pipe in compliance with ASTM D2122.
5. Perform test without mechanical pulling devices.
6. Locate, excavate, replace and retest pipe exceeding allowable deflection.

E. Testing Manholes:

1. General: Test using air whenever possible prior to backfilling to assist in locating leaks. Make joint repairs on both outside and inside of joint to ensure permanent seal. Test manholes with manhole frame set in place.
2. Vacuum test in accordance with ASTM C1244 and as follows:
 - a. Plug pipe openings; securely brace plugs and pipe.
 - b. Inflate compression band to effect seal between vacuum base and structure; connect vacuum pump to outlet port with valve open; draw vacuum to 10 inches of Hg; close valve; start test.
 - c. Test:
 - 1) Determine test duration for manhole from the following table:

Manhole Diameter	Test Period
4 feet	120 seconds (GBRA standard)
5 feet	120 seconds (GBRA standard)
6 feet	120 seconds (GBRA standard)

- 2) Record vacuum drop during test period; when vacuum drop is greater than 1 inch of Hg during test period, repair and retest manhole; when vacuum drop of 1 inch of Hg does not occur during test period, discontinue test and accept manhole.
- 3) When vacuum test fails to meet 1 inch Hg drop in specified time after repair, repair and retest manhole.

3. Infiltration and Exfiltration Testing: Not allowed.

F. Video Inspection and Golf Ball Testing: Perform video inspection and golf ball testing of gravity wastewater piping after corrosion resistant manhole lining but prior to paving streets. Pipe and manholes must be cleaned free of dirt, rocks, scale, mud, silt, and any other foreign matter prior to performing video inspection and golf ball testing. Flood system with water immediately prior to performing video inspection. Hang and drag a golf ball in front of

camera. Pipe grade is out of tolerance if golf ball becomes fully submerged. Schedule GBRA to witness video inspection. Provide DVD's and written reports to GBRA.

G. GBRA Standards:

1. All other utilities must be complete prior to performing any water or wastewater testing.
2. All testing must be complete prior to paving streets.
3. All testing must be complete prior to performing tie-ins to existing water or wastewater systems.
4. Contractor shall perform pre-testing to verify passing results prior to requesting GBRA inspection.
5. All testing shall be performed by the contractor and witnessed by GBRA.
6. Perform trench backfill density testing at intervals specified by the design engineer, exact locations to be designated by inspector. Schedule GBRA to witness testing. Provide copies of reports to GBRA.
7. All gravity wastewater piping shall be subject to low pressure air testing in accordance with TCEQ requirements. Infiltration and exfiltration testing are not allowed.
8. Mandrel testing shall be performed for all gravity wastewater mains prior to installation of corrosion resistant manhole lining.
9. All manholes, regardless of vehicular traffic detouring, shall be vacuum tested after completion of backfill, compaction, and final grading of road base but prior to paving streets and prior to corrosion resistant manhole lining. Vacuum testing shall be performed with a plate type test head placed on top of completed manhole metal casting ring which has been installed and encased in concrete at final grade.

END OF SECTION

SECTION 33 05 14 - MANHOLES AND STRUCTURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cast-in-Place concrete manholes and structures with transition to cover frame, covers, anchorage, and accessories.
 - 2. Modular precast concrete manholes and structures with tongue-and-groove joints with transition to cover frame, covers, anchorage, and accessories.
 - 3. Doghouse manhole connections to existing sanitary and storm sewer lines.
 - 4. Bedding, embedment, and backfill materials.
- B. Related Sections:
 - 1. Section 03 10 00 - Concrete Forming and Accessories.
 - 2. Section 03 20 00 - Concrete Reinforcing.
 - 3. Section 03 30 00 - Cast-In-Place Concrete: Concrete type for manhole and structure foundation slab construction.
 - 4. Section 31 05 13 - Soils for Earthwork: Soils for backfill in trenches.
 - 5. Section 31 23 16 - Excavation: Excavating for manholes, structures and foundation slabs.
 - 6. Section 31 23 23 - Fill: Backfilling after manhole and structure installation.
 - 7. Section 32 05 16 - Aggregates for Civil Site Improvements: Aggregate for backfill in trenches.
 - 8. Section 33 01 30 - Frames, Grates, Rings, and Covers.
 - 9. Section 33 01 32 - Sewer and Manhole Testing.
 - 10. Section 33 05 16 - Utility Structures.
 - 11. Section 33 31 13 - Public Sanitary Utility Sewerage Piping: Piping connections to manholes.
 - 12. Section 33 41 13 - Public Storm Utility Drainage Piping: Piping connections to manholes and structures.

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

- A. Manholes and Structures:
 - 1. Basis of Measurement: Per each.
 - 2. Basis of Payment: Includes excavating, concrete foundation slab, concrete structure sections, concrete structure construction, cover frame and cover, to indicated depth, forming and sealing pipe inlets and outlets.
 - 3. For manholes greater than five feet in depth, each additional foot above five feet shall be paid by the vertical foot.

1.3 REFERENCES

- A. American Association of State Highway Transportation Officials:
 - 1. AASHTO M288 - Geotextiles.
 - 2. AASHTO M306 - Drainage Structure Castings.
 - 3. AASHTO M91 - Sewer and Manhole Brick (Made from Clay or Shale).

- B. American Concrete Institute:
 - 1. ACI 530/530.1 - Building Code Requirements for Masonry Structures and Specifications for Masonry Structures.
- C. ASTM International:
 - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
 - 2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM C32 - Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale).
 - 4. ASTM C55 - Standard Specification for Concrete Brick.
 - 5. ASTM C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
 - 6. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - 7. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
 - 8. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
 - 9. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate structure locations, elevations, piping, conduit, and invert sizes and elevations of penetrations.
- C. Product Data: Submit manhole covers, component construction, features, configuration, dimensions and invert configuration.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Comply with precast concrete manufacturer's instructions and ASTM C913 for unloading, storing and moving precast manholes and drainage structures.
- C. Store precast concrete manholes and drainage structures to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.
- D. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Cold Weather Requirements: ACI 530/530.1.

PART 2 PRODUCTS

2.1 MANHOLES AND STRUCTURES

- A. Furnish materials in accordance with GBRA standards.
- B. Precast Concrete Manholes and Structures (Wastewater): Precast Reinforced Concrete Manhole sections shall be made from crushed limestone coarse aggregates and natural silica fine sand aggregates. The concrete shall be sulfate resistant concrete with Type V Portland Cement and antimicrobial admixture as per Paragraph 2.4(A). The maximum water-cement ratio shall be 0.40 and the 28-day concrete compressive strength shall not be less than 5000 psi and the absorption shall not exceed 9%. Fly ash may be used for up to 30% of the cementitious material provided it has been tested in accordance with ASTM C1012 and exhibits a positive sulfate resistance when used with the sulfate-resistant concrete mix design. Type C fly ash shall not be used in sulfate resistant concrete. The structure shall be “moist-cured” for a minimum period of four (4) days.

The minimum wall thickness of the manhole shall be as follows:

Manhole Size	Minimum Wall Thickness
48" I.D.	5"
60" I.D.	6"
72" I.D.	7"
84" I.D.	8"

Cone sections will be made with 5" minimum wall at the bottom and an 8" wall thickness at the top. All base riser sections will be made with the bottom cast monolithically. The minimum thickness of the bottom shall be 6" for all manhole diameters. The manhole diameter to be used shall be as indicated on Drawings.

- C. Precast Concrete Manholes and Structures (Stormwater): Precast Structural Concrete as specified in Section 03 41 00.
- D. Cast-in-Place Manholes and Structures (Wastewater): Reinforced cast-in-place concrete as specified in Section 03 30 00 with antimicrobial admixture per Paragraph 2.4(A).
- E. Cast-in-Place Manholes and Structures (Stormwater): Reinforced cast-in-place concrete as specified in Section 03 30 00.
- F. Grout: As specified in Section 03 60 00.
- G. Reinforcement: As specified in Section 03 20 00.

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2.2 FRAMES, GRATES, RINGS AND COVERS

- A. Furnish and install in accordance with Section 33 01 30 - Frames, Grates, Rings and Covers.

2.3 CONFIGURATION

- A. Shaft Construction and Concentric or Eccentric (as indicated) Cone Top Section: Reinforced precast or Cast-In-Place Concrete pipe sections, lipped male/female gasketed joints, sleeved to receive pipe.
- B. Shape: Cylindrical.
- C. Clear Inside Dimensions: 48, 60, or 72-inch diameter as indicated on Drawings.
- D. Design Depth: As indicated on Drawings.
- E. Clear Cover Opening: 30 inches diameter.
- F. Pipe Entry: Furnish openings as indicated on Drawings.
- G. Structure Joint Gaskets: ASTM C361; ASTM C990; and Federal Specification No. SS-S-00210; rubber.
 - 1. Manufacturers:
 - a. Ram-Neck.
 - b. Kent-Seal No. 2.

2.4 ACCESSORIES

- A. Antimicrobial Admixture for Sulfate Resistant Concrete for Wastewater Manholes:
 - 1. An antimicrobial agent, ConmicShield®, or approved equal, shall be used to render the concrete uninhabitable for bacteria growth.
 - 2. The liquid antibacterial admixture shall be an EPA registered material and the registration number shall be submitted for approval prior to use in the project.
 - 3. The amount to be used shall be as recommended by the manufacturer of the antibacterial admixture. This amount shall be included in the total water content of the concrete mix design.
 - 4. The admixture shall be added into the concrete mix water to insure even distribution of the admixture throughout the concrete mixture.
 - 5. ConTint concrete colorant, or approved equal, shall be added at the manufacturer's recommended dosage.
 - 6. Acceptance: acceptance of a product on the basis of a letter of certification to the Engineer stating that the correct amount and correct mixing procedure was followed for all antimicrobial concrete.
 - 7. Product Marking: add the name of the antimicrobial product.
- B. Concrete: Specified in Section 03 30 00.
- C. Cement: ASTM C150, Type V – sulfate resistant Portland type.
- D. Grout: Specified in Section 03 30 00.

E. Watertight Polyethylene: Heat-shrinkable manhole encapsulation system:

1. Manufacturers:

a. WrapidSeal by CCI Pipeline Systems.

b. Substitutions: Section 01 60 00 - Product Requirements.

2.5 FOUNDATION AND BACKFILL MATERIALS

A. Foundation: Coarse Aggregate Type A2 (Grade No. 3) as specified in Section 32 05 16.

B. Backfill Materials:

1. Backfill Materials Outside of Traffic Areas: Excavated backfill material outside of traffic areas shall consist of an excavated material of gravel, fine rock cuttings, sandy loam, or clay having dimensions no greater than 2 inches.

2. Backfill Materials Beneath Pavements:

a. Coarse Aggregate Type A1 (Flexible Base) per Section 32 11 23 – Flexible Base.

b. Aggregate Type A3 (Gravel for Trench Backfill) per Section 32 05 16 – Aggregates for Civil Site Improvements.

c. Flowable Fill per Section 32 23 24 – Flowable Fill.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify items provided by other sections of Work are properly sized and located.

C. Verify built-in items are in proper location, and ready for roughing into Work.

D. Verify correct size of manhole and structure excavation.

3.2 PREPARATION

A. Coordinate placement of inlet and outlet pipe.

B. Do not install manholes and structures where site conditions induce loads exceeding structural capacity of manholes or structures.

C. Inspect precast concrete manholes and structures immediately prior to placement in excavation to verify manholes and structures are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION - GENERAL

A. Excavation:

1. Excavate for manholes and structures in accordance with Section 31 23 16 in location and to depth shown. Provide clearance around sidewalls of manhole or structure for construction operations.

2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes or structures in dry trench.
3. Where possibility exists of watertight manhole or structure becoming buoyant in flooded excavation, anchor manhole or structure to avoid flotation.

B. Install manholes and structures supported at proper grade and alignment on Coarse Aggregate Type A2 (Crushed Stone) foundation as shown on Drawings. When indicated on Drawings, install geotextile fabric over subgrade in accordance with manufacturer's instructions.

C. Backfill excavations for manholes and structures in accordance with Section 31 23 17.

D. Form and place manhole or structure cylinder plumb and level, to correct dimensions and elevations.

E. Grout base of manhole to construct invert and achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel as indicated on Drawings.

F. Set cover frames and covers level without tipping, to correct elevations.

3.4 PRECAST CONCRETE MANHOLE AND STRUCTURE INSTALLATION

- A. Lift precast manholes and structures at lifting points designated by manufacturer.
- B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and manhole or structure remains clean.
- C. Set precast manholes and structures bearing firmly and fully on Coarse Aggregate Type A2 (Crushed Stone), compacted in accordance with provisions of Section 31 23 23. When indicated on Drawings, install geotextile fabric over subgrade in accordance with manufacturer's instructions.
- D. Assemble multi-section manholes and structures by lowering each section into excavation. Install rubber gasket joints between precast sections in accordance with manufacturer's recommendations. Lower, set level, and firmly position base section before placing additional sections.
- E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.
- F. Joint sealing materials may be installed on site or at manufacturer's plant.
- G. Verify manholes and structures installed satisfy required alignment and grade.
- H. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.
- I. Cut pipe to finish flush with interior of manhole or structure.
- J. Grout base of manhole to construct invert and achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage channel as indicated on Drawings.

3.5 SANITARY MANHOLE DROP CONNECTIONS

- A. Construct drop connections into sanitary manholes in accordance with Drawings.
- B. Form channel from pipe drop to sweep into main channel at maximum angle of 30 degrees.

3.6 CASTINGS INSTALLATION

- A. Set frames using mortar as indicated on Drawings. Install precast concrete grade rings with 1/4 inch thick joints. Lay concrete rings in full bed of mortar and completely fill joints.
- B. Unless indicated otherwise, set frame and cover 8 inches above finished grade for manholes and other structures with covers located within unpaved areas to allow area to be graded away from cover beginning 2 inches below top surface of frame.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test cast-in-place concrete in accordance with Section 03 30 00.
- C. Test concrete manhole and structure sections in accordance with ASTM C497.
- D. Vertical Adjustment of Existing Manholes and Structures: Conform with Section 33 01 31.
 1. Where required, adjust top elevation of existing manholes and structures to finished grades shown on Drawings.
 2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
 3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated on Drawings.
 4. Clean and apply sand-cement bonding compound on existing concrete surfaces to receive cast-in-place concrete in accordance with Section 03 30 00.

END OF SECTION

SECTION 33 05 16 - UTILITY STRUCTURES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes precast concrete utility structures:
 - 1. Drainage system catch basins.
 - 2. Drainage system inlets.
 - 3. Drainage system junction boxes.
 - 4. Drainage system sedimentation chambers.
 - 5. Drainage system retention/diversion structures.
 - 6. Drainage headwalls and safety end treatments.
 - 7. Sanitary sewer lift station pits.
 - 8. Sanitary sewer lift station valve chambers.
 - 9. Sanitary drain field dosing chambers.
 - 10. Knock out boxes.
 - 11. Single and multiple box culverts.
 - 12. Oil water separators.
 - 13. Grease interceptors.
 - 14. Acid retention basins.
 - 15. Irrigation well pits.
 - 16. Meter vaults.
 - 17. Valve vaults.
 - 18. Frames and covers.
 - 19. Access hatches.
- B. Related Sections:
 - 1. Section 03 11 00 - Concrete Forming.
 - 2. Section 03 21 00 – Reinforcing Steel.
 - 3. Section 03 30 00 - Cast-In-Place Concrete: Concrete type for manhole and structure foundation slab construction.
 - 4. Section 03 60 00 - Grouting: Mortar and non-shrink grout.
 - 5. Section 04 20 00 - Unit Masonry: Product requirements for clay brick units for use in structure construction.
 - 6. Section 31 23 10 – Structural Excavation and Backfill: Excavating for structures and foundation slabs.
 - 7. Section 31 23 23 - Fill: Backfilling after structure installation.
 - 8. Section 33 31 00 - Sanitary Utility Sewerage Piping: Piping connections to structures.
 - 9. Section 33 41 13 - Public Storm Utility Drainage Piping: Piping connections to structures.

1.2 REFERENCES

- A. American Association of State Highway Transportation Officials:
 - 1. AASHTO M306 - Drainage Structure Castings.
 - 2. AASHTO S99-HB - Standard Specifications for Highway Bridges.
- B. American Concrete Institute:

1. ACI 318 - Building Code Requirements for Structural Concrete.
2. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.
3. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete.

C. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
3. ASTM A82/A82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
4. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
6. ASTM A496 - Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
7. ASTM A497/A497M - Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
8. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
9. ASTM A706/A706M - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
10. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
11. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
12. ASTM A884/A884M - Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
13. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.
14. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
15. ASTM C33 - Standard Specification for Concrete Aggregates.
16. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
17. ASTM C138/C138M - Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
18. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
19. ASTM C150 - Standard Specification for Portland Cement.
20. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
21. ASTM C192/C192M - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
22. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
23. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
24. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

25. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.
26. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
27. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.
28. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
29. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
30. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Section Precast Concrete Water and Wastewater Structures.
31. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
32. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
33. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals.
34. ASTM C989 - Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
35. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
36. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
37. ASTM C1244 - Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test prior to Backfill.
38. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
39. ASTM C1433 - Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers.
40. ASTM C1504 - Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts, Storm Drains, and Sewers.

D. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

E. Federal Aviation Administration:

1. FAA AC 150/5320-6 - Airport Pavement Design and Evaluation.
2. FAA AC 150/5370-10A - Standards for Specifying Construction for Airports.

F. National Precast Concrete Association:

1. NPCA Quality Control Manual for Precast Plants.
2. NPCA Plant Certification Program.

G. South Coast Air Quality Management District:

1. SCAQMD Rule 1168 - January 7, 2005 - Adhesive and Sealant Applications.

H. SSPC: The Society for Protective Coatings:

1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II - Organic).

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1.3 DESIGN REQUIREMENTS

- A. Design structures for minimum loads in accordance with ASTM C857 and ASTM C890.
 - 1. Roof Live Load: Comply with the following loading conditions, including impact load.
 - a. Traffic: AASHTO S99-HB; HS20-44, maximum 16,000 lb each wheel.
 - b. Non-traffic Areas: AASHTO S99-HB; HS10, maximum 8,000 lb each wheel.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings:
 - 1. Indicate structure locations, elevations, sections, equipment supports, piping, conduit, and elevations of penetrations.
 - 2. Indicate design, construction and installation details, typical reinforcement and additional reinforcement at openings.
- C. Product Data:
 - 1. Submit data for frames and covers, steps (if applicable), component construction, features, configuration, dimensions and hardware (if applicable).
- D. Design Data:
 - 1. Submit concrete mix design for each different mix.
 - 2. Submit design calculations for custom fabrications signed and sealed by professional engineer.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Obtain precast concrete utility structures from single source.
- B. Perform structural design in accordance with ACI 318.
- C. Perform Work in accordance with NPCA Quality Control Manual for Precast Plants.
- D. Conform to the following for material and fabrication requirements:
 - 1. Single Box Culverts: ASTM C1433.
 - 2. Multiple Box Culverts: ASTM C1433.
 - 3. Three Sided Structures: ASTM C1504.
 - 4. Other Structures: ASTM C913.
- E. Perform welding in accordance with the following:
 - 1. Structural Steel: AWS D1.1.
 - 2. Reinforcing Steel: AWS D1.4.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.

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- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.
- C. Design non-standard utility structures under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Texas.
- D. Welders: AWS qualified within previous 12 months.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Comply with precast concrete manufacturer's instructions for unloading, storing and moving precast structures. Lift structures from designated lifting points.
- C. Do not deliver products until concrete has cured 7 days or attained minimum 85 percent of specified 28 day compressive strength.
- D. Store precast concrete structures to prevent damage to Owner's property or other public or private property. Repair property damaged from materials storage.
- E. Mark each precast structure by indentation or waterproof paint showing date of manufacture, manufacturer, and identifying symbols and numbers shown on Drawings to indicate its intended use.

PART 2 PRODUCTS

2.1 PRECAST CONCRETE UTILITY STRUCTURES

- A. Fabricators:
 - 1. Forterra, Inc.
 - 2. Capital Precast, Inc.
 - 3. Oldcastle Precast, Inc.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Precast Concrete Utility Structures: Reinforced precast concrete.
- C. Foundation Slab: Cast-in-place or precast concrete of type specified in Section 03 30 00, leveled top surface.

2.2 CONCRETE MATERIALS

- A. Concrete:
 - 1. Cast-in-Place Concrete: Section 03 30 00.

2.3 ADMIXTURES

- A. Manufacturers:

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1. Axim Italcementi Group, Inc.
2. BASF Construction Chemicals.
3. Cortec Corporation.
4. Euclid Chemical Company.
5. General Resource Technology.
6. Grace Construction Products.
7. Green Umbrella.
8. Sika Corporation.
9. Substitutions: Section 01 60 00 - Product Requirements.

B. Air Entrainment: ASTM C260.

C. Chemical Admixtures: ASTM C494/C494M.

D. Fly Ash: Not allowed.

E. Blast Furnace Slag: Not allowed.

F. Pigments: Mineral oxide, non-fading, lime resistant; color as selected by Owner.

2.4 CONCRETE REINFORCEMENT

A. Reinforcing Steel: ASTM A615/A615M, 60 ksi yield grade, deformed billet bars, uncoated finish.

2.5 FRAMES , GRATES, RINGS, AND COVERS

A. Frames, grates, rings, and covers as specified in Section 33 01 30 and as indicated on the Drawings.

B. Manufacturers:

1. Barry Pattern & Foundry Company.
2. East Jordan Iron Works, Inc.
3. McKinley Iron Works, Inc.
4. Neenah Foundry Company.
5. Substitutions: Section 01 60 00 - Product Requirements.

2.6 ACCESS HATCHES

A. Manufacturers:

1. Halliday Products, Inc.
2. Substitutions: Section 01 60 00 - Product Requirements.

B. Access Hatch: Aluminum welded construction, size as indicated; door as indicated on plans.

1. Cover: Diamond plate aluminum reinforced with structural stiffeners to support required loads.
2. Frame: Angle type or channel type, as indicated; with integral seat to support cover stiffeners; anchor flange around frame perimeter.
3. Hinges: Stainless steel.
4. Lift Handle: Flush drop handle, non-removable type mounted in cover.

5. Lifting Mechanism: Stainless steel compression springs with automatic hold open and dead stop to retain cover in open position. Cover springs to prevent contact by personnel entering utility structure.
6. Latch Mechanism: Stainless steel lock with tamper-proof external handle and permanent internal release mechanism.
7. Hardware: Stainless steel.

2.7 WALL SEAL ASSEMBLIES FOR PIPE PENETRATIONS

- A. Manufacturers:
 1. Link-Seal, Model "C" or "L" by Pipeline Seal and Insulator, Inc.
 2. Substitutions: Section 01 60 00 - Product Requirements.

2.8 ACCESSORIES

- A. Membrane Curing Compound: ASTM C309 Type 1-D clear or translucent, with fugitive dye or Type 2 white pigmented.
- B. Steps: Formed galvanized steel rungs.
 1. Diameter: 3/4 inch.
 2. Width: 12 inches.
 3. Spacing: 16 inches on center vertically or as indicated on Drawings.
- C. Inserted and Embedded Items:
 1. Structural Steel Sections: ASTM A36/A36M; hot-dipped galvanized.
- D. Joint Sealants and Joint Gaskets:
 1. Gasket Joints for Circular Concrete Pipe: ASTM C443; standard rubber gaskets.
 2. External Sealing Bands: ASTM C877; Type I rubber and mastic bands.
 3. Preformed Joint Sealants for Concrete Pipe and Box Sections: ASTM C990.
 4. Elastomeric Joint Sealants: ASTM C920; polyurethane; Grade NS, Class 25; Sonolastic NPI manufactured by Sonneborn Building Products.
- E. Pipe Entry Connectors: ASTM C923.
- F. Grout:
 1. Cement Grout: Portland cement, sand and water mixture with stiff consistency to suit intended purpose.
 2. Non-Shrink Grout: ASTM C1107/C1107M; premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.
- G. Bituminous Coating (where indicated):
 1. Manufacturers:
 - a. CarboLine Company, RPM International.
 - b. Duron, Inc.
 - c. Laurence, C.R. Co., Inc.
 - d. Substitutions: Section 01 60 00 - Product Requirements.
- H. Touch-Up Primer for Galvanized Surfaces: SSPC 20 Type I Inorganic.

2.9 CONCRETE MIX

- A. Select proportions for normal weight concrete in accordance with ACI 318. and ACI 211.1.
- B. Provide concrete to the following criteria:
 - 1. Compressive Strength: 4,000 psi at 28 days.
 - 2. Water Cement Ratio:
 - a. Concrete Exposed to Freezing and Thawing: Maximum 0.45 percent by mass.
 - b. Watertight Concrete Not Exposed to Freezing and Thawing: Maximum 0.45 percent by mass.
 - c. Concrete Exposed to Corrosive Conditions: 0.40 percent by mass.
 - 3. Air Content:

Maximum Aggregate Size inches	Air Content, Percent	
	Severe Exposure	Moderate Exposure
3/8 inches	6.0 to 9.0	4.5 to 7.5
1/2 inches	5.5 to 8.5	4.7 to 7.0
3/4 inches	4.5 to 7.5	3.5 to 6.5
1 inches	4.5 to 7.5	3.0 to 6.0
1-1/2 inches	4.5 to 7.0	3.0 to 6.0

- C. Admixtures: Include admixture types and quantities indicated in concrete mix designs approved through submittal process.
 - 1. Do not use calcium chloride.

2.10 FABRICATION

- A. Fabricate precast concrete utility structures in accordance with ACI 318. and NPCA Quality Control Manual for Precast Plants.
- B. Fabricate precast concrete utility structures to size, configuration, knock out panels, and openings as indicated on Drawings.
- C. Construct forms to provide uniform precast concrete units with consistent dimensions.
- D. Clean forms after each use.
- E. Install reinforcing by tying or welding to form rigid assemblies. Position reinforcing to maintain minimum 1 1/2 inch cover. Secure reinforcement to prevent displacement when placing concrete.
- F. Position and secure embedded items to prevent displacement when placing concrete.
- G. Deposit concrete in forms. Consolidate concrete without segregating aggregate.
- H. Provide initial curing by retaining moisture using one of the following methods:
 - 1. Cover with polyethylene sheets.

2. Cover with burlap or other absorptive material and keep continually moist.
3. Apply curing compound in accordance with manufacturer's instructions.

- I. Provide final curing in accordance with manufacturer's standard.
- J. Remove forms without damaging concrete.

2.11 CONCRETE FINISHES

- A. Formed Surfaces Not Exposed to View: As formed.
- B. Unformed Surfaces: Finish with vibrating screed or hand float.
 1. Permitted: Color variations, minor indentations, chips, and spalls.
 2. Not Permitted: Major imperfections, honeycomb, or other defects.
- C. Exposed to View Finishes: Troweled.

2.12 SOURCE QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. Perform the following tests for each 150 cy of concrete placed, with minimum one set of tests each week.
 1. Slump: ASTM C143/C143M.
 2. Compressive Strength: ASTM C31/C31M and ASTM C39/C39M.
 3. Air Content: ASTM C231 or ASTM C173/C173M.
 4. Unit Weight: ASTM C138/C138M.
- D. Visually inspect completed precast structures for defects.
 1. Repair defects affecting exposed to view surfaces to achieve uniform appearance.
 2. Repair honeycomb by removing loose material and applying grout to produce smooth surface flush with adjacent surface.
 3. Repair major defects only when permitted by Engineer.
- E. Submit test results to Engineer upon request.
- F. Allow witnessing of factory inspections and test at manufacturer's test facility. Notify Engineer at least seven days before inspections and tests are scheduled.

2.13 FINISHING - STEEL

- A. Galvanizing: ASTM A123/A123M; hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify items provided by other sections of Work are properly sized and located.
- C. Verify correct size and elevation of excavation.
- D. Verify subgrade and bedding is properly prepared, compacted and ready to receive Work of this section.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
- B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
- C. Inspect precast concrete structures immediately prior to placement in excavation to verify are internally clean and free from damage. Remove and replace damaged units.

3.3 INSTALLATION

- A. Install underground precast utility structures in accordance with ASTM C891.
- B. Lift precast concrete structures at lifting points designated by manufacturer.
- C. When lowering structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.
- D. Install precast concrete base to elevation and alignment indicated on Drawings.
- E. Install precast concrete utility structures to elevation and alignment indicated on Drawings.
- F. Assemble multi-section structures by lowering each section into excavation.
 1. Clean joint surfaces.
 2. Install watertight joint seals in accordance with manufacturer's instructions using gasket joints, external sealing bands, preformed joint sealants, elastomeric joint sealants, grout, or as indicated on Drawings.
- G. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with grout.
- H. Connect pipe to structure and seal watertight. Cut pipe flush with interior of structure.
- I. Grout base to achieve slope to exit piping. Trowel smooth. Contour to form continuous drainage as indicated on Drawings.

- J. Set frame and cover and access hatch level without tipping, to elevations indicated on Drawings.
 - 1. Set cover and access hatch 3 inches above finished grade for structures located within unpaved areas to allow area to be graded away from cover.
 - 2. Connect drain from access hatch frame to storm drainage system.
- K. Touch up damaged galvanized coatings.
- L. Backfill excavations for structures in accordance with Section 31 23 23 - Fill.

3.4 FIELD QUALITY CONTROL

- A. Sections 01 40 00 – Construction Materials Testing, Section 01 45 16 – Contractor Quality Control, and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

END OF SECTION

SECTION 33 05 17 - PRECAST CONCRETE VALVE VAULTS AND METER BOXES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Precast concrete valve vaults.
 - 2. Precast concrete meter boxes.
- B. Related Sections:
 - 1. Section 32 05 16 - Aggregates for Civil Site Improvements.
 - 2. Section 33 11 13 – Public Water Utility Distribution Piping.

1.2 REFERENCES

- A. ASTM International:
 - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
 - 2. ASTM A185/A185M - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - 3. ASTM A536 - Standard Specification for Ductile Iron Castings.
 - 4. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 5. ASTM C33 - Standard Specification for Concrete Aggregates.
 - 6. ASTM C150 - Standard Specification for Portland Cement.
 - 7. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - 8. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
 - 9. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - 10. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.
 - 11. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
 - 12. ASTM C913 - Standard Specification for Precast Concrete Water and Wastewater Structures.
 - 13. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joints Sealants.
 - 14. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 15. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 16. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 17. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
 - 18. ASTM D4104 - Standard Test Method (Analytical Procedure) for Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Test)

1.3 DESIGN REQUIREMENTS

- A. Design Criteria:
 - 1. Watertight precast reinforced air-entrained concrete structures designed to AASHTO HS20-16 kip and ASTM C890 live loading and installation conditions, and manufactured to conform to ASTM C913.
 - 2. Minimum 28-day Compressive Strength: 4,000 psi.
 - 3. Honeycombed or retempered concrete is not permitted.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawing: Indicate plan, location and inverts of connecting piping.
- C. Product Data: Submit data on valve vaults and meter boxes.
- D. Manufacturer's Certificates: Submit Statement of Compliance, supporting data, from materials suppliers attesting that precast concrete valve vaults and meter boxes provided meet or exceed ASTM Standards and specification requirements.
- E. Manufacturer's Installation Instructions: Submit special procedures for precast concrete valve vaults and meter boxes installation.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Accurately record actual locations and inverts of buried pipe, components and connections.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Transport and handle precast concrete units with equipment designed to protect units from damage.
- C. Do not place concrete units in position to cause overstress, warp or twist.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.8 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate work with utilities within construction area.

PART 2 PRODUCTS

2.1 PRECAST CONCRETE VALVES AND METER BOXES

- A. Manufacturers:
 - 1. Forterra, Inc.
 - 2. Capital Precast, Inc.
 - 3. Oldcastle Precast, Inc.
 - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Materials:
 - 1. Portland Cement: ASTM C150, Type II.
 - 2. Coarse Aggregates: ASTM C33; Graded 1 inch to No. 4 Sieve.
 - 3. Sand: ASTM C33; 2.35 fineness modulus.
 - 4. Water: Potable; clean and free of injurious amounts of acids, alkalis, salts, organic materials, and substances incompatible with concrete or steel.
 - 5. Air-Entraining Admixtures: ASTM C260.
 - 6. Reinforcing Steel:
 - a. Deformed Bars: ASTM A615/A615M, Grade 60.
 - b. Welded Wire Fabric: ASTM A185/A185M.
 - 7. Joint Sealant:
 - a. ASTM C990.
- C. Mixes:
 - 1. Design concrete mix to produce required concrete strength, air-entrainment, watertight properties, and loading requirements.
- D. Meter Box Frames and Covers:
 - 1. Cast Iron Castings: ASTM A48/A48M, Class 30 or better; free of bubbles, sand and air holes, and other imperfections.
 - 2. Ductile Iron Castings: ASTM A536.
 - 3. Contact surfaces machined and matched.
 - 4. Cast cover inscription with pipeline service and Owner's name.
- E. Access Steps:
 - 1. As indicated on Drawings.

2.2 BEDDING AND BACKFILL MATERIALS

- A. Bedding Material: Fill Type S1, A1, A2, or A3 as specified in Section 31 23 23.
- B. Backfill Materials: Subsoil Type S1, Select Fill, as specified in Section 31 05 13.

2.3 FABRICATION AND MANUFACTURE

- A. Fabricate precast reinforced concrete structures in accordance with ASTM C913, to dimensions indicated on Drawings, and to specified design criteria.

2.4 ACCESS HATCHES

A. Manufacturers:

- 1. Halliday Products, Inc.
- 2. Substitutions: Section 01 60 00 - Product Requirements.

B. Access Hatch: Aluminum welded construction, size as indicated; single or double door, as indicated.

- 1. Cover: Diamond plate aluminum reinforced with structural stiffeners to support required loads.
- 2. Frame: Angle type or channel type, as indicated; with integral seat to support cover stiffeners; anchor flange around frame perimeter.
- 3. Hinges: Stainless steel.
- 4. Lift Handle: Flush drop handle, non-removable type mounted in cover.
- 5. Lifting Mechanism: Stainless steel compression springs with automatic hold open and dead stop to retain cover in open position. Cover springs to prevent contact by personnel entering utility structure.
- 6. Latch Mechanism: Stainless steel lock with tamper-proof external handle and permanent internal release mechanism.
- 7. Hardware: Stainless steel.

2.5 WALL SEAL ASSEMBLIES FOR PIPE PENETRATIONS

A. Manufacturers:

- 1. Link-Seal, Model "C" or "L" by Pipeline Seal and Insulator, Inc.
- 2. Substitutions: Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping connection, size, location and invert are as indicated on Drawings.

3.2 PREPARATION

- A. Ream pipe ends and remove burrs.
- B. Remove scale and dirt from components before assembly.
- C. Establish invert elevations for each component in system.

- D. Hand trim excavation to suit valve vaults and meter boxes. Remove stones, roots or other obstructions.

3.3 VAULT BEDDING AND BACKFILL

- A. Excavate in accordance with Section 31 23 10 - Structural Excavation and Backfill for work of this Section. Hand trim excavation for accurate placement of vaults and meter boxes to elevations indicated.
- B. Place bedding material level in one continuous layer not exceeding 6 inches compacted depth, compact to 95 percent Standard Proctor Density.
- C. Backfill around sides of vaults and meter boxes, tamped in place and compacted to 95 percent Standard Proctor Density.
- D. Maintain optimum moisture content of bedding material to attain required compaction density.
- E. Install vaults and meter boxes and related components on bedding.

3.4 CONNECTING PIPING

- A. Connect piping.

3.5 FIELD QUALITY CONTROL

- A. Sections 01 40 00 – Construction Materials Testing, Section 01 45 16 – Contractor Quality Control, and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Request inspection by Engineer prior to placing trench backfill over piping.
- C. Compaction Testing: In accordance with ASTM D698.
- D. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- E. Frequency of Tests: 2 per vault.

3.6 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.

END OF SECTION

SECTION 33 05 19 - PRESSURE PIPING TIED JOINT RESTRAINT SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Tied joint restraint system.
- B. Related Sections:
 - 1. Section 31 23 17 - Trenching.
 - 2. Section 33 11 13 – Public Water Utility Distribution Piping.

1.2 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI B1.1 - Unified Inch Screw Threads.
- B. ASTM International (ASTM):
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM A143 - Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
 - 4. ASTM A242 – Standard Specification for High Strength Low Alloy Weathering Steel.
 - 5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
 - 6. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - 7. ASTM A563 - Standard Specification for Carbon and Alloy Steel Nuts.
 - 8. ASTM A588/A588M - Specification for High Strength Low-Alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point to 4 in. (100 mm) Thick.
 - 9. ASTM F436 - Specification for Hardened Steel Washers.
- C. American Water Work Association (AWWA):
 - 1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.

1.3 DESIGN REQUIREMENTS

- A. Provide pressure pipeline with restrained joints at each bends, tees, and changes in direction.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate restrained joint details and materials being utilized. Submit layout drawings showing piece numbers and locations. Also, indicate restrained joint locations.
- C. Product Data: Submit catalog data for restrained joint details and installation instructions.

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- D. Samples: Submit samples of joint restraint parts.
- E. Design Data: Submit design calculations showing determination of restrained lengths and submit joint restraint details. Use joint restraint devices specifically designed for applications described in manufacturer's data.
- F. Manufacturer's Installation Instructions: Submit installation instructions.
- G. Manufacturer's Certificate: Certify mechanical joints meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of joint restraints.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five years documented experience.
- B. Fabricator: Company specializing in performing work of this section with minimum three years documented experience approved by manufacturer.
- C. Design tied joint restraint system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Texas.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate work with installation of tied joint restraint systems with installation of fittings and joints that require restraint.

PART 2 PRODUCTS

2.1 TIED JOINT RESTRAINT SYSTEM

- A. Manufacturers:

1. Approved Manufacturer for DIP Push-on Joint Restraints:
 - a. EBAA Iron Sales, Inc.: Series 1700 "MEGALUG," or equal.
 - b. Ford Meter Box Co., Inc.: Uni-Flange Series 1390.
2. Approved Manufacturer for PVC Push-on Joint Restraints:
 - a. EBAA Iron Sales, Inc.: Series 1900 for 4-inch through 12-inch pipe diameters and Series 2800 for 14-inch through 48-inch pipe diameters.
 - b. Ford Meter Box Co., Inc.: Uni-Flange Series 1390.

2.2 MATERIALS

A. Steel Types:

1. High Strength Low Alloy Weathering Steel, A242 (modified to meet AWWA C111/A21.11), Core-Ten A.

2.3 COMPONENTS

A. Tie Bolts: ANSI/AWWA C111/A21.11.

1. 3/4 inch for 4 inch to 24 inch diameter mechanical joints; ASTM A242 high strength low alloy weathering steel, Core-Ten A (modified to meet AWWA C111/A21.11), coated with FlouroKote#1 by Metal Coatings Corp.
2. 1 inch for 30 inch diameter and larger mechanical joints, ASTM A242 high strength low alloy weathering steel, Core-Ten A (modified to meet AWWA C111/A21.11), coated with FlouroKote#1 by Metal Coatings Corp.

B. Tee-head Bolts: ANSI/AWWA C111/A21.11 and ASTM A242 high strength low alloy weathering steel, Core-Ten A (modified to meet ANSI/AWWA C111/A21.11) coated with FlouroKote#1 by Metal Coatings Corp.

C. Tie Nut: Hex nut for each tie bolt and tie rods.

1. ASTM A242; coated with FlouroKote#1 by Metal Coatings Corp.

D. Tiepin: 3/4 inch round bar stock for use on bends and hydrants.

1. 6 inch hairpin shape, ASTM A242; coated with FlouroKote#1 by Metal Coatings Corp.

E. Tie Coupling: Used to extend continuous threaded rods and provided with center stop to aid installation.

1. ASTM A242; coated with FlouroKote#1 by Metal Coatings Corp.

F. Tie Clamp: Retainer clamp for ductile iron, and PVC, push-on pipe in front of bell.

1. ASTM A536 64-45-12 Ductile Iron.

G. Tie Rod: Continuous threaded rod for cutting to desired lengths.

1. ASTM A242; coated with FlouroKote#1 by Metal Coatings Corp.

H. Tie Bar: Steel bar used to restrain push-in plugs.

1. ASTM A36/A36M; galvanized.

I. Tie Washer: Round flat washers.

1. ASTM F436, Type 3; coated with FlouroKote#1 by Metal Coatings Corp.

J. Insulating Sleeves and Washers: One-piece integral sleeves and washers manufactured of high-density polyethylene, NEMA grade LE phenolic, or Mylar, by Advance Products and Systems, Inc., or equal.

2.4 FACTORY APPLIED FINISHES - STEEL

A. Items to be zinc plated or galvanized to meet the following requirements:

1. ASTM A153/A153M for galvanizing iron and steel hardware.
2. Galvanizing: ASTM A123/A123M; hot dip galvanize after fabrication.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify pipe and fittings are ready to receive work.

C. Field measure and verify conditions.

3.2 PREPARATION

A. Clean surfaces of pipe and fittings to receive tied joint restraint system.

3.3 INSTALLATION

A. Install pipe and fittings in accordance with AWWA C600.

B. Install joint restraint system so joints are mechanically locked together to prevent joint separation.

3.4 ERECTION TOLERANCES

A. Section 01 40 00 - Construction Materials Testing.

B. Section 01 45 16 – Contractor Quality Controls.

C. Torque nuts on mating threaded fasteners to 45 foot pounds to 60 foot pounds for 5/8 inch nut.

D. Torque nuts on mating threaded fasteners to 75 foot pounds to 90 foot pounds for 3/4 inch nut.

E. Torque 1-inch nuts to 100 foot pounds to 120 foot pounds.

END OF SECTION

SECTION 33 11 13 - PUBLIC WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Water piping.
 - 2. Tapping Sleeves and Valves.
 - 3. Valves and Fire Hydrants.
 - 4. Turbine Water Meters.
 - 5. Air Release Valves.
 - 6. Combination Air Valves (Air Release and Air/Vacuum Valves).
 - 7. Underground pipe markers.
 - 8. Precast concrete valve vaults and meter boxes.
 - 9. Concrete encasement and cradles.
 - 10. Bedding, embedment, and backfill materials.
 - 11. Accessories.
- B. Related Requirements:
 - 1. Section 03 21 00 - Concrete Reinforcing.
 - 2. Section 03 30 00 - Cast-In-Place Concrete: Concrete for thrust restraints.
 - 3. Section 31 05 13 - Topsoil: Soils for restoration of trenches.
 - 4. Section 31 23 10 – Rough Grading: Product and execution requirements for excavation and backfill required by this section.
 - 5. Section 31 23 17 - Trenching: Execution and backfill requirements for trenching required by this section.
 - 6. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.
 - 7. Section 33 05 17 - Precast Concrete Valve Vaults and Meter Boxes.
 - 8. Section 33 12 13 - Water Service Connections: Backflow prevention at water main.
 - 9. Section 33 13 00 - Disinfecting of Water Utility Distribution: Disinfection of water piping.

1.2 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. American Society of Mechanical Engineers:
 - 1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- C. ASTM International:
 - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 3. ASTM A193 – Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature and High Pressure Service.

4. ASTM A194 – Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service.
5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
6. ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 KSI Minimum Tensile Strength.
7. ASTM F593 – Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
8. ASTM A594 – Standard Specification for Stainless Steel Nuts.
9. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
10. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
11. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
12. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
13. ASTM D2466 – PVC Plastic Fittings, Schedule 40
14. ASTM D2564 – Solvent Cements for PVC Pipe and Fittings
15. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
16. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
17. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
18. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
19. ASTM F1668 – Procedures for Buried Plastic Pipe

D. American Water Works Association:

1. AWWA C104 - ANSI Standard for Cement Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
2. AWWA C105 - ANSI Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110 - ANSI Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1,219 mm), for Water.
4. AWWA C111 - ANSI Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C115 - ANSI Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
6. AWWA C151 - ANSI Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
7. AWWA C153 - ANSI Standard for Ductile-Iron Compact Fittings for Water Service.
8. AWWA C200 - Steel Water Pipe 6 In. (150 mm) and Larger.
9. AWWA C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot Applied.
10. AWWA C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 In. and Larger - Shop Applied.
11. AWWA C206 - Field Welding of Steel Water Pipe.

12. AWWA C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm through 3,600 mm).
13. AWWA C208 - Dimensions for Fabricated Steel Water Pipe Fittings.
14. AWWA C213 - Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
15. AWWA C500 - Gate Valves for Water and Sewage Systems.
16. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
17. AWWA C605 - Water Treatment - Underground Installation of Polyvinyl Chloride PVC Pressure Pipe and Fittings for Water.
18. AWWA C606 - Grooved and Shouldered Joints.
19. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
20. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
21. AWWA C702 - Cold-Water Meters - Compound Type.
22. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
23. AWWA C909 – Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 in. (100 mm) and Larger.
24. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.
25. AWWA M11 - Steel Water Pipe; “A Guide for Design and Installation.”

E. Manufacturer's Standardization Society of the Valve and Fittings Industry:

1. MSS SP-60 - Connecting Flange Joint between Tapping Sleeves and Tapping Valves.

F. National Fire Protection Agency:

1. NFPA 24 - Standard for the Installation of Private Fire Service Mains and Their Appurtenances.

G. NSF International:

1. NSF Standard 14 - Plastic Piping Components & Related Materials.
2. NSF Standard 61 – Drinking Water System Components – Health Effects

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories.
- C. Shop Drawings: Indicate piping layout, including piping specialties.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

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1.5 QUALITY ASSURANCE

- A. Valves: Mark valve body with manufacturer's name and pressure rating.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver and store valves in shipping containers with labeling in place.
- C. Block individual and stockpiled pipe lengths to prevent moving.
- D. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
- E. Store polyethylene materials out of sunlight.

1.7 EXISTING CONDITIONS

- A. Verify field measurements prior to fabrication. Indicate field measurements on shop drawings.

PART 2 PRODUCTS

2.1 WATER PIPING

- A. Ductile Iron Pipe: AWWA C150 and C151 of the class indicated. Asphaltic outside coating: AWWA C151. Cement-Mortar Lining: AWWA C104, double thickness cement-mortar lining with asphaltic seal coat. Polyethylene Encasement: AWWA C105.
 - 1. Pipe Class: As indicated on the Drawings and conforming to AWWA C151, for nominal thickness, rated water working pressure and maximum depth of cover.
 - 2. Fittings: Ductile iron, AWWA C110, Class 350; or compact fittings AWWA C153, Class 350.
 - a. Coating and Lining:
 - 1) Asphaltic Coating: AWWA C110.
 - 2) Cement-Mortar Lining: AWWA C104 and C111, double thickness cement and seal coated.
 - 3. Joints:
 - a. Mechanical and Push-On Joints: AWWA C111.
 - 1) Wedge Action Restraining Gland for Ductile Iron Mechanical Joints.
 - a) Materials:
 - (1) Gland body, wedge segment, and actuating bolts per ASTM A536 64-45-12 ductile iron.
 - (2) Wedge Segments: heat treated to a minimum hardness of 370 BHN.
 - (3) Tee-head Bolts and Nuts: ASNI/AWWA C111/A21.11; ASTM A242 High Strength Low Alloy Weathering Steel, Core-Ten A (modified to meet ASNI/AWWA C111/A21.11) coated with FluoroKote #1 by Metal Coatings Corp.
 - b) Approved manufacturers for DIP Mechanical Joint Restraints:

- (1) EBAA Iron Sales Inc.: Series 1100 "MEGALUG."
- (2) SIGMA Corporation: ONE-LOK Series D-SLDE.
- (3) Romac Industries, Inc.: RomaGrip.
- (4) Tyler Union: TUFGRIP.
- c) Approved manufacturers for PVC Pipe Mechanical Joint Restraints:
 - (1) EBAA Iron Sales, Inc.: Series 2000PV for 3-inch through 36-inch diameters and Series 2200 for 36-inch through 48-inch diameters.
 - (2) SIGMA Corporation: ONE-LOK Series D-SLCE.
 - (3) Romac Industries, Inc.: PVC RomaGrip.
 - (4) Tyler Union: TUFGRIP.
- 2) Gaskets: AWWA C111.
- b. Flanged Joints: AWWA C111 and C115.
 - 1) Bolts: ASTM A193, Grade B8M, Class 2 Stainless Steel, AISI 316.
 - 2) Nuts: ASTM A194, Grade 8M, Stainless Steel, AISI 316; cold punched, hexagonal, trimmed and chamfered. Nuts shall be coated with FlouroKote #1 by Metal Coatings Corp. to prevent galling.
 - 3) Insulating Sleeves and Washers: One-piece integral sleeves and washers manufactured of high-density polyethylene, NEMA grade LE phenolic, or Mylar, by Advance Products and Systems, Inc., or equal.
 - 4) Gaskets: Full faced, 1/8-inch minimum thickness SBR (Styrene Butadiene) elastomer per ANSI/AWWA C111, A21.11. Flange gaskets shall be the high-performance type rated for a water working pressure of 350 psi for 4-inch through 24-inch diameters; 250 psi for 30-inch through 48-inch diameters; and 150 psi for 54-inch through 64-inch diameters.
 - a) Approved Manufacturers: U.S. Pipe and Foundry Co.: "Full Face Flange-Tyte," or equal.
- c. Restrained Joints:
 - 1) "Push-on Pipe" Joint Restraint: Section 33 05 19 – Pressure Piping Tied Joint Restraint System.
 - 2) Proprietary Restrained, Integral, Boltless, Flexible, Push-on Joint Pipe and Fittings: Restrained joint pipe, fittings, and restraining components shall be Ductile Iron in accordance with these Specifications. The restrained joint shall be manufactured integrally with the pipe and shall have a working pressure rating equivalent to the working pressure of the parent pipe. The restrained joint pipe and fittings shall utilize a conventional gasket for Mechanical and Push-on Joints.
 - a) Approved Manufacturers:
 - (1) U.S. Pipe and Foundry Co.: TR FLEX for 4-inch through 36-inch pipe diameters.
 - (2) Griffin Pipe Products Co.: SNAP-LOK for 6-inch through 48-inch pipe diameters.
 - (3) American Cast Iron Pipe Co.: Flex-Ring for 4-inch through 48-inch pipe diameters and Lok-Ring for 54-inch through 64-inch pipe diameters.
 - (4) Clow Water Systems Company: TR FLEX for 4-inch through 36-inch pipe diameters.
- 4. Thrust-Blocking: As indicated on the Drawings.
- 5. Jackets: All ductile iron water pipe and fittings shall be double wrapped with 8 mil (minimum) polyethylene film meeting AWWA C105, with all edges and laps taped (with polyethylene tape) securely to provide a continuous wrap to prevent contact between the

pipe and the surrounding backfill and bedding material. Repair rips, punctures, or other damage to the polyethylene wrap with polyethylene tape.

6. Ductile Iron Pipe Installed Above Grade or in Below Ground Concrete Vaults:

- Flanged Ductile Iron Pipe: AWWA C115 and as per "Ductile Iron Pipe," above, with the following exception:
 - Pipe and fittings exposed to view in the finished work are to be painted in accordance with the specifications. Pipe shall not receive the standard bituminous coating on the outside surfaces but shall be shop primed on the outside with one coat of Kop-Coat No. 621 Rust Inhibitive Primer or equal.

B. Polyvinyl Chloride (PVC) Water Pipe: All polyvinyl chloride (PVC) water pipe shall be of the rigid (UNPLASTICIZED) type and must bear the National Sanitation Foundation seal of approval for potable water pipe. Each joint of pipe shall consist of single continuous extrusion; bells or other components attached by solvent welding are not acceptable. Pipe in size 4 inches through 12 inches in diameter shall conform to the applicable requirement of AWWA C909 and ASTM D3139 with gasketed integral bell ends and shall be pressure rated at 235 psi.

- Fittings: Fittings for AWWA C909 pipe shall conform to the specifications herein for ductile iron pipe.

2.2 VALVES AND FIRE HYDRANTS

- Valves: Conform to Section 33 12 16.
- Fire Hydrants: Conform to Section 33 12 19.

2.3 AIR RELEASE VALVES

- Manufacturer and Model:
 - APCO Valve and Primer Corporation: APCO Model No. 200A.
 - Substitutions: Section 01 60 00 – Product Requirements.
- Description: AWWA C512. Cast Iron Body (ASTM A126, Grade B); stainless steel float, plug, guide shafts, and bushings (ASTM A240; T304 Stainless Steel).

2.4 COMBINATION AIR VALVES (AIR RELEASE AND AIR/VACUUM VALVES)

- Manufacturer and Model:
 - APCO Valve and Primer Corporation: APCO Model No. 145C.
 - Substitutions: Section 01 60 00 – Product Requirements.
- Description: AWWA C512. Cast Iron Body (ASTM A126, Grade B); stainless steel float, plug, guide shafts, and bushings (ASTM A240; T304 Stainless Steel).

2.5 UNDERGROUND PIPE MARKERS

- Pipe shall be identified in conformance with ANSI/AWWA C909 or C905 as appropriate.
- Description: Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

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2.6 PRECAST CONCRETE VALVE VAULTS AND METER BOXES

- A. Precast Concrete Valve Vaults and Meter Boxes: Conform to Section 33 05 17.

2.7 PIPE SUPPORTS AND ANCHORING

- A. Metal for pipe support brackets: Structural steel, galvanized and thoroughly coated with bituminous paint.
- B. Tie rods and clamps or lugs: Stainless steel, AISI Type 304.

2.8 CONCRETE ENCASEMENT AND CRADLES

- A. Concrete: Conform to Section 03 30 00, 2500 psi 28 day concrete, air entrained rough troweled finish.

2.9 BEDDING, EMBEDMENT, AND BACKFILL MATERIALS

- A. Bedding Material: As specified in Section 31 23 17.
- B. Embedment Material: as specified in Section 31 23 17.
- C. Backfill Material: as specified in Section 31 23 17.

2.10 ACCESSORIES

- A. Concrete for Thrust Restraints: Conform to Section 03 30 00.
- B. Steel Rods, Bolts, Lugs, and Brackets: Conform to Section 33 05 19, unless indicated otherwise.
- C. Protective Coating: Bituminous paint.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify that the existing utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Pre-Construction Site Photos:

1. Take photographs along centerline of proposed pipe trench; minimum one photograph for each 50 feet of pipe trench.
2. Show mail boxes, curbing, lawns, driveways, signs, culverts, and other existing site features.
3. Include project description, date taken and sequential number on back of each photograph.

C. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs. Use only equipment specifically designed for pipe cutting. The use of chisels or hand saws will not be permitted. Grind edges smooth with beveled end for push-on connections.

D. Remove scale and dirt on inside and outside before assembly.

E. Prepare pipe connections to equipment with flanges or unions.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 31 23 17 for Work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated on Drawings.
- B. Dewater excavations to maintain dry conditions and preserve final grades at bottom of excavation.
- C. Provide sheeting and shoring in accordance with Sections 31 23 15 and 31 23 17.
- D. Bedding shall be required to bring the trench bottom up to grade and shall be the same material as the embedment. The bedding shall be contoured at each belled joint to permit proper joint assembly while maintaining uniform pipe support.
- E. Place bedding to a compacted depth as indicated on the Drawings and in accordance with Section 31 23 17.
- F. Maintain optimum moisture content of bedding material to attain the required compaction density.

3.4 INSTALLATION - PIPE

- A. Install pipe in accordance with AWWA C600 and/or AWWA C605, whichever is applicable.
- B. Handle and assemble pipe in accordance with manufacturer's instructions and as indicated on Drawings.
- C. Joint Deflection: Deflection at the joint shall not exceed 1.5 degrees or 75% of the maximum deflection recommended by the manufacturer, whichever is less.
- D. Maintain 9 ft horizontal separation of water main from sanitary sewer piping in accordance with TCEQ Chapter 290.
- E. Install all buried piping to the lines and grades as shown on the Drawings. All underground piping shall slope uniformly between joints where elevations are shown.

- F. Install ductile iron piping and fittings to AWWA C600.
- G. Install buried Schedule 40 PVC pipe to ASTM F1668 and ASTM D2564.
- H. Route pipe in straight line. Relay pipe that is out of alignment or grade.
- I. Install pipe with no high points. If unforeseen field conditions arise which necessitate high points, install air release valves as directed by Engineer.
- J. Install pipe to have bearing along entire length of pipe. Excavate bell holes to permit proper joint installation. Do not lay pipe in wet or frozen trench.
- K. Prevent newly installed waterline from becoming contaminated with groundwater. If contamination occurs, the entire length of pipe affected shall be thoroughly cleaned prior to installing additional pipe.
- L. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- M. Sanitary precautions shall be taken during waterline installation in accordance with AWWA standards. Precautions include keeping pipe clean and capping or otherwise effectively covering open pipe ends to exclude insects, animals, foreign material, debris, or other sources of contamination from unfinished pipe lines at times when construction is not in progress.
- N. Close pipe openings with watertight plugs during work stoppages and at the conclusion of each day's work. Trenches shall not be left open overnight. After installation of the temporary night cap, the trench shall be backfilled to provide blocking to keep the night cap in place and prevent floatation of the pipe in the event of rainfall events or excessive groundwater. Backfill of the excavation will not be required to meet the density requirements for trench backfill. Contractor shall provide a submittal for the night cap fitting for approval by Engineer.
- O. Install access fittings to permit disinfection of water system performed under Section 33 13 00.
- P. Establish elevations of buried piping with not less than 3.5 ft of cover for pipes less than 12 inches in diameter. Measure depth of cover from final surface grade to top of pipe barrel.
- Q. Shore up and protect from damage all existing underground water lines and power lines, and all existing structures.
- R. Do not lay pipe on unstable material, in wet trench, or when trench or weather conditions are unsuitable.
- S. Do not lay pipe in same trench with other pipes or utilities unless shown otherwise on Drawings.
- T. Hold pipe securely in place while joint is being made.
- U. Do not walk on pipes in trenches until covered by embedment and tamped in place over pipe.

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- V. Full length of each section of pipe shall rest solidly upon pipe bed with recesses excavated to accommodate bells or joints. Do not lay pipes on wood blocking.
- W. Tees, plugs, caps, bends and hydrants on pipe installed underground shall be restrained and anchored.
- X. Tightly cover and protect equipment. At completion of all work, thoroughly clean equipment.
- Y. Install plastic ribbon tape continuous over top of pipe buried 24 inches below finish grade above pipe line; coordinate with Section 31 23 17. Tape shall be continuous and shall not deviate outside the horizontal profile of the pipe.
- Z. Stamp a "W" in curb face at all service locations on new construction.

3.5 INSTALLATION - VALVES AND HYDRANTS

- A. Install valves in accordance with Section 33 12 16.
- B. Install hydrants in accordance with Section 33 12 19.

3.6 INSTALLATION - TAPPING SLEEVES AND VALVES

- A. Install tapping sleeves and valves in accordance with Drawings and in accordance with manufacturer's instructions.

3.7 POLYETHYLENE ENCASEMENT

- A. Encase ductile iron piping and fittings in polyethylene wrap to prevent contact with surrounding backfill material.
- B. Install in accordance with AWWA C105.
- C. Terminate polyethylene encasement 3 to 6 inches above ground where pipe is exposed.

3.8 THRUST RESTRAINT

- A. Provide valves, tees, bends, caps, and plugs with concrete thrust blocks. Pour concrete thrust blocks against undisturbed earth. Locate thrust blocks at each elbow or change of pipe direction to resist resultant force and so pipe and fitting joints will be accessible for repair. Provide thrust restraint bearing on subsoil in accordance with the Drawings.
- B. Install tie rods, clamps, set screw retainer glands, or restrained joints prior to the installation of the concrete thrust blocking.
- C. Install thrust blocks, tie rods, and joint restraint at dead ends of water main.

3.9 SERVICE CONNECTIONS

- A. Install service connections in accordance with Section 33 12 13.

3.10 EMBEDMENT

- A. Place embedment beneath the haunches of the pipe, around sides of the pipe, and above the top of pipe in accordance with Section 31 23 17.
- B. Maintain optimum moisture content of bedding material to attain required compaction density.

3.11 DISINFECTION OF POTABLE WATER PIPING SYSTEM

- A. Flush and disinfect system in accordance with Section 33 13 00.

3.12 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- D. Pressure and leakage test system in accordance with AWWA C600 and the following:
 1. Test Pressure: Not less than 200 psi or 133% of the nominal pipe pressure class indicated, whichever is greater.
 2. Conduct hydrostatic test for at least four-hour duration. Contractor shall furnish all pumps, gauges, and equipment necessary for the tests. The Engineer must be present to observe the tests.
 3. Test pressure shall not vary by more than ± 5 psi (24.5 kPa) for the duration of the test.
 4. Fill section to be tested with water slowly. Before applying the specified test pressure, air shall be expelled completely from the section of piping under test. If permanent air vents are not located at all high points, corporation cocks shall be installed at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks and air vents shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place as required by the specifications.
 5. All exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damage or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be replaced with new material, and the test shall be repeated until satisfactory results are obtained.
 6. Correct all observed deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig of test pressure. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.
 7. Compute maximum allowable leakage by the following formula:

$L = (SD\sqrt{P})/C$
L = allowable leakage, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure during hydrostatic test, in psig
C = 148,000
When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

8. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.
9. No pipe installation will be accepted if the leakage is greater than the allowable determined by the formula prescribed above. If any test of laid pipe discloses leakage greater than that specified in (7), above, repairs or replacements shall be accomplished in accordance with the specifications.
10. All visible leaks are to be repaired regardless of the amount of leakage.

E. Compaction Testing for Embedment: In accordance with Section 31 23 17.

F. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.

G. Frequency of Compaction Tests: per Section 31 23 17.

END OF SECTION

SECTION 33 12 00 - WATER UTILITY DISTRIBUTION EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Reduced pressure backflow preventer assemblies.
 - 2. Double check valve backflow preventer assemblies.
 - 3. Valve vaults.
 - 4. Buried piping within 5 feet of valve vault.
 - 5. Interior piping.
 - 6. Valves.
 - 7. Pipe supports.
 - 8. Embedment and backfill materials.
- B. Related Requirements:
 - 1. Section 09 91 00 - Painting and Coating: Painting pipes, valves, and associated items.
 - 2. Section 32 05 16 - Aggregates for Civil Site Improvements: Aggregate for backfill.
 - 3. Section 31 23 10 – Structural Excavation and Backfill: Excavating for backflow preventer assemblies.
 - 4. Section 31 23 17 - Trenching: Trenching for buried pipe installation.
 - 5. Section 31 23 23 - Fill: Backfilling after backflow preventer assembly installation.
 - 6. Section 33 05 17 - Precast Concrete Valve Vaults and Meter Boxes: Backflow preventer precast concrete valve vault.
 - 7. Section 33 11 13 - Public Water Utility Distribution Piping: Potable water piping beyond backflow preventer valve vault.
 - 8. Section 33 13 00 - Disinfecting of Water Utility Distribution: Disinfection of domestic water piping beyond backflow preventer valve vault.

1.2 REFERENCE STANDARDS

- A. American Society of Mechanical Engineers:
 - 1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
 - 3. ASME B31.9 - Building Services Piping.
- B. American Society of Sanitary Engineering:
 - 1. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.
 - 2. ASSE 1015 - Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies.
 - 3. ASSE 1047 - Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies.
 - 4. ASSE 1048 - Double Check Detector Fire Protection Backflow Prevention Assemblies.

- C. ASTM International:
 - 1. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 2. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
 - 3. ASTM D2241 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
 - 4. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
 - 5. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
 - 6. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
 - 7. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
- D. American Water Works Association:
 - 1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 - 2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
 - 4. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
 - 5. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
 - 6. AWWA C510 - Double Check Valve Backflow Prevention Assembly.
 - 7. AWWA C511 - Reduced-Pressure Principle Backflow Prevention Assembly.
 - 8. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.
 - 9. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. through 3 in., for Water Service.
- E. American Welding Society:
 - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
- F. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data:
 - 1. Submit data on backflow preventer assemblies.
 - 2. Piping: Submit data on pipe materials, fittings, and accessories.

3. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
4. Supports: Submit manufacturers catalog information including load capacity.

C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

D. Manufacturer's Instructions: Submit installation instructions for backflow preventer assemblies, valves, and accessories.

1.5 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of backflow preventer assemblies.

C. Operation and Maintenance Data: Submit spare parts list, exploded assembly views, and recommended maintenance intervals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.

B. Extra Stock Materials:

1. Furnish two sets of seals for each backflow preventer assembly.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Accept backflow preventer assemblies, valves, and equipment on site in shipping containers with labeling in place. Inspect for damage.

C. Furnish cast iron and steel valves with temporary protective coating.

D. Furnish pipe and fittings with temporary end caps and closures. Maintain caps and closure in place until installation.

E. Protect backflow preventer assemblies from entry of foreign materials by temporary covers.

1. Protect openings in sections of completed piping systems.

2. Protect openings in piping systems when Work is not in progress.

1.9 EXISTING CONDITIONS

A. Verify field measurements prior to fabrication. Indicate field measurements on shop drawings

1.10 WARRANTY

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.

B. Furnish five year manufacturer's warranty for backflow preventer assemblies.

PART 2 PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Manufacturers:

1. FEBCO
2. Flomatic Corporation
3. Matco-Norca
4. NIBCO Inc.
5. Watts Water Technologies, Inc.
6. Substitutions: Section 01 60 00 - Product Requirements.

B. Reduced Pressure Backflow Preventers:

1. Size: 3/4 inch to 2 inches.
2. Comply with ASSE 1047 and AWWA C511.
3. Bronze body, with bronze internal parts and stainless steel springs.
4. Two independently operating, spring loaded check valves.
5. Diaphragm type differential pressure relief valve located between check valves.
6. Third check valve opening under back pressure in case of diaphragm failure.
7. Furnish with two quarter-turn, full port resilient seated bronze, ball valves, strainer, and test cocks.

2.2 PIPING

A. Refer to Section 33 11 13 – Public Water Utility Distribution Piping.

2.3 PIPE SUPPORTS

A. Manufacturers:

1. Anvil International.
2. Substitutions: Section 01 60 00 - Product Requirements.

B. Floor Support for Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

C. Copper Pipe Support: Carbon steel ring, adjustable, copper plate.

2.4 EMBEDMENT AND BACKFILL MATERIALS

- A. Embedment: Fill Type A4 as specified in Section 31 23 17.
- B. Backfill: Fill Type A1 as specified in Section 31 23 17.

2.5 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 3 inches and Smaller:
 1. Ferrous pipe: Class 150 malleable iron threaded unions.
 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Grooved and Shouldered Pipe End Couplings:
 1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
 2. Sealing gasket: "C" shape composition sealing- gasket.
- C. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.6 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum **6 inches** wide by **4 mil** thick, manufactured for direct burial service.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify excavations are to required grade, dry, and not over-excavate.
- C. Verify piping connection, size, location and invert are as indicated on Drawings.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Remove scale and dirt, on inside and outside, before assembly.

3.3 INSTALLATION - PIPE SUPPORTS

- A. Pipe Supports:
 1. Install pipe supports in accordance with MSS SP 89.
 2. Prime coat exposed supports. Refer to Section 09 91 00.

3.4 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to existing piping system with regard to size, location, and invert.
- B. Establish elevations of buried piping with not less than 3.5 ft of cover.
- C. Establish minimum 10 feet separation from sanitary sewer piping in accordance with TCEQ Regulations.
- D. Remove scale and dirt on inside of piping before assembly.
- E. Excavate pipe trench in accordance with Section 31 23 17.
- F. Install pipe to elevation as indicated on Drawings.
- G. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding six inches compacted depth; compact to 95 percent Standard Proctor density.
- H. Install pipe on prepared bedding.
- I. Route pipe in straight line.
- J. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- K. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- L. Install plastic ribbon tape continuous over top of pipe buried 24 inches below finish grade; coordinate with Section 31 23 17.

3.5 INSTALLATION - INTERIOR PIPING SYSTEMS

- A. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Establish elevations of buried piping outside valve vault to obtain not less than 3.5 ft of cover.
- C. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 00.
- D. Install water piping in accordance with ASME B31.9.
- E. Install unions downstream of valves and at equipment or apparatus connections.
- F. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

3.6 INSTALLATION - BACKFLOW PREVENTER ASSEMBLIES

- A. Install backflow preventer of type, size, and capacity indicated.

- B. Install air-gap fitting on units with atmospheric vent connection and pipe relief outlet drain to nearest floor drain.
- C. Do not install bypass around backflow preventer.

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing.
- B. Section 01 45 16 – Contractor Quality Control.
- C. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- D. Perform pressure test on backflow pressure assemblies installation with Section 33 11 13.

3.8 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Disinfect backflow preventer assemblies installation in accordance with Section 33 13 00.

END OF SECTION

SECTION 33 12 13 - WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings for residential and commercial water service connections.
 - 2. Corporation stop assembly.
 - 3. Curb stop assembly.
 - 4. Meter setting equipment.
 - 5. Water meters.
 - 6. Backflow preventers.
 - 7. Underground pipe markers.
 - 8. Precast concrete vault.
 - 9. Embedment and backfill materials.

- B. Related Requirements:
 - 1. Section 03 30 00 - Cast-In-Place Concrete.
 - 2. Section 31 05 13 - Topsoil.
 - 3. Section 31 22 13 – Rough Grading.
 - 4. Section 31 23 17 - Trenching.
 - 5. Section 31 23 23 - Fill.
 - 6. Section 32 05 16 - Aggregates for Civil Site Improvements.
 - 7. Section 33 05 17 - Precast Concrete Valve Vaults and Meter Boxes.
 - 8. Section 33 12 00 - Water Utility Distribution Equipment.
 - 9. Section 33 13 00 - Disinfecting of Water Utility Distribution.

1.2 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

- B. American Society of Mechanical Engineers:
 - 1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
 - 2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

- C. American Society of Sanitary Engineering:
 - 1. ASSE 1012 - Backflow Preventer with Intermediate Atmospheric Vent.
 - 2. ASSE 1013 - Reduced Pressure Principle Backflow Preventers.

- D. ASTM International:
 - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
 - 2. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
 - 3. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
 - 4. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.

5. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN·m/m³)).
6. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN·m/m³)).
7. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
8. ASTM F876 – Standard Specification for Crosslinked Polyethylene (PEX) Tubing
9. ASTM F2023 – Standard Test Method for Evaluating the Oxidative Resistance of Crosslinked Polyethylene (PEX) Tubing and Systems to Hot Chlorinated Water
10. ASTM F2080 – Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe
11. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
12. ASTM F2657 - Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing
13. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
14. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
15. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
16. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

F. American Water Works Association:

1. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
2. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
3. AWWA C701 - Cold-Water Meters - Turbine Type, for Customer Service.
4. AWWA C702 - Cold-Water Meters - Compound Type.
5. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold-Water Meters.
6. AWWA C800 - Underground Service Line Valves and Fittings.
7. AWWA C904 – Crosslinked Polyethylene (PEX) Pressure Tubing, 1/2 in. through 3 in., for Water Service.
8. AWWA M6 - Water Meters - Selection, Installation, Testing, and Maintenance.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data on pipe materials, pipe fittings, corporation stop assemblies, curb stop assemblies, meters, meter setting equipment, service saddles, backflow preventer, and accessories.
- C. Shop Drawings: Provide shop drawings for precast concrete vaults to include detail drawings showing the vault and accessories.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of piping mains, curb stops, connections, thrust restraints, and invert elevations.
- C. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. During loading, transporting, and unloading of materials and products, exercise care to prevent any damage.
- C. Store products and materials off ground and under protective coverings and custody, away from walls and in manner to keep these clean and in good condition until used.
- D. Exercise care in handling precast concrete products to avoid chipping, cracking, and breakage.

PART 2 PRODUCTS

2.1 WATER SERVICE PIPING AND FITTINGS

- A. Crosslinked Polyethylene (PEX) Tubing (1" in size, on GVSUD's side of meter): ASTM F876; ASTM F2023; ASTM F2080; ASTM F2657; and NSF/ANSI 14 and 61: high density, PEX 3306, SDR-9, 200 psi pressure rated.
 1. Fittings: ASTM F2080; and AWWA C800.
 2. Joints: Compression joint fittings or cold-expansion compression-sleeve fittings based upon manufacturer's recommendation and approved by Engineer.
- B. Yelomine RJ Certa-Lok Pipe (2" in size, on GVSUD's side of meter): ASTM D2241; and NSF/ANSI 14 and 61; PVC, DR-17, 250 psi pressure rated.
 1. Fittings: ASTM D3139; and ASTM F477.
 2. Joints: Integral restrained joint – coupled.
- C. Schedule 80 PVC (on owner's side of meter): ASTM D1785; and NSF/ANSI 14 and 61.
 1. Fittings: ASTM D2467.
 2. Joints: Solvent weld in accordance with ASTM D2672.

2.2 CORPORATION STOP ASSEMBLY

- A. Manufacturers:
 1. The Ford Meter Box Company, Inc.: Model FB 1000-6-G-NL.
 2. Substitutions: Section 01 60 00 - Product Requirements.

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- B. Service Saddles:
 - 1. Double strap type: Smith Blair No. 317 Double Strap Saddle, or approved equal.
 - 2. Designed for 200 psi working pressure.

2.3 CURB STOP ASSEMBLY

- A. Manufacturers:
 - 1. The Ford Meter Box Company, Inc.: Model B11-444W-NL, or B11-777W-NL.
 - 2. Substitutions: Section 01 60 00 - Product Requirements.
- B. Curb Stops:
 - 1. Brass conforming to ASTM B62, Table 1.
 - 2. Plug type valve.
 - 3. Positive pressure sealing.
 - 4. Designed for 200 psi working pressure.

2.4 METER BOXES

- A. Manufacturers:
 - 1. Meter Boxes for 3/4 Inch Meters (Non-traffic Areas):
 - a. DFW36C 16"x11" plastic meter box with rebar, arm and knock out.
 - 2. Meter Boxes for 1 Inch Meters (Non-traffic Areas):
 - a. DFW65C-14-1A 30-3/8"x15-1/4" plastic meter box with rebar, arm and knock out.
 - 3. Substitutions: Section 01 60 00 - Product Requirements.

2.5 WATER METERS

- A. Water Meters: Materials shall be furnished and installed by the City of Cedar Park.

2.6 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers: Refer to Section 33 12 00 – Water Utility Distribution Equipment.

2.7 UNDERGROUND PIPE MARKERS

- A. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.8 PRECAST CONCRETE VAULT

- A. Refer to Section 33 05 17 – Precast Concrete Valve Vaults and Meter Boxes.

2.9 EMBEDMENT AND BACKFILL MATERIALS

- A. Embedment: Fill Type A4 as specified in Section 31 23 17.
- B. Backfill: Fill Type A1, as specified in Section 31 23 17.

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2.10 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00 and indicated on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.
- B. Verify building service connection and municipal utility water main size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation preparation.
- B. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare pipe connections to equipment with flanges or unions.

3.3 INSTALLATION - CORPORATION STOP ASSEMBLY

- A. Make connection for each different kind of water main using suitable materials, equipment and methods approved by the Engineer.
- B. Provide service clamps for mains other than of cast iron or ductile iron mains.
- C. Screw corporation stops directly into tapped and threaded iron main at 10 and 2 o'clock position on main's circumference; locate corporation stops at least 12 inches apart longitudinally and staggered.
- D. For plastic pipe water mains, provide full support for service clamp for full circumference of pipe, with minimum 2 inches width of bearing area; exercise care against crushing or causing other damage to water mains at time of tapping or installing service clamp or corporation stop.
- E. Use proper seals or other devices so no leaks are left in water mains at points of tapping; do not backfill and cover service connection until approved by the Architect/Engineer.

3.4 EMBEDMENT

- A. Excavate pipe trench in accordance with Section 31 23 17 for Work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated on Drawings.

- B. Dewater excavations to maintain dry conditions and preserve final grades at bottom of excavation.
- C. Provide sheeting and shoring in accordance with Sections 31 23 17 and 31 23 15.
- D. Place embedment material at trench bottom; level embedment fill material in one continuous layer not exceeding 6 inches compacted depth; compact to 95 percent of standard Proctor density, as prescribed in Section 31 23 17.

3.5 INSTALLATION - PIPE AND FITTINGS

- A. Maintain separation of water main from sewer piping in accordance with TCEQ Regulations.
- B. Install pipe to indicated elevations.
- C. Route pipe in straight line.
- D. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- E. Install access fittings to permit disinfection of water system performed under Section 33 13 00.
- F. Form and place concrete for thrust restraints at each elbow or change of direction of pipe main.
- G. Establish elevations of buried piping with not less than 3.5 ft of cover.
- H. Install plastic ribbon tape continuous over top of pipe buried 24 inches below finish grade; coordinate with Sections 31 23 23 and 31 23 17.
- I. Backfill trench in accordance with Section 31 23 23.

3.6 INSTALLATION - CURB STOP ASSEMBLY

- A. Set curb stops on compacted soil.
- B. Center and plumb curb box over curb stops. Set box cover flush with finished grade.

3.7 INSTALLATION - WATER METERS

- A. Meters shall be furnished and installed by the City of Cedar Park.

3.8 INSTALLATION - BACKFLOW PREVENTERS

- A. Install backflow preventer where indicated on the Contract Drawings and in accordance with manufacturer's instructions.
- B. Comply with public water supply requirements and plumbing codes in regards to testing and installation requirements.

3.9 SERVICE CONNECTIONS

- A. Install residential water service in accordance with public water supply requirements with meter box as indicated.
- B. Install commercial water meter in precast concrete vault when indicated. Refer to Section 33 05 17.
- C. Install water service to the right-of-way or property line, or as indicated on Drawings.

3.10 PRECAST CONCRETE VAULT

- A. Construct precast concrete as per Section 33 05 17.
- B. Seal vault joints watertight with preformed plastic joint sealant compound. Apply asphalt waterproofing to exterior walls.
- C. Seal annular space between pipe and wall sleeves as indicated on the Contract Drawings.
- D. Install vault covers and frames; adjust to finished grade elevation.

3.11 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing
- B. Section 01 45 16 – Contractor Quality Control.
- C. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.
- D. Pressure test system in accordance with AWWA C600 and the following:
 1. Test Pressure: Not less than 200 psi.
 2. Conduct hydrostatic test for at least two-hour duration.
 3. Fill section to be tested with water slowly, expel air from piping at high points. Install corporation cocks at high points. Close air vents and corporation cocks after air is expelled. Raise pressure to specified test pressure.
 4. Observe joints, fittings and valves under test. Remove and renew cracked pipe, joints, fittings, and valves showing visible leakage. Retest.
 5. Correct visible deficiencies and continue testing at same test pressure for additional 2 hours to determine leakage rate. Maintain pressure within plus or minus 5.0 psig of test pressure. Leakage is defined as quantity of water supplied to piping necessary to maintain test pressure during period of test.
 6. Compute maximum allowable leakage by the following formula:

$L = (SD \sqrt{P})/C$
L = testing allowance, in gallons per hour
S = length of pipe tested, in feet
D = nominal diameter of pipe, in inches
P = average test pressure during hydrostatic test, in psig
C = 148,000
When pipe under test contains sections of various diameters, calculate allowable leakage from sum of computed leakage for each size.

7. When test of pipe indicates leakage greater than allowed, locate source of leakage, make corrections and retest until leakage is within allowable limits. Correct visible leaks regardless of quantity of leakage.
- E. Compaction Testing for Embedment and Backfill: In accordance with ASTM D698.
- F. When tests indicate Work does not meet specified requirements, remove Work, replace and retest.
- G. Frequency of Compaction Tests: One per service.

END OF SECTION

SECTION 33 12 16 - WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Valves.
 - 2. Valve boxes.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete.
 - 2. Section 31 23 16 - Excavation.
 - 3. Section 31 23 23 - Fill.
 - 4. Section 32 05 16 - Aggregates for Civil Site Improvements.
 - 5. Section 33 11 13 - Public Water Utility Distribution Piping.
 - 6. Section 33 12 13 - Water Service Connections.
 - 7. Section 33 12 19 - Water Utility Distribution Fire Hydrants.
 - 8. Section 33 13 00 - Disinfecting of Water Utility Distribution.

1.2 REFERENCES

- A. American Water Works Association:
 - 1. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service.
 - 2. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
 - 3. AWWA C550 - Protecting Epoxy Interior Coating for Valves and Hydrants.
 - 4. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
- B. National Sanitation Foundation:
 - 1. NSF 61 - Drinking Water System Components - Health Effects

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawing:
 - 1. Installation Plan: Submit description of proposed installation.
- C. Design Data: Submit manufacturer's latest published literature including illustrations, installation instructions, maintenance instructions and parts lists.
- D. Manufacturer's Certificates: Submit Statement of Compliance, supporting data, from material suppliers attesting that valves and accessories provided meet or exceed AWWA Standards and specification requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

- B. Project Record Documents: Record actual locations of valves.
- C. Provide Operation and Maintenance Data for valves.

1.5 QUALIFICATIONS

- A. Manufacturer: company specializing in manufacturing Products specified in this section with minimum ten years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation Meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Prepare valves and accessories for shipment according to AWWA Standards and seal valve and ends to prevent entry of foreign matter into product body.
- C. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate work with Owner and utilities within construction area.

1.10 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for maintenance materials.
- B. Furnish one tee wrench to Owner; required length.

PART 2 PRODUCTS

2.1 RESILIENT SEAT GATE VALVES

- A. Manufacturers:
 - 1. American Flow.
 - 2. AVR.
 - 3. Mueller.
 - 4. East Jordan.
 - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Resilient Wedge Gate Valves (for Gate Valves 3-inch through 24-inch diameters): AWWA C509; and AWWA C515; ductile iron body; including the manufacturer's name, pressure rating, and year of fabrication cast into valve body.
 - 1. Gate: Resilient seat.
 - 2. Stem: Non-rising stem.
 - 3. Seals: O-ring stem seals.
 - 4. Operating Nut: 2-inch square; open counterclockwise unless otherwise indicated.
 - 5. Ends: Flanged or mechanical joint end connections.
 - 6. Coating: AWWA C550; epoxy-coated interior/exterior.
 - 7. Sizes 12-inch diameter and smaller: 200 psig pressure rated.
 - 8. Sizes 16- inch diameter through 24-inch diameter: 150 psig pressure rated.
 - 9. Valves shall be installed in a vertical position.
 - 10. Tapping valves shall have lip for tapping machine.
 - 11. The number of turns to fully open or close a valve shall be 3 times the diameter plus 2.
 - 12. All external nuts, bolts, and washers shall be as specified in Section 33 11 13 - Public Water Utility Distribution Piping.
 - 13. Mechanical joint end connections shall be connected to the pipe with a Wedge Action Restraining Gland for Ductile Iron Mechanical Joint as per Section 33 11 13 – Public Water Utility Distribution Piping.

2.2 GATE VALVE BOXES

- A. 12-inch Diameter Valves and Smaller: Ductile iron, two-piece, screw type.
- B. 12-inch through 20-inch Diameter Valves: Cast iron, three-piece, screw type; round base.
- C. Valves Larger than 20-inch Diameter: Precast concrete manhole as per Section 33 05 14 – Public Manholes and Structures.
- D. Cast iron lid, marked "Water".

2.3 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete as specified in Section 03 30 00 and as indicated.
- B. Valve Box Aligner: High-strength, plastic device designed to automatically center valve box base and prevent valve box base from shifting off center during backfilling.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Determine exact location and size of valves from Drawings; obtain clarification and directions from Engineer prior to execution of work.
- C. Verify invert elevations of existing work prior to excavation and installation of valves.

3.2 PREPARATION

- A. Identify required lines, levels, contours and datum locations.
- B. Locate, identify, and protect utilities to remain from damage.
- C. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.
 - 1. Notify Engineer not less than two days in advance of proposed utility interruption.
 - 2. Do not proceed without written permission from the Engineer.
- D. Perform trench excavation, backfilling and compaction in accordance with Section 31 23 17.

3.3 INSTALLATION

- A. Install valves in conjunction with pipe laying; set valves plumb.
- B. Provide buried valves with valve boxes installed flush with finished grade.

3.4 DISINFECTION OF WATER PIPING SYSTEM

- A. Flush and disinfect system in accordance with Section 33 13 00.

3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Construction Materials Testing, Section 01 45 16 – Contractor Quality Control, and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform pressure test on site water distribution system in accordance with Section 33 11 13 – Public Water Utility Distribution Piping.

END OF SECTION

SECTION 33 12 19 - WATER UTILITY DISTRIBUTION FIRE HYDRANT ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fire hydrants.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete.
 - 2. Section 33 11 13 - Public Water Distribution Piping.
 - 3. Section 33 12 13 - Water Service Connections.
 - 4. Section 40 05 61 – Gate Valves.

1.2 REFERENCES

- A. American Water Works Association:
 - 1. AWWA C502 - Dry-Barrel Fire Hydrants.
 - 2. AWWA C550 - Protecting Epoxy Interior Coating for Valves and Hydrants.
 - 3. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
- B. National Sanitation Foundation:
 - 1. NSF 61 - Drinking Water System Components - Health Effects
- C. National Fire Protection Association:
 - 1. NFPA 281 - Recommended Practice for Fire Flow Testing and Marking of Hydrants

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawing:
 - 1. Installation Plan: Submit description of proposed installation.
- C. Design Data: Submit manufacturer's latest published literature include illustrations, installation instructions, maintenance instructions and parts lists.
- D. Manufacturer's Certificates: Submit Statement of Compliance, supporting data, from material suppliers attesting that hydrants and accessories provided meet or exceed AWWA Standards and specification requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of fire hydrants.
- C. Provide Operation and Maintenance Data for fire hydrants.

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1.5 QUALITY ASSURANCE

- A. Provide uniform color scheme for fire hydrants in accordance with NFPA 281 and in accordance with the public water supply entity.

1.6 QUALIFICATIONS

- A. Manufacturer: company specializing in manufacturing Products specified in this section with minimum ten years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation Meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing and protecting products.
- B. Prepare hydrants and accessories for shipment according to AWWA Standards and seal hydrant and ends to prevent entry of foreign matter into product body.
- C. Store products in areas protected from weather, moisture, or possible damage; do not store products directly on ground; handle products to prevent damage to interior or exterior surfaces.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface or subsurface structures or utilities, and landscape in immediate or adjacent areas.

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate work with Travis County standards and utilities within construction area.

PART 2 PRODUCTS

2.1 FIRE HYDRANTS

- A. Manufacturers:

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1. American Flow.
2. AVR.
3. Mueller.
4. East Jordan.
5. Substitutions: Section 01 60 00 - Product Requirements.

B. Dry-barrel Break-away Type: AWWA C502; Factory Mutual Research Corporation and Underwriter's Laboratories UL 246 Standard.

1. Rated Working Pressure: 200 psi.
2. Test Pressure: 400 psi.
3. Body: Cast iron.
4. Main Valve Closure: Compression type, opening against pressure and closing with pressure.
5. Traffic "breakaway" type with safety stem coupling and breakable flanges that permits full 360 degree rotation of the nozzle section.
6. Bury Depth: 3.5 feet.
7. Inlet Connection: 6 inches.
8. Valve Opening: 5-1/4 inches diameter designed to permit removal of all working parts (including waste valve) from top of hydrant without disturbing the surface adjacent to the hydrant and without disassembling the ground-line joint or nozzle connections.
9. Ends: Mechanical Joint (with wedge-type restraints).
10. Fittings: Ductile iron pipe per Section 33 11 13 – Public Water Distribution Piping.
11. Bolts and Nuts: Per Section 33 11 13 – Public Water Distribution Piping.
12. Operating Nut: Tapered, pentagon (five sided) measuring $\frac{1}{2}$ inch point to flat and 1 inch flat measurement (National Standard).
13. Direction of Opening: Clockwise unless otherwise indicated.
14. Fire Hydrant Leads: Ductile iron pipe per Section 33 11 13 – Public Water Distribution Piping.
15. Hydrant Bonnet Assembly: Provide with a lubrication reservoir that automatically circulates lubricant to all operating stem threads and bearing surfaces each time the hydrant is operated. Downward stem travel limited by a travel stop located in the upper housing of the hydrant.
16. Hydrants shall be provided with a minimum of one internal and two external automatic and positively operating non-corrodible drain valves so as to allow main pressure to flush the drain valves completely during the opening motion and drain the hydrant completely when the main valve is shut. Drain valves operating by gravity or springs are not acceptable. Outlets for drainage of the barrel shall be made of bronze or non-corrodible metal or bushed therewith completely from the valve to the outside.

C. Outlets/Nozzles

1. Two Hose Outlets: 2-1/2 inch outlet per National Standard.
2. One Pumper Outlet: Harrington Integral 5" Hydrant Storz connection, AWWA C502-73, Appendix A, Table A-2.
3. Caps furnished for the two hose nozzles and 1 pumper nozzle. Threads for nozzles/caps per National Standard.

D. Coating: AWWA C550.

1. Exterior Finish: Primer and two coats of epoxy, red color in accordance with public water supply entity.
2. Interior: Epoxy.

2.2 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00 and as indicated.
- B. Aggregate: Coarse Aggregate Type A2 (Crushed Stone) for hydrant drainage as specified in Section 32 05 16.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Determine exact location and size of hydrants from Drawings; obtain clarification and directions from Engineer prior to execution of work.
- C. Verify invert elevations of existing work prior to excavation and installation of fire hydrants.

3.2 PREPARATION

- A. Identify required lines, levels, contours and datum locations.
- B. Locate, identify, and protect utilities to remain from damage.
- C. Do not interrupt existing utilities without permission and without making arrangements to provide temporary utility services.
 - 1. Notify Engineer not less than two days in advance of proposed utility interruption.
 - 2. Do not proceed without authorization from the Engineer.
- D. Perform trench excavation, backfilling and compaction in accordance with Section 31 23 17.

3.3 INSTALLATION

- A. Install fire hydrants; provide support blocking and drainage aggregate; do not block drain hole.
- B. Set hydrants plumb with pumper nozzle facing roadway; set hydrants with centerline of pumper nozzle 18 inches above finished grade and safety flange not more than 6 inches nor less than 2 inches above grade.
- C. Paint hydrants in accordance with local color scheme.
- D. After hydrostatic testing, flush hydrants and check for proper drainage.

3.4 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Flush and disinfect system in accordance with Section 33 13 00.

3.5 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing, Section 01 45 16 – Contractor Quality Control, and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Perform pressure test on water distribution system in accordance with Section 33 11 13 – Public Water Distribution Piping.

END OF SECTION

SECTION 33 13 00 - DISINFECTING OF WATER UTILITY DISTRIBUTION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes disinfection of potable water distribution and transmission system; and testing and reporting results.
- B. Related Sections:
 - 1. Section 33 11 13 - Public Water Utility Distribution Piping.

1.2 REFERENCES

- A. American Water Works Association:
 - 1. AWWA B300 - Hypochlorites.
 - 2. AWWA B301 - Liquid Chlorine.
 - 3. AWWA B302 - Ammonium Sulfate.
 - 4. AWWA B303 - Sodium Chlorite.
 - 5. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 6. AWWA C651 - Disinfecting Water Mains.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit procedures, proposed chemicals, and treatment levels for review.
- C. Test Reports: Indicate results comparative to specified requirements.
- D. Certificate: Certify cleanliness of water distribution system meets or exceeds specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Disinfection Report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Name of person collecting samples.
 - 5. Initial and 24 hour disinfectant residuals in treated water in ppm for each outlet tested.
 - 6. Date and time of flushing start and completion.
 - 7. Disinfectant residual after flushing in ppm for each outlet tested.
- C. Bacteriological Report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.

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3. Name of person collecting samples.
4. Test locations.
5. Initial and 24-hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.
7. Certify water conforms, or fails to conform, to bacterial standards of public water supply entity.

D. Water Quality Certificate: Certify water conforms to quality standards of public water supply entity, suitable for human consumption.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with AWWA C651.
- B. Laboratory approved by the Texas Health Department and the Texas Commission on Environmental Quality (TCEQ).

1.6 QUALIFICATIONS

- A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this section with minimum three years documented experience.
- B. Testing Firm: Company specializing in testing potable water systems, certified by State of Texas.
- C. Submit bacteriologist's signature and authority associated with testing.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

- A. Chemicals:
 1. AWWA B300, Hypochlorite.
 2. AWWA B301, Liquid Chlorine.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system has been flushed at a minimum velocity of three feet per second at a 40 psi residual pressure such that all particles are removed from the line.
- C. Verify piping system has been pressure tested in accordance with Section 33 11 13 – Public Water Utility Distribution Piping.

- D. Perform scheduling and disinfecting activity with start-up, water pressure testing, adjusting and balancing, demonstration procedures, including coordination with related systems.

3.2 DISINFECTING PROCEDURE AND DOSAGE

- A. Disinfect all potable water pipelines and appurtenances per AWWA C651.
- B. Provide equipment to perform the Work of this section.
- C. Provide the water source for filling, flushing, and disinfecting the lines. Only potable water shall be used. Provide all required temporary pumps and storage facilities required to complete the specified flushing and disinfecting operations.
- D. Introduce treatment into one end of the piping system. A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be a minimum of 50 mg/l. All valves, hydrants, etc. shall be operated to disinfect all parts. Care shall be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.
- E. Maintain disinfectant in system for 24 hours. After 24 hours, the free chlorine residual of the chlorine-treated water at the extremities of the pipeline being tested shall be at least 25 mg/l.
- F. After the 24-hour retention period, the water shall contain no less than 25 mg/l chlorine throughout the treated section of pipeline.
- G. Repetition of Test: The disinfection testing procedure shall be repeated if the initial tests fail to produce satisfactory results. Two consecutive satisfactory test results shall be required after any unsatisfactory test.
- H. Upon completion of retention period required for disinfection, flush pipeline until chlorine concentration in water leaving pipeline is no higher than that generally prevailing in existing system or is acceptable for domestic use.
- I. Neutralization of Chlorinated Water: Neutralizing and disposing of chlorinated water shall be in accordance with Appendix "B" of AWWA Standard C651.

3.3 BACTERIOLOGICAL TESTING OF DISINFECTED PIPELINES

- A. After final flushing and before pipeline is connected to existing system, or placed in service, employ an approved independent testing laboratory to sample, test for bacteriological quality and certify water quality suitable for human consumption. Two sets of samples drawn 24 hours apart shall be taken at locations prescribed by AWWA C651. One test sample shall be drawn from the end of the main and additional samples collected at intervals not exceeding 1000 feet along the pipeline.
- B. Install sufficient sampling taps at proper locations along the pipeline. Each sampling tap shall consist of a standard corporation cock installed in the line and extended with a copper tubing

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gooseneck assembly. After samples have been collected, the gooseneck assembly may be removed and retained for future use.

- C. Samples for bacteriological analysis shall be collected only from suitable sampling taps in sterile bottles treated with sodium thiosulfate. Samples shall not be drawn from hoses, fire hydrants, etc.
- D. Bacteriological testing shall be in accordance with the "Standard Methods for the Examination of Water and Wastewater," latest edition.
- E. If the initial disinfection fails to produce acceptable sample tests, the disinfection procedure shall be repeated (without extra compensation) until satisfactory test results have been obtained before the piping may be placed in service.

END OF SECTION

SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sanitary sewage pipe.
 - 2. Underground pipe markers.
 - 3. Manholes.
 - 4. Bedding and cover materials.
- B. Related Sections:
 - 1. Section 03 30 00 - Cast-In-Place Concrete: Concrete type for manhole base pad construction.
 - 2. Section 31 23 10 – Structural Excavation and Backfill: Product and execution requirements for excavation and backfill required by this section.
 - 3. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.
 - 4. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.
 - 5. Section 32 05 16 - Aggregates for Civil Site Improvements: Aggregate for embedment in trenches.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
 - 2. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
 - 3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - 4. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
 - 5. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - 6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 8. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
 - 9. ASTM D2241 - Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
 - 10. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

11. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
12. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
13. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
14. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
15. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
16. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
17. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
18. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
19. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
20. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data indicating pipe material used and pipe accessories.
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record location of pipe runs, connections, cleanouts, and invert elevations.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with the International Plumbing Code as adopted by the City.

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1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements and elevations are as indicated in Drawings.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate the Work with termination of sanitary sewer connection to the building and connection to municipal sewer utility service.

PART 2 PRODUCTS

2.1 SANITARY SEWAGE PIPE

- A. Plastic Pipe: ASTM D3034, SDR 26, Poly (Vinyl Chloride) (PVC) material; bell and spigot style rubber ring sealed gasket joint.
 - 1. Fittings: PVC, SDR 26.
 - 2. Joints: ASTM F477, elastomeric gaskets.
- B. Plastic Pipe: ASTM D2241, SDR 26, Poly (Vinyl Chloride) (PVC) material; bell and spigot style rubber ring sealed gasket joint, rated at 160 psi (for water crossings including fire hydrant leads).
 - 1. Fittings: PVC, SDR 26.
 - 2. Joints: ASTM F477, elastomeric gaskets.

2.2 BEDDING, EMBEDMENT, AND BACKFILL MATERIALS

- A. Bedding Material: As specified in Section 31 23 17.
- B. Embedment Material: As specified in Section 31 23 17.
- C. Backfill Material: As specified in Section 31 23 17.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify trench cut and manhole excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION

- A. Correct over excavation with coarse aggregate.
- B. Remove large stones or other hard matter which could damage pipe or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 31 23 17.
- B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 8 inches.
- C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321. Seal joints watertight.
- B. Lay pipe to slope gradients noted on Drawings; with maximum variation from indicated slope of 1/8 inch in 10 feet.
- C. Install embedment at sides and over top of pipe to minimum compacted thickness of 12 inches.
- D. Refer to Section 31 23 17 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.
- E. Connect to municipal sewer system as indicated on Drawings.
- F. Install site sanitary sewage system piping to 5 feet of building, or as indicated on Drawings, and cap or plug.

3.5 INSTALLATION - MANHOLES

- A. Excavate for manholes in accordance with Section 31 23 10.
- B. Form bottom of excavation clean and smooth to correct elevation.
- C. Form and place cast-in-place concrete base pad, with provision for sanitary sewer pipe end sections.
- D. Establish elevations and pipe inverts for inlets and outlets as indicated on Drawings.
- E. Mount lid and frame level in grout, secured to top cone section to elevation indicated.

3.6 FIELD QUALITY CONTROL

- A. Section 01 40 00 – Construction Materials Testing, Section 01 45 16 – Contractor Quality Control, and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Request inspection prior to and immediately after placing bedding.
- C. Compaction Testing: In accordance with Section 31 23 17.
- D. When tests indicate Work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Compaction Tests: Per Section 31 23 17.

3.7 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

SECTION 33 41 13 - PUBLIC STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Storm drainage piping.
 - 2. Drainage structures.
 - 3. Bedding, embedment, and backfill materials.
 - 4. Concrete encasement and cradles.
- B. Related Sections:
 - 1. Section 03 21 00 – Reinforcing Steel: Reinforcement of concrete cradles.
 - 2. Section 03 30 00 - Cast-In-Place Concrete: Concrete type for [catch basin] [manhole] foundation slab construction.
 - 3. Section 03 60 00 - Grouting: Non-shrink grout.
 - 4. Section 31 23 10 – Structural Excavation and Backfill: Product and execution requirements for excavation and backfill required by this section.
 - 5. Section 31 23 17 - Trenching: Execution requirements for trenching required by this section.
 - 6. Section 31 23 23 - Fill: Requirements for backfill to be placed by this section.
 - 7. Section 32 05 16 - Aggregates for Civil Site Improvements: Aggregate for embedment in trenches.
 - 8. Section 33 05 16 – Utility Structures: Concrete inlets and structures for storm drainage.

1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
 - 2. AASHTO M36/M36M - Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains.
 - 3. AASHTO M86 - Concrete, Sewer, Storm Drain, and Culvert Pipe.
 - 4. AASHTO M170 - Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - 5. AASHTO M196/M196M - Corrugated Aluminum Pipe for Sewers and Drains.
 - 6. AASHTO M198 - Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets.
 - 7. AASHTO M206 - Reinforced Concrete Arch Culvert Storm Drain, and Sewer Pipe.
 - 8. AASHTO M207 - Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe.
 - 9. AASHTO M252 - Corrugated Polyethylene Drainage Tubing.
 - 10. AASHTO M264 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly Vinyl Chloride (PVC) Composite Sewer Piping.
 - 11. AASHTO M278 - Class PS 50 Polyvinyl Chloride (PVC) Pipe.
 - 12. AASHTO M288 - Geotextiles.
 - 13. AASHTO M294 - Corrugated Polyethylene Pipe, 12- to 36-in Diameter.
- B. ASTM International:
 - 1. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
4. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.
5. ASTM C924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.
6. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
7. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
8. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
9. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
10. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
11. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
12. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
13. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
14. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
15. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
16. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
17. ASTM F667 - Standard Specification for Large Diameter Corrugated Polyethylene Pipe and Fittings.

1.3 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data indicating pipe, pipe accessories, and gasket material.
- C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 00 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents:
 1. Accurately record actual locations of pipe runs, connections, manholes, inlets, catch basins, and invert elevations.

ZIPP FAMILY SPORTS PARK

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with City of Austin standards and specifications.
- B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 – Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Block individual and stockpiled pipe lengths to prevent moving.
- C. Do not place pipe or pipe materials on private property or in areas obstructing pedestrian or vehicle traffic.
- D. Do not place pipe flat on ground. Cradle to prevent point stress.
- E. Store UV sensitive materials out of direct sunlight.

1.9 COORDINATION

- A. Section 01 30 00 – Administrative Requirements: Requirements for coordination.
- B. Coordinate the Work with termination of storm sewer, trenching, connection to public storm sewer or public drainage way.
- C. Coordinate unrecorded or variations in site conditions, and corresponding adjustments to construction requirements.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

- A. Reinforced Concrete Pipe: ASTM C76, Class III (or as indicated on Drawings) with Wall Type either B or C (minimum); reinforcement; tongue and groove ends.
 - 1. Fittings: Reinforced concrete; prefabricated.
 - 2. Joints: ASTM C443 rubber compression gasket.
 - 3. ASTM C990 preformed flexible joint sealant.
- B. Manufacturers of Reinforced Concrete Pipe:
 - 1. Forterra, Inc.
 - 2. Oldcastle Precast, Inc.
 - 3. Rinker Materials, Hydro Conduit, LLC
 - 4. Substitutions: Section 01 60 00 - Product Requirements.

2.2 ACCESSORIES

- A. Grout: Specified in Section 03 60 00.

2.3 DRAINAGE STRUCTURES

- A. Drainage Structures: Precast concrete or Cast-In-Place concrete manholes, junction boxes, and inlets, as specified in Section 33 05 16.
 - 1. Structures shall have cast iron covers inscribed with "STORM SEWER".

2.4 BEDDING, EMBEDMENT, AND BACKFILL MATERIALS

- A. Bedding Material: As specified in Section 31 23 17.
- B. Embedment Material: As specified in Section 31 23 17.
- C. Backfill Material: As specified in Section 31 23 17.

2.5 PIPE SUPPORTS AND ANCHORING

- A. Metal for pipe support brackets: Galvanized structural steel thoroughly coated with bituminous paint.
- B. Metal tie rods and clamps or lugs: Galvanized steel sized in accordance with NFPA 24 thoroughly coated with bituminous paint.

2.6 CONCRETE ENCASEMENT AND CRADLES

- A. Concrete as specified in Section 03 30 00.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 – Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify trench cut and bedding material is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings. Notify Engineer of discrepancies.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with coarse aggregate (compacted).
- B. Remove large stones and other hard or organic matter capable of damaging piping or impeding consistent backfilling or compacting.

3.3 EXCAVATION AND BEDDING

- A. Excavate pipe trench in accordance with Section 31 23 17. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Dewater excavations to maintain dry conditions to preserve final grades at bottom of excavation.
- C. Provide sheeting and shoring in accordance with Section 31 23 17.
- D. Place bedding material at trench bottom to a compacted depth as indicated on Drawings and in accordance with Section 31 23 17. Level materials in continuous layers not exceeding 8 inches compacted depth. Bedding material shall be the same material as the embedment.
- E. Install pipe on compacted subgrade meeting bedding requirements. Cradle bottom 20 percent of diameter to avoid point load.
- F. Compact according to requirements.
- G. Place geotextile fabric over backfill when indicated in Drawings.

3.4 INSTALLATION - PIPE

- A. RCP Pipe: Install pipe, fitting, and accessories in accordance with manufacturer's recommendations.
- B. Place pipe on minimum 6-inch-deep bedding, or as indicated in Drawings.
- C. Lay pipe to slope gradients noted on Drawings. Connect pipe to drainage structures.
- D. Install aggregate embedment at sides and over top of pipe to minimum compacted thickness of 12 inches and compact in accordance with Section 31 23 17 and as indicated on Drawings.

E. Refer to Section 31 23 17 for backfilling and compacting requirements. Do not displace or damage pipe when compacting.

F. Install Work in accordance with City of Austin standards.

3.5 INSTALLATION - DRAINAGE STRUCTURES

A. Install catch basins, inlets, junction boxes, and manholes in accordance with Section 33 05 16.

3.6 FIELD QUALITY CONTROL

A. Sections 01 40 00 – Construction Materials Testing, Section 01 45 16 – Contractor Quality Control, and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

C. Compaction Testing: In accordance with Section 31 23 17.

D. When tests indicate work does not meet specified requirements, remove work, replace and retest.

E. Frequency of Compaction Tests for Bedding, Embedment, and Backfill: In accordance with Section 31 23 17.

F. Infiltration Test: Test in accordance with ASTM 969.

G. Deflection Test (for HDPE Pipe Only): Test in accordance with Section 33 01 32.

H. Pressure Test (for Plastic Pipe Only): Test in accordance with ASTM C924 and ASTM 1103, depending on size of pipe.

3.7 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.

B. Protect pipe and aggregate embedment from damage or displacement until backfilling operation is complete.

1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.

2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION