

MIRAMAR COLLEGE
INFRASTRUCTURE AND SITE DEVELOPMENT PHASE II (SOUTH)
SCOPE "B"

100% SUBMITTAL

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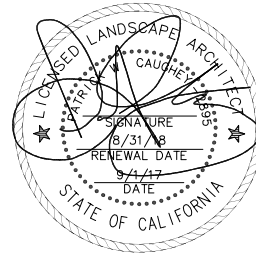
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SECTION 01 57 13

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Prevention of erosion due to construction activities.
- B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
- C. Restoration of areas eroded due to insufficient preventive measures.
- D. Performance bond.
- E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.2 REFERENCE STANDARDS

- A. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus; 2007.
- B. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 1999a (Reapproved 2014).
- C. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2011.
- D. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2008.
- E. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile; 2012.
- F. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples; 2002 (Reapproved 2009).
- G. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; current edition.

1.3 PERFORMANCE REQUIREMENTS

- A. Comply with all requirements of U.S. Environmental Protection Agency for erosion and sedimentation control, as specified for the National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2003 Construction General Permit (CGP), whether the project is required by law to comply or not.
- B. Also comply with all more stringent requirements of Erosion and Sedimentation Control Manual of the State in which the Project is located.
- C. Also comply with all more stringent requirements of State of California Erosion and Sedimentation Control Manual.
- D. Develop and follow an Erosion and Sedimentation Prevention Plan and submit periodic inspection reports.
- E. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
 - 1. Obtain and pay for permits and provide security required by authority having jurisdiction.
 - 2. Owner will withhold payment to Contractor equivalent to all fines resulting from non-compliance with applicable regulations.
- F. Provide to Owner a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.
- G. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- H. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
 - 1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
 - 2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.
- I. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 - 1. Control movement of sediment and soil from temporary stockpiles of soil.

2. Prevent development of ruts due to equipment and vehicular traffic.
 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
 - J. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 1. Prevent windblown soil from leaving the project site.
 2. Prevent tracking of mud onto public roads outside site.
 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
 - K. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - L. Open Water: Prevent standing water that could become stagnant.
 - M. Maintenance: Maintain temporary preventive measures until permanent measures have been established.
- 1.4 SUBMITTALS
- A. See Section 013000 - Administrative Requirements, for submittal procedures.
 - B. Erosion and Sedimentation Control Plan:
 1. Submit within 2 weeks after Notice to Proceed.
 2. Include:
 - a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.
 - b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.

- c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.
 - d. Schedule of temporary preventive measures, in relation to ground disturbing activities.
 - e. Other information required by law.
 - f. Format required by law is acceptable, provided any additional information specified is also included.
- 3. Obtain the approval of the Plan by authorities having jurisdiction.
- 4. Obtain the approval of the Plan by Owner.
- C. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance, repair, and corrective action required and accomplished. Include date-stamped photographs of conditions with each inspection report.
- D. Maintenance Instructions: Provide instructions covering inspection and maintenance for temporary measures that must remain after Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Bales: Air dry, rectangular straw bales.
 - 1. Cross Section: 14 by 18 inches (350 by 450 mm), minimum.
 - 2. Bindings: Wire or string, around long dimension.
- B. Bale Stakes: One of the following, minimum 3 feet (1 m) long:
 - 1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot (1.98 kg per linear m).
 - 2. Wood, 2 by 2 inches (50 by 50 mm) in cross section.
- C. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
 - 1. Average Opening Size: 30 U.S. Std. Sieve (0.600 mm), maximum, when tested in accordance with ASTM D4751.

2. Permittivity: 0.05 sec^{-1} , minimum, when tested in accordance with ASTM D4491.
 3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D4355 after 500 hours exposure.
 4. Tensile Strength: 100 lb-f (450 N), minimum, in cross-machine direction; 124 lb-f (550 N), minimum, in machine direction; when tested in accordance with ASTM D4632.
 5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D4632.
 6. Tear Strength: 55 lb-f (245 N), minimum, when tested in accordance with ASTM D4533.
 7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.
- D. Silt Fence Posts: One of the following, minimum 5 feet (1500 mm) long:
1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot (1.98 kg per linear m).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.2 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.3 SCOPE OF PREVENTIVE MEASURES

- A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.
- B. See Drawings for scope and extent of required erosion and sediment control measures.
- C. Construction Entrances: Traffic-bearing aggregate surface.
 1. Width: As required; 20 feet (7 m), minimum.
 2. Length: 50 feet (16 m), minimum.
 3. Provide at each construction entrance from public right-of-way.

4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- D. Linear Sediment Barriers: Made of silt fences.
 1. Provide linear sediment barriers:
 - a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.
 - b. Along the top of the slope or top bank of drainage channels and swales that traverse disturbed areas.
 2. Space sediment barriers with the following maximum slope length upslope from barrier:
 - a. Slope of Less Than 2 Percent: 100 feet (30 m).
 - b. Slope Between 2 and 5 Percent: 75 feet (23 m).
 - c. Slope Between 5 and 10 Percent: 50 feet (15 m).
 - d. Slope Between 10 and 20 Percent: 25 feet (7.5 m).
 - e. Slope Over 20 Percent: 15 feet (4.5 m).

3.4 INSTALLATION

- A. General: Install temporary erosion and sediment controls as indicated on Drawings.
- B. Traffic-Bearing Aggregate Surface:
 1. Excavate minimum of 6 inches (150 mm).
 2. Place geotextile fabric full width and length, with minimum 12 inch (300 mm) overlap at joints.
 3. Place and compact at least 6 inches (150 mm) of 1.5 to 3.5 inch (40 to 90 mm) diameter stone.
- C. Silt Fences:
 1. Store and handle fabric in accordance with ASTM D4873.
 2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch (405 mm) high barriers with minimum 36 inch (905 mm) long posts

spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 4 inches (100 mm) in ground.

3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch (710 mm) high barriers, minimum 48 inch (1220 mm) long posts spaced at 6 feet (1830 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet (6 m), use nominal 32 inch (810 mm) high barriers with woven wire reinforcement and steel posts spaced at 4 feet (1220 mm) maximum, with fabric embedded at least 6 inches (150 mm) in ground.
5. Install with top of fabric at nominal height and embedment as specified.
6. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches (460 mm), with extra post.
7. Fasten fabric to steel posts using wire, nylon cord, or integral pockets.
8. Wherever runoff will flow around end of barrier or over the top, provide temporary splash pad or other outlet protection; at such outlets in the run of the barrier, make barrier not more than 12 inches (300 mm) high with post spacing not more than 4 feet (1220 mm).

D. Straw Bale Rows:

1. Install bales in continuous rows with ends butting tightly, with one bale at each end of row turned uphill.
2. Install bales so that bindings are not in contact with the ground.
3. Embed bales at least 4 inches (100 mm) in the ground.
4. Anchor bales with at least two stakes per bale, driven at least 18 inches (450 mm) into the ground; drive first stake in each bale toward the previously placed bale to force bales together.
5. Fill gaps between ends of bales with loose straw wedged tightly.
6. Place soil excavated for trench against bales on the upslope side of the row, compacted.

3.5 MAINTENANCE

- A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.

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- B. Repair deficiencies immediately.
- C. Silt Fences:
 - 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 - 2. Remove silt deposits that exceed one-third of the height of the fence.
 - 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- D. Straw Bale Rows:
 - 1. Promptly replace bales that fall apart or otherwise deteriorate unless need has passed.
 - 2. Remove silt deposits that exceed one-half of the height of the bales.
 - 3. Repair bale rows that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- E. Clean out temporary sediment control structures weekly and relocate soil on site.
- F. Place sediment in appropriate locations on site; do not remove from site.

3.6 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.
- B. Clean out temporary sediment control structures that are to remain as permanent measures.
- C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

END OF SECTION

SECTION 26 05 00
BASIC ELECTRICAL REQUIREMENTS

PART I GENERAL

1.01 POWER AND CONTROL WIRING

- A. Provide power system conduit and wiring to mechanical equipment. Controls system conduit and wiring for mechanical systems is included under mechanical divisions of work. "Power" wiring includes line voltage wiring from distribution apparatus to disconnecting means provided or installed under this section, and from such disconnecting means to motors and to terminal boxes of 'package' equipment. "Controls" wiring includes wiring, regardless of voltage, which provides start-stop control for mechanical equipment and/or which is used to monitor functions of mechanical systems. Where line voltage wiring is extended from a local disconnecting means to relays, thermostats, by-pass timers, starter coils or the like, or from mechanical control panels or motor control centers to control devices, such extensions are considered "controls" wiring.

1.02 SUBMITTALS

- A. Within 30 days after award of contract, submit shop drawings, product data [coordination study] and wiring diagrams. Do not install materials or equipment until written approval has been obtained from Architect.
1. Before submitting, check submittals to ascertain that materials and equipment meet all requirements of plans and specifications and conform to structural and space conditions. Mark submittal sheets covering several types or sizes of equipment to indicate clearly specific equipment being proposed.
- B. Shop Drawings: Submit 6 sets.
1. Make shop drawings to scale, showing overall dimensions and other dimensions required for proper installation of equipment. Identify clearly each item on drawings to show piece of equipment it represents. Indicate corrosion resisting treatment and finish.
 2. Provide drawings with title block identifying project name, specification section, responsible contractor, and name of preparer.
- C. Product Data: Submit 6 copies of catalog cuts or manufacturers' data sheets. For circuit breakers, include full size (10-1/2 by 16 inch with 9-1/2 by 11 inch log-log graph) time current characteristic curves. For fuses, include minimum melting time/total clearing time characteristic curves. For panelboards, distribution panels, and distribution boards, show size, number of poles, trip rating of each circuit breaker, and circuit numbering system. For panelboards, show width of top, bottom, and side wire-ways, method of attaching circuit identification markers, characteristics of each type of circuit breaker, and details of circuit breaker locking device.
- D. Wiring Diagrams: Submit 6 sets of wiring diagrams. Schematic, line to line type, using standard symbols and with components arranged in logical sequence, so that system operation can be checked easily. Where special symbols are used or where function of components is not obvious, include suitable legend or functional guide. Number all terminals for external wiring connections on diagrams.
- E. Make submittals sufficiently complete to show compliance with specified features and standards.
- F. Coordination Study: Submit with or prior to submission of product data on affected equipment.
- G. Coordinated Installation Drawings: Show all equipment in affected space or room. Indicate required workspace. Show plan view and elevations.
- H. Field Test Reports:
1. When specified in individual specification sections, submit 3 copies of field test reports for record purposes.
 2. Indicate methods, procedures, and instruments used.
 3. Identify deficiencies discovered and corrective action taken.

1.03 OPERATING AND MAINTENANCE DATA

- A. Provide in acceptable form, 2 bound copies of operating manuals. Include:
 - 1. Where required in their respective technical sections for equipment and systems: Provide catalog cuts, functional description of operation, wiring diagrams, operating and maintenance instructions, parts lists and other data useful and necessary for complete maintenance and operation of equipment. For signal systems, also include system diagrams showing interconnections between various units, terminal markings at each unit, and schematic diagrams of each typical component, such as amplifier, power supply, tuner, etc.
 - 2. Corrected copies of all submittals.
- B. Deliver operating manuals to Architect prior to final acceptance.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

END OF SECTION

SECTION 26 05 01
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical demolition.

PART 2 PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as shown on Drawings.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
- D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
 - 1. Obtain permission from Owner at least 72 hours before partially or completely disabling system.
 - 2. Make temporary connections to maintain service in areas adjacent to work area.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- D. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Single conductor building wire.
- B. Wiring connectors.
- C. Electrical tape.
- D. Heat shrink tubing.
- E. Oxide inhibiting compound.
- F. Wire pulling lubricant.
- G. Cable ties.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 01 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
 - 2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- B. Field Quality Control Test Reports.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- D. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.05 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- I. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- J. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 100: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.
 - 2. Control Circuits: 14 AWG.
- K. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- L. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. Equipment Ground, All Systems: Green.

- d. Isolated Ground, All Systems: Green with yellow stripe.
- e. Travelers for 3-Way and 4-Way Switching: Pink.
- f. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
- g. For control circuits, comply with manufacturer's recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Conductor Stranding:
 - 1. Feeders and Branch Circuits:
 - a. Size 10 AWG and Smaller: Solid.
 - b. Size 8 AWG and Larger: Stranded.
 - 2. Control Circuits: Stranded.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below, rated 90 degree C.
 - a. Installed Underground: Type XHHW-2.
 - b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors or compression connectors.
- C. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
 - 4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
 - 5. Copper Conductors Size 8 AWG and Larger: Use compression connectors where connectors are required.
 - a. Provide compression type, long barrel, double-hole, copper-type lugs (2 crimp minimum) for all power and grounding connections landed on bus.
 - 6. Conductors for Control Circuits: Use crimped terminals for all connections.
- D. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- E. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F (105 degrees C) for standard applications and 302 degrees F (150 degrees C) for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
- F. Mechanical Connectors: Provide bolted type or set-screw type.
 - 1. Manufacturers:
 - a. IlSCO: www.ilsco.com.

- b. Thomas & Betts Corporation: www.tnb.com.
- G. Compression Connectors: Provide circumferential type or hex type crimp configuration with inspection port.
 - 1. Manufacturers:
 - a. IlSCO: www.ilSCO.com.
 - b. Thomas & Betts Corporation: www.tnb.com.
- H. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.

2.05 WIRING ACCESSORIES

- A. Electrical Tape:
 - 1. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
 - 2. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
 - 3. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
 - 4. Varnished Cambric Electrical Tape: Cotton cambric fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil (0.18 mm); suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
 - 5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
 - 1. Manufacturers:
 - a. 3M: www.3m.com.
 - b. Thomas & Betts Corporation: www.tnb.com.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
 - 1. Manufacturers:
 - a. Ideal Industries, Inc: www.idealindustries.com.
 - b. IlSCO: www.ilSCO.com.
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as shown on the drawings.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
 - 3. Arrange circuiting to minimize splices.
 - 4. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 - 5. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among up to three single phase branch circuits of different phases installed in the same raceway is permitted where not otherwise prohibited, except for the following:
 - a. Branch circuits fed from ground fault circuit interrupter (GFCI) circuit breakers.
 - b. Branch circuits fed from feed-through protection of GFI receptacles.
 - c. Branch circuits with dimming controls.
 - d. Branch circuits with isolated grounding conductor.
 - 6. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
- D. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- E. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- G. Install conductors with a minimum of 12 inches (300 mm) of slack at each outlet.
- H. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet (1.5 m) of slack.
- I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.
- J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

- K. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies..
- L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- M. Insulate ends of spare conductors using vinyl insulating electrical tape.
- N. Identify conductors and cables in accordance with Section 26 05 53.
- O. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
 - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Ground enhancement material.
- G. Ground access wells.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
 - 1. Includes oxide inhibiting compound.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03 REFERENCE STANDARDS

- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System; 2012.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2007.
- D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- B. Field quality control test reports.
- C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
 - 3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- F. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet (3.0 m) at an accessible location not more than 5 feet (1.5 m) from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Metal In-Ground Support Structure:
 - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
 - 4. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet (6.0 m) of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
 - 5. Ground Ring:

- a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches (750 mm).
- b. Where location is not indicated, locate ground ring conductor at least 24 inches (600 mm) outside building perimeter foundation.
- c. Provide ground enhancement material around conductor where indicated.
- d. Provide connection from ground ring conductor to:
 - 1) Perimeter columns of metal building frame.
 - 2) Ground rod electrodes located as indicated.
6. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet (3.0 m) from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet (1.5 m) outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 - d. Provide ground enhancement material around electrode where indicated.
 - e. Provide ground access well for each electrode.
7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
 - a. Ground Bar Size: 1/4 by 4 by 12 inches (6 by 100 by 300 mm) unless otherwise indicated or required.
 - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
 - c. Ground Bar Mounting Height: 18 inches (450 mm) above finished floor unless otherwise indicated.
9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.
- G. Service-Supplied System Grounding:
 1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
 2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- H. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
 1. Provide grounding electrode system for each separate building or structure.
 2. Provide equipment grounding conductor routed with supply conductors.
 3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
 4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- I. Separately Derived System Grounding:
 1. Separately derived systems include, but are not limited to:
 - a. Transformers (except autotransformers such as buck-boost transformers).
 - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
 - c. Generators, when neutral is switched in the transfer switch.

2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
 3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
 4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
 5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
 6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
 7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- J. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
- K. Communications Systems Grounding and Bonding:
1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
 - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
 - b. Raceway Size: 3/4 inch (21 mm) trade size unless otherwise indicated or required.
 - c. Ground Bar Size: 1/4 by 4 by 12 inches (6 by 100 by 300 mm) unless otherwise indicated or required.
 - d. Ground Bar Mounting Height: 18 inches (450 mm) above finished floor unless otherwise indicated.
- L. Pole-Mounted Luminaires: Also comply with Section 26 56 00.

2.02 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
 - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 - 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
 - 1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
- C. Connectors for Grounding and Bonding:
 - 1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 - 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 - 3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
- D. Ground Bars:
 - 1. Description: Copper rectangular ground bars with mounting brackets and insulators.
 - 2. Size: As indicated.
 - 3. Holes for Connections: As indicated or as required for connections to be made.
- E. Ground Rod Electrodes:
 - 1. Comply with NEMA GR 1.
 - 2. Material: Copper-bonded (copper-clad) steel.
 - 3. Size: 3/4 inch (19 mm) diameter by 10 feet (3.0 m) length, unless otherwise indicated.
 - 4. Where rod lengths of greater than 10 feet (3.0 m) are indicated or otherwise required, sectionalized ground rods may be used.
- F. Ground Enhancement Material:
 - 1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
- G. Ground Access Wells:
 - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
 - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
 - a. Round Wells: Not less than 8 inches (200 mm) in diameter.
 - b. Rectangular Wells: Not less than 12 by 12 inches (300 by 300 mm).
 - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches (250 mm).
 - 4. Cover: Factory-identified by permanent means with word "GROUND".
- H. Oxide Inhibiting Compound: Comply with Section 26 05 19.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
 - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches (150 mm) below finished grade.
 - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches (100 mm) of top of rod exposed.
- D. Make grounding and bonding connections using specified connectors.
 - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
 - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
 - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL

- A. Inspect and test in accordance with NETA ATS except Section 4.
- B. Perform inspections and tests listed in NETA ATS, Section 7.13.
- C. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- D. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Underground warning tape.
- E. Warning signs and labels.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.03 REFERENCE STANDARDS

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2011.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 969 - Marking and Labeling Systems; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

1.07 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature is lower than recommended by manufacturer.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - a. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.

- 3) Identify power source and circuit number. Include location when not within sight of equipment.
- 4) Use identification nameplate to identify main overcurrent protective device.
- 5) Use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
- b. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces using pencil.
- c. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location when not within sight of equipment.
 - 4) Identify load(s) served. Include location when not within sight of equipment.
- d. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location when not within sight of equipment.
2. Service Equipment:
 - a. Use identification nameplate to identify each service disconnecting means.
 - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
 - a. Use identification nameplate to identify emergency system equipment in accordance with NFPA 70.
 - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
4. Use identification label to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
6. Use identification label at each fused switch to identify required NEMA fuse class and size.
7. Use identification label at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
8. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
9. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
 - a. Service equipment.
 - b. Industrial control panels.
 - c. Motor control centers.
 - d. Elevator control panels.
 - e. Industrial machinery.

10. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
 11. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.
- B. Identification for Conductors and Cables:
1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
 5. Use underground warning tape to identify direct buried cables.
- C. Identification for Boxes:
1. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
 - a. For exposed boxes in public areas, provide identification on inside face of cover.
- D. Identification for Devices:
1. Use identification label to identify fire alarm system devices.
 2. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
 3. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
 4. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Materials:
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
 2. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch (1.6 mm); engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch (3 mm) when any dimension is greater than 4 inches (100 mm).
 3. Stainless Steel Nameplates: Minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
 4. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch (0.8 mm); engraved or laser-etched text.
 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch (25 mm) high; Four, located at corners for larger sizes.

- B. Identification Labels:
1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
 - a. Use only for indoor locations.
 2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch (25 mm) by 2.5 inches (64 mm).
 2. Legend:
 - a. System designation where applicable:
 - 1) Emergency Power System: Identify with text "EMERGENCY".
 - 2) Fire Alarm System: Identify with text "FIRE ALARM".
 - b. Equipment designation or other approved description.
 - c. Other information as indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height:
 - a. System Designation: 1/2 inch (13 mm).
 - b. Equipment Designation: 1/4 inch (6 mm).
 - c. Other Information: 1/8 inch (3 mm).
 - d. Exception: Provide minimum text height of 1 inch (25 mm) for equipment located more than 10 feet (3.0 m) above floor or working platform.
 5. Color:
 - a. Normal Power System: White text on black background.
 - b. Emergency Power System: White text on red background.
 - c. Fire Alarm System: White text on red background.
- D. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches (51 mm) by 4 inches (100 mm).
 2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 1/2 inch (13 mm).
 5. Color: Black text on yellow background unless otherwise indicated.
- E. Format for Receptacle Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
 2. Legend: Power source and circuit number or other designation indicated.
 - a. Include voltage and phase for other than 120 V, single phase circuits.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch (5 mm).
 5. Color: Black text on clear background.
- F. Format for Control Device Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
 2. Legend: Load controlled or other designation indicated.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch (5 mm).
 5. Color: Black text on clear background.
- G. Format for Fire Alarm Device Identification:
1. Minimum Size: 3/8 inch (10 mm) by 1.5 inches (38 mm).
 2. Legend: Designation indicated and device zone or address.
 3. Text: All capitalized unless otherwise indicated.
 4. Minimum Text Height: 3/16 inch (5 mm).
 5. Color: Red text on white background.

2.03 WIRE AND CABLE MARKERS

- A. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
- B. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- C. Legend: Power source and circuit number or other designation indicated.
- D. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
 - 1. Do not use handwritten text.
- E. Minimum Text Height: 1/8 inch (3 mm).
- F. Color: Black text on white background unless otherwise indicated.

2.04 UNDERGROUND WARNING TAPE

- A. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.
- B. Foil-backed Detectable Type Tape: 3 inches (76 mm) wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:
 - 1. Tape for Buried Power Lines: Black text on red background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

2.05 WARNING SIGNS AND LABELS

- A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
- B. Warning Signs:
 - 1. Materials:
 - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
 - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
 - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
 - 3. Minimum Size: 7 by 10 inches (178 by 254 mm) unless otherwise indicated.
- C. Warning Labels:
 - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
 - a. Do not use labels designed to be completed using handwritten text.
 - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
 - 3. Minimum Size: 2 by 4 inches (51 mm by 102 mm) unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Enclosure front.

3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 4. Elevated Equipment: Legible from the floor or working platform.
 5. Branch Devices: Adjacent to device.
 6. Interior Components: Legible from the point of access.
 7. Boxes: Outside face of cover.
 8. Conductors and Cables: Legible from the point of access.
 9. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
 - D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
 - E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
 - F. Install underground warning tape above buried lines with one tape per trench at 3 inches (75 mm) below finished grade.
 - G. Secure rigid signs using stainless steel screws.
 - H. Mark all handwritten text, where permitted, to be neat and legible.

3.03 FIELD QUALITY CONTROL

- A. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior luminaires.
- B. Ballasts.
- C. Lamps.
- D. Poles and accessories.
- E. Luminaire accessories.

1.02 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

- A. AASHTO LTS - Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals; American Association of State Highway and Transportation Officials; 6th Edition, with 2015 Interim Revisions.
- B. IEEE C2 - National Electrical Safety Code; 2012.
- C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2010.
- E. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2006.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

- A. Shop Drawings:
 - 1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
 - 2. Provide photometric calculations where luminaires are proposed for substitution with substitution request.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
 - 1. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
 - 2. Lamps: Include rated life and initial and mean lumen output.
 - 3. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

- C. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
- D. Field Quality Control Reports.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
- F. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- G. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.06 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
- H. Exposed Hardware: Stainless steel.

2.03 BALLASTS

- A. Manufacturers:
 1. General Electric Company/GE Lighting www.gelighting.com.
 2. Osram Sylvania: www.sylvania.com.
 3. Philips Lighting Electronics/Advance: www.advance.philips.com.
 4. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.
 5. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
- B. Ballasts/Drivers - General Requirements:
 1. Provide ballasts containing no polychlorinated biphenyls (PCBs).

2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.04 LAMPS

- A. Manufacturers:
 1. General Electric Company/GE Lighting; _____: www.gelighting.com.
 2. Osram Sylvania; _____: www.sylvania.com.
 3. Philips Lighting Company; _____: www.lighting.philips.com.
 4. Manufacturer Limitations: Where possible, provide lamps produced by a single manufacturer.
 5. Where a specific manufacturer or model is indicated elsewhere in the luminaire schedule or on the drawings, substitutions are not permitted unless explicitly indicated.
- B. Lamps - General Requirements:
 1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
 2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
 3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
 4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

2.05 POLES

- A. All Poles:
 1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
 2. Structural Design Criteria:
 - a. Comply with AASHTO LTS.
 - b. Wind Load: Include effective projected area (EPA) of luminaire(s) and associated supports and accessories to be installed.
 - 1) Design Wind Speed: _____ miles per hour (_____ kph), with gust factor of 1.3.
 - c. Dead Load: Include weight of proposed luminaire(s) and associated supports and accessories.
 - d. Include structural calculations demonstrating compliance with submittals.
 3. Mounting: Install on concrete foundation, height as indicated on the drawings, unless otherwise indicated.
 4. Unless otherwise indicated, provide with the following features/accessories:
 - a. Top cap.
 - b. Handhole, 11" x 17" size.
 - c. Anchor bolts with leveling nuts or leveling shims.
 - d. Anchor base cover.
- B. Metal Poles: Provide ground lug, accessible from handhole.

2.06 ACCESSORIES

- A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
- B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
- C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.

- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
- B. Install products according to manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
- D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- E. Pole-Mounted Luminaires:
 - 1. Maintain the following minimum clearances:
 - a. Comply with IEEE C2.
 - b. Comply with utility company requirements.
 - 2. Foundation-Mounted Poles:
 - a. Provide cast-in-place concrete foundations for poles as indicated.
 - 1) Install anchor bolts plumb per template furnished by pole manufacturer.
 - 2) Position conduits to enter pole shaft.
 - b. Install foundations plumb.
 - c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - d. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
 - f. Install anchor base covers or anchor bolt covers as indicated.
 - 3. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - b. Provide supplementary ground rod electrode as specified in Section 26 05 26 at each pole bonded to grounding system as indicated.
 - 4. Install separate service conductors, size as indicated on drawings, from each luminaire down to handhole for connection to branch circuit conductors.
- F. Install accessories furnished with each luminaire.
- G. Bond products and metal accessories to branch circuit equipment grounding conductor.
- H. Install lamps in each luminaire.

3.04 FIELD QUALITY CONTROL

- A. Inspect each product for damage and defects.
- B. Operate each luminaire after installation and connection to verify proper operation.
- C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

- B. Luminaires with Field-Rotatable Optics: Position optics according to manufacturer's instructions to achieve lighting distribution as indicated or as directed by Architect.

3.06 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES

- A. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 31 00 00

EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, artificial turf and plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for concrete slabs-on-grade.
4. Subbase course for concrete walks and pavements.
5. Subbase course and base course for asphalt paving.
6. Excavating and backfilling for utility trenches.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Construction Manager. Authorized

additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Construction Manager. Unauthorized excavation, as well as remedial work directed by Construction Manager, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.

B. Do not commence earth moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

1.5 GEOTECHNICAL REPORT

A. Geotechnical Evaluation; Proposed Science And Mathematics Building; Southwestern College, Chula Vista, California; prepared by Ninyo & Moore, 5710 Ruffin Road, San Diego, CA, 92123; dated January 30, 2015; Project No. 107763001

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. Approved borrow soils shall be determined by project Geotechnical Consultant.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Refer to project Geotechnical Consultant for additional requirements for satisfactory soils.
 - 1. Expansion Index: 50 max
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- F. General Site Fill (Engineered Fill): Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve, 70% passing through a ¾-inch sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve. No objects greater than 3” in diameter.
- G. Select Fill – Granular material exhibiting a very low to low expansion potential (an expansion index of 50 or less as evaluated by the ASTM Test Method D 4829). See Geotechnical Report for additional information and requirements. At least 70% passing through a ¾-inch sieve. No objects greater than 3” in diameter.
- H. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- I. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.

2.2 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
 - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

3.3 REMEDIAL GRADING

- A. Remedial grading is required to mitigate the effects of potentially compressible fill existing on the project site. Existing fill requires excavation to the depths described below. Excavated material can be processed/mixed as needed to produce fill materials that meet required criteria for usage on this project.

1. For Building Improvements, remedial grading is required to a depth of surficial materials, as determined by the geotechnical representative. Fill material shall be Select Fill per project geotechnical report.
2. For Building Improvements Spanning the Cut/Fill Transition, remedial grading is required 5 feet below pad grade, or 1/3 depth of the deepest fill, whichever is deeper. Fill material shall be Select Fill per project geotechnical report.
3. For Retaining Walls > 4', remedial grading is required to a depth of 3 feet below bottom of footing. Fill material shall be Select Fill per project geotechnical report.
4. For Concrete Flatwork and Vehicular Pavements, remedial grading is required to a depth of 1 foot below subgrade. Fill material shall be Select Fill per project geotechnical report.

3.4 EXCAVATION FOR STRUCTURES

- A. Excavate to indicate elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 2. The existing fill below the planed building shall be excavated in its entirety. Additionally, clayey materials shall be excavated to a depth of three feet below footing bottom levels in structure areas. The excavation shall extend five feet beyond the perimeter of the footing or up to existing improvements whichever is less. Material with an expansion index less than 50 shall be placed within upper five feet of the pad grade on building and five feet beyond pad.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.5 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.
- B. Existing fill shall be removed and replaced with select fill to a depth of 1 foot below top of proposed subgrade. The excavation shall extend two feet beyond the perimeter of the

hardscape or up to existing improvements, whichever is less. Material with an expansion index of less than 50 shall be used in upper three feet of subgrade and two feet beyond paved and hardscaped areas.

3.6 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches (300 mm) higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: 8 inches (203 mm) each side of pipe or conduit.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 - 1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material, 6 inches (150 mm) deeper elsewhere, to allow for bedding course.
- D. Trenches in Tree- and Plant-Protection Zones:
 - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
 - 2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
 - 3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.7 SUBGRADE INSPECTION

- A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Reconstruct subgrades damaged by rain, accumulated water, or construction activities, as directed by Construction Manager, without additional compensation.

3.8 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Construction Manager.
 - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Construction Manager.

3.9 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.10 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 36 inches (900 mm) of bottom of footings with satisfactory, General Site Fill; fill with concrete to elevation of bottom of footings. Concrete is specified in "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 6 inches (50 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in "Cast-in-Place Concrete."
- E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.11 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Under footings and foundations, use engineered fill.

3.12 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 60 inches (1500 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and recompact top 24 inches (600 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.

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3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 90 percent.

3.14 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Rough Grading: Slope grades to direct water away from buildings at a minimum of 2% to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
 2. Walks: Plus or minus 1 inch (25 mm).
 3. Pavements: Plus or minus 1/4 inch (8 mm).
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/4 inch (8 mm) when tested with a 10-foot (3-m) straightedge.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 1. Shape subbase course and base course to required crown elevations and cross-slope grades.
 2. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
 3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.16 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.

- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 - 1. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
 - 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Construction Manager.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping or sealing site utilities.
7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

- ###### A.
- Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

- ###### A. Traffic:
- Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- ###### B. Salvable Improvements:
- Carefully remove items indicated to be salvaged and store on construction premises.

- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- E. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Foot traffic.
 - 4. Erection of sheds or structures.
 - 5. Impoundment of water.
 - 6. Excavation or other digging unless otherwise indicated.
 - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
 - 1. Obtain approved borrow soil material per project geotechnical recommendations off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Construction Manager.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Construction Manager not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Construction Manager's written permission.
- C. Removal of underground utilities is included in earthwork sections and with applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security and utilities sections and Section 024116 "Structure Demolition" and Section 024119 "Selective Structure Demolition."

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
 - 2. Use only hand methods for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Section 310000 "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material, from manufacturer.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by Caltrans.
- B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Standard Specifications of Caltrans for asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- C. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
 - 1. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
 - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
 - 3. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials and 55 deg F (12.8 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- B. Fine Aggregate: ASTM D 1073, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
- C. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 70-22.
- B. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
 - 1. Color: As indicated.
- C. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
 - 1. Color: As indicated.
- D. Glass Beads: AASHTO M 247, Type 1.

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: $\frac{3}{4}$ inch open graded.
 - 3. Surface Course: $\frac{1}{2}$ inch medium.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
 - 1. Mill to a depth of 2 inches (50 mm). Ensure existing pavement section still has a minimum **1.5 inches** (38 mm) after mill has been complete.

3.3 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.
 - 1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.5 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 1. Spread mix at minimum temperature of 250 deg F (121 deg C).
 2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 1. Clean contact surfaces and apply tack coat to joints.
 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
 3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 1. Base Course: Plus or minus 1/2 inch (13 mm).
 2. Surface Course: Plus 1/4 inch (6 mm), no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
 1. Base Course: 1/4 inch (6 mm).
 2. Surface Course: 1/8 inch (3 mm).
 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3.9 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Construction Manager.
- B. Contractor shall apply three coats of paint. First coat shall be performed a minimum of 72 hours after paving:
- C. Allow paving to age for 30 days before starting second pavement marking.
- D. Sweep and clean surface to eliminate loose material and dust.
- E. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
 - 1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).
- F. Contractor shall apply second coat after 90 days.
- G. Accessible parking spaces serving a particular building or facility shall be located on the shortest accessible route to an entrance complying with CBC Section 11B-206.4
- H. Accessible parking spaces serving more than one accessible entrance shall be dispersed and located on the shortest accessible route to the accessible entrances.
- I. Accessible parking spaces in a parking facility not serving a particular building or facility shall be located on the shortest accessible route to an accessible pedestrian entrance of the parking facility. CBC Section 11B-208.3.1
- J. Minimum number of required accessible parking spaces shall be provided in accordance with CBC Table 11B-208.2 for each parking facility provided on a site.
- K. For every six or fraction of six accessible parking spaces, at least one shall be an accessible van parking space. CBC Section 11B-208.2.4
- L. Accessible parking spaces and access aisles shall comply with CBC Section 11B-502 and shall be dimensioned to the centerline of the marked lines as follows:
 - 1. Parking spaces and access aisles shall be marked according to CBC Figures 11B-502.2, 11B-502.3., and 11B-502.3.3. Their surfaces shall comply with CBC Section 11B-302 and shall be at the same level with slopes not steeper than 1:48 in any direction. CBC Section 11B-502.4
 - 2. Parking spaces shall be 9'x18' minimum and van parking spaces shall be 12'x18' minimum with an adjacent access aisle of 5'x18' minimum. Access aisles shall be placed on either side of the parking spaces except be located on the passenger side for van parking spaces.

Van parking spaces shall be permitted to be 9'x18' minimum where the access aisle is 8'x18' minimum.

3. Access aisles shall be marked by a blue painted borderline around their perimeter. The area within the blue borderlines shall be marked with hatched lines a maximum of 36" on center in a color contrasting with that of the aisle surface, preferably blue or white. Access aisles markings may extend beyond the minimum required length. CBC Section 11B-502.3.3
4. Access aisles (accessible parking spaces as well – similar application) shall not overlap the vehicular way. CBC Section 11B-502.3.4
5. A Vertical clearance of 8'-2" minimum shall be provided for accessible parking spaces, access aisles, and vehicular routes serving them. CBC Section 11B-502

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.11 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

1. Section Includes:
 1. Curbs and gutters.
 2. Walks.
 3. Precast Concrete Detectable Warning Pavers

1.2 ACTION SUBMITTALS

1. Product Data: For each type of product indicated.
2. LEED Submittals:
 1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
3. Samples: For each exposed product and for each color and texture specified.
4. Other Action Submittals:
 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

1. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
2. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
3. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
4. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
5. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
6. Deformed-Steel Wire: ASTM A 496/A 496M.
7. Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
8. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

1. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
 1. Portland Cement: ASTM C 150, gray portland cement Type II/ Type V. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
 2. Blended Hydraulic Cement: ASTM C 595, Type IP, portland-pozzolan cement.
2. Normal-Weight Aggregates: ASTM C 33, conforming to Section 201 of Standard Specifications for Public Works uniformly graded. Provide aggregates from a single source.
3. Water: Potable and complying with ASTM C 94/C 94M.

4. Air-Entraining Admixture: ASTM C 260.
5. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
6. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
 1. Color: As indicated by manufacturer's designation and as selected by Architect from manufacturer's full range.
7. Portland cement concrete paving shall be stable, firm, and slip resistant and shall comply with CBC Section 11B-302 and 11B-403.

2.3 PRECAST CONCRETE DETECTABLE WARNING PAVERS

1. Division of the State Architect (DSA/Access Compliance) approved products shall be used, in conformance with CBC Section 11B-705.
2. Dimensions: Dimensioned, pre-cast units as indicated on drawings.
3. Colors: Contrasting integral color as indicated on drawings.

2.4 FIBER REINFORCEMENT

1. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.

2.5 CURING MATERIALS

1. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Water: Potable.
4. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

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6. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.6 RELATED MATERIALS

1. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
2. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

2.7 CONCRETE MIXTURES

1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), with the following properties:
 1. Compressive Strength (28 Days): **3000 psi (20.7 MPa).**
 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
 3. Slump Limit: **4 inches (100 mm)**, plus or minus 1 inch (25 mm).
 4. Air Content: 3 percent plus or minus 1.5 percent.
2. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
3. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than **1.0 lb/cu. yd. (0.60 kg/cu. m).**
4. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions.

2.8 CONCRETE MIXING

1. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

2.9 DETECTABLE WARNING SURFACES

1. Detectable warning surfaces shall comply with CBC Section 11B-705.1
2. Detectable warning surfaces at transit boarding platform edges, bus stops, hazardous vehicular areas, reflecting pool, and track crossings shall be yellow and approximate FS 33538 of Federal

Standard 595C. Detectable warning surfaces at other locations shall be either the aforementioned yellow or a color providing a 70 percent minimum visual contrast with that of adjacent walking surfaces. The material used to provide visual contrast shall be an integral part of the surface. CBC Section 11B-705.1.1.3

3. Detectable warning surfaces shall differ from adjoining surfaces in resiliency or sound-on-cane contact. Such constraint shall not be required for detectable warning surfaces at curb ramps, islands, or cut-through medians. CBC Section 11B-705.1.1.4
4. Provide minimum 5 year warranty per DSA Bulletin 10.31.02, revised 04/09/08.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

1. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
2. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
2. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving:
5. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a **1/4-inch (6-mm)** radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

1. Moisten subbase to provide a uniform dampened condition at time concrete is placed.
2. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, placing, and consolidating concrete.
3. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
4. Screed paving surface with a straightedge and strike off.
5. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

1. General: Do not add water to concrete surfaces during finishing operations.
2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.
3. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.
 1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
 2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.7 DETECTABLE WARNINGS

1. Blockouts: Form blockouts in concrete for installation of detectable paving units.
 1. Tolerance for Opening Size: Plus 1/4 inch, no minus.

3.8 CONCRETE PROTECTION AND CURING

1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.
3. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
5. Curing Methods: Cure concrete by moisture-retaining-cover curing.

3.9 PAVING TOLERANCES

1. Comply with tolerances in ACI 117 and as follows:
 1. Elevation: 3/4 inch (19 mm).
 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).

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3. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/2 inch (13 mm).
4. Joint Spacing: 3 inches (75 mm).
5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
6. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.10 REPAIRS AND PROTECTION

1. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Construction Manager.
2. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
3. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.
4. All improvements have been designed to the following:
 1. Concrete plazas have been designed to be less than 2% in any direction.
 2. Concrete walkways have been designed to be less than 5 percent in the direction of travel with a cross slope not to exceed 1.5%.
 3. Concrete ramps have been designed to not exceed 8.33% in the direction of travel, with a cross slope not to exceed 1.5%.
5. All improvements that are constructed that do not comply with requirements herein shall be removed and replaced at the contractor's expense.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

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. Cold-applied joint sealants.
 - 2. Hot-applied joint sealants.

- B. Related Sections:

- 1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
 - 2. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

- 1. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
 - 2. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
 - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
 - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
 - 5. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for

compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.4 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Pavement-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each type of joint sealant and accessory, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.
- D. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Preinstallation Conference: Conduct conference at Project site.

1.7 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crafco Inc., an ERGON company; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Pecora Corporation; 301 NS.

- d. Or Equal.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crafcro Inc., an ERGON company; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Pecora Corporation; 300 SL.
 - d. Or Equal.
- C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Pecora Corporation; Urexpan NR-200.
 - b. Sika Corporation; Sikaflex-2c SL
 - c. Or Equal.

2.3 HOT-APPLIED JOINT SEALANTS

- A. Hot-Applied, Single-Component Joint Sealant for Concrete: ASTM D 3406.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crafcro Inc., an ERGON company; Superseal 444/777.
 - b. Or Equal.
- B. Hot-Applied, Single-Component Joint Sealant for Concrete and Asphalt: ASTM D 6690, Types I, II, and III.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Meadows, W. R., Inc.; Sealtight Hi-Spec.
 - b. Right Pointe; D-3405 Hot Applied Sealant.

- c. Or Equal.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- E. Control Joint System: Basis-of-Design Product: WR Meadows; “SNAP-CAP” or comparable product.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior

experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. Remove excess joint sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application: Joints within cement concrete pavement.
 - 1. Joint Location:
 - a. Expansion and isolation joints in cast-in-place concrete pavement.
 - b. Contraction joints in cast-in-place concrete slabs.
 - c. Other joints as indicated.
 - 2. Silicone Joint Sealant for Concrete: Single component, self-leveling.
 - 3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
 - 4. Hot-Applied Joint Sealant for Concrete: Single component.
 - 5. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement <PJS-#>.
 - 1. Joint Location:
 - a. Joints between concrete and asphalt pavement.
 - b. Joints between concrete curbs and asphalt pavement.
 - c. Other joints as indicated.
 - 2. Hot-Applied Joint Sealant for Concrete and Asphalt: Single component.

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3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION

SECTION 32 33 13- CEMENT CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 GENERAL CONDITIONS

- A. Requirements of "Contract Documents, General, and Technical Provisions" and "General Provisions," apply to work in this Section with same force and effect as though repeated in full herein.

1.2 SCOPE OF WORK

- A. Furnish materials, labor, transportation, services, and equipment necessary to install Portland cement concrete paving as indicated on Drawings and as specified herein.
- B. Work included in this Section:
 - 1. Formwork.
 - 2. Reinforcing steel and dowels.
 - 3. Architectural concrete placement.

1.3 REFERENCES

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- B. ACI 304R - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- C. ACI 305R - Hot Weather Concreting.
- D. ACI 306R - Cold Weather Concreting.
- E. ACI 309R - Guide for Consolidation of Concrete.
- F. ASTM A 615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
- G. ASTM C 31 - Standard Specification for Making and Curing Concrete Test Specimens in the Field.
- H. ASTM C 33 - Standard Specification for Concrete Aggregates.
- I. ASTM C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
- J. ASTM C 94 - Standard Specification for Ready Mix Concrete.

- K. ASTM C 150 - Standard Specification for Portland Cement.
- L. ASTM C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
- M. ASTM C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- N. ASTM C 494 - Standard Specification for Chemical Admixtures for Concrete.
- O. ASTM C 1064 - Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
- P. L. M. Scofield Tech-Data Bulletin D-203 – Application of Surface Retarder (for retardant finished concrete).

1.4 SYSTEM DESCRIPTION

- A. Reproduction of paving surfaces includes texture, color, and jointing.

1.5 SUBMITTALS

- A. In accordance with Contract Documents, General, and Technical Provisions and General Provisions.
- B. Paving Mix Designs: Provide documentation for each paving type specified on Drawings:
 - 1. Laboratory and Cement Test Reports: Submit six (6) copies of laboratory test reports for concrete materials and a certificate with each concrete mixer truck, stating mix design, PSI rating, slump, water and cement quantity, cement/water ratio, fine and coarse aggregate and color additives.
 - 2. Cement:
 - a. Manufacturer and plant location.
 - b. Cement type, i.e. Type I, II, III, or V.
 - 3. Admixtures:
 - a. Manufacturer and plant location.
 - 4. Sand:
 - a. Source and type.
 - 5. Aggregates:
 - a. Source and type.
 - 6. Signed certification from a licensed structural engineer.
- C. Certification that Owner's Representative's mock-up has been reviewed and that materials and processes provided, will achieve intended effects indicated on Owner's Representative's mock-up.

- D. Shop drawings:
 - 1. Indicate paving joints and scoring for cement concrete pavement areas on copies of plan view Drawings.
 - 2. Notate additions/deletions/recommendations/deviations from Drawings.
 - 3. Submit six (6) copies at same scale of full-size Drawings
- E. Submit specification data “Cut Sheets” for integral color, color hardener, release agent, plastic dowel sleeves, chemical stain, curing agents, and clear sealers.
- F. Products: Submit one pound samples, clearly identified, for each component used to prepare each paving type, including but not limited to, cement, sand, aggregate, coloring pigment, release agents, and chemical stains.

1.6 QUALITY ASSURANCE

- A. Pre-Bid Conference: Prior to submitting bid, attend pre-bid conference with Owner’s Representative to review Owner’s Representative mock-up and to review requirements and artistic effect desired.
- B. Contractor Mock-Ups:
 - 1. Contractor shall prepare 4 x 4-foot mock-ups for each paving type indicated on Drawings, prior to installation.
 - 2. Mock-ups shall be completed to the satisfaction of the Architect, Landscape Architect, and City including aggregates, texture, color, and finishes.
 - 3. Mock-ups shall be poured no less than 7 days prior to inspection by the Architect, Landscape Architect and City. Any mock-up which has not dried for 7 days will not be inspected due to potential color variations from not being dry.
 - 4. These mock-ups will become the standard of quality by which future paving samples and work will be judged.
 - 5. Mock-ups to remain on-site and be protected during the course of construction, as a means to compare work in progress.
 - 6. If mock-ups are damaged or removed, Contractor shall repair/replace in-kind immediately.
- C. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
- D. Installer: Provide evidence to indicate successful experience in providing patterned concrete work similar to that specified herein and can demonstrate successful experience through past project documentation and references.
 - 1. Experience: Minimum 5 years experience in the installation of patterned concrete paving.
 - 2. Demonstration of Experience: 10 projects which have been completed within the past 36 months utilizing similar products, scope, and complexity.

3. Supervision: Perform placement and finishing of concrete work under supervision of a person having a minimum of 5 years of experience in placement and finishing of products specified herein.
 4. Submit qualifications to Owner’s Representative for information purposes. Submit a resume of Project Manager and Superintendent who will be overseeing the Work.
- E. Slip Resistance: Provide a finish surface slip resistance coefficient of friction equal or greater than 0.6 for flat surfaces and 0.8 for ramps, when tested in accordance with ASTM F 489.

1.7 SITE OBSERVATIONS

- A. Site observations herein specified shall be made by the Landscape Architect during regular business hours. The Contractor shall be on the site at the time of each observation. The Contractor shall notify the Landscape Architect of a site observation at least three (3) business days in advance of an observation.
- B. All changes and deviations to the plans and specifications shall be communicated to the Construction Manager, and shall be confirmed in writing.
- C. The Contractor shall have sufficient work personnel available during normal working hours to correct deficiencies immediately upon request of the Landscape Architect. Such repair or re-work services are to be performed without interference of regular project schedule.
- D. Site observations will be required for the following parts of work:
 1. Pre-Construction Meeting - Immediately prior to the commencement of work of this section, the Owner’s Representative, Contractor, and Landscape Architect shall meet for the approval of the materials specified, equipment, schedule of work and the method of installation.
 2. Layout of concrete forms shall be reviewed and approved by the Landscape Architect prior to pouring the concrete.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store materials in dry and protected locations and protect from damage.
- B. Do not change brand of cement nor source of aggregate during course of Work.

1.9 SITE CONDITIONS

- A. Do not place concrete when subbase surface temperature is less than 40 degrees F, nor when surface is wet.

1.10 COORDINATION

- A. In accordance with Section 01041 - Project Coordination.

- B. Ensure that irrigation sleeves, electrical conduit, food cart outlets and other utility elements are accommodated and as-built located prior to pouring concrete.

1.11 INSPECTION OF SITE

- A. Verify conditions at site that affect Work of this Section, and take field measurements as required. Report major discrepancies between Drawings and field dimensions to Owner's Representative prior to commencing work.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form work to be #2 grade Douglas Fir, free of grooves, gouges, knots, checks, bows, and cracks.

2.2 READY MIXED CONCRETE

- A. Batched, mixed and transported in accordance with ASTM C94 - "Specifications for Ready Mixed Concrete."

2.3 PORTLAND CEMENT

- A. Refer to Architecture Drawings for specific paving finishes requiring different cement types, to include Type I, II, III, or II/V cements conforming to ASTM C150.
- B. Use same brand of cement from single source throughout entire project for each paving type.

2.4 FINE AGGREGATE (WASHED CONCRETE SAND)

- A. Clean, hard, and durable washed concrete sand, uniformly graded, conforming to ASTM C33.
- B. Use same fine aggregate from single source throughout entire project.
- C. Free of materials with deleterious reactivity to alkali in cement.

2.5 WATER

- A. Free from deleterious materials such as oils, acids, and organic matter.

2.6 REINFORCING

- A. Reinforcing Steel: Conforming to ASTM A615, clean and free of rust, dirt, grease or oils.

- B. Tie Wire: 16-gauge plain cold-drawn steel conforming to ASTM A82, clean, and free of rust, dirt, grease or oils.
- C. Supports for Reinforcement:
 - 1. Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars in place.

2.7 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150 - Type II.
- B. Fly Ash: ASTM C 618 - Type F. The combined weight of fly ash conforming to ASTM C 618 shall not exceed 25% of the total weight of cementitious materials.
- C. Concrete Aggregate: ASTM C 33 - Class 4, and as follows. Provide aggregates from a single source:
 - 1. Maximum aggregate size: 1-inch.
 - 2. Uniformly graded.
- D. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

2.8 ADMIXTURES

- A. Provide concrete admixtures that contain not more than 1 percent chloride ions and no calcium chloride.
- B. Water-Reducing Admixture: ASTM 4 94, Type A.
- C. High-Range Water-Reducing Admixture: ASTM C 494, Type F or Type G.
- D. Water-Reducing and Retarding Admixture: ASTM C 494, Type D or E.
- E. Acceptable Manufacturers:
 - 1. Water-Reducing Admixtures:
 - a. ChemMasters Corp; Chemtard.
 - b. Cormix Construction Chemicals; Type A Series.
 - c. Euclid Chemical Company; Eucon WR-75.
 - d. Or approved equal.
 - 2. High-Range Water-Reducing Admixtures:
 - a. Anti-Hydro Co. Inc.; Super P.
 - b. Cormix Construction Chemicals; Cormix 2000, PSI Super.
 - c. Euclid Chemical Company; Eucon 37.
 - d. Or approved equal.

3. Water-Reducing and Acceleration Admixtures:
 - a. Conspec Marketing & Manufacturing Company; Q-Set.
 - b. Cormix Construction Chemicals; Gilco Accelerator or Lub NCR.
 - c. Euclid Chemical Company; Accelguard 80.
 - d. Or approved equal.
4. Water-Reducing and Retarding Admixtures:
 - a. Cormix Construction Chemicals; Type D Series.
 - b. Euclid Chemical Company; Eucon Retarder 75.
 - c. W.R. Grace Company; Daratard-17.
 - d. Or approved equal.
5. Surface Retarding Admixture:
 - a. L.M. Scofield Company; Lithochrome Surface Retarder.
 - b. Or approved equal.

2.9 CURING MATERIALS

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

Moisture-Retaining Cover: One of the following complying with ASTM C 171:

1. Waterproof paper.
2. Polyethylene film.
3. White burlap-polyethylene sheeting.

- B. Clear, Waterborne Membrane-Forming Curing Compounds:

1. Provide curing materials that have a maximum volatile organic compound (VOC) rating of 350 g/l.

- C. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.

1. Clear, Waterborne Membrane-Forming Curing Compounds Acceptable Manufacturers:

- a. Anti-Hydro Company; Clear Cure Water Base.
- b. The Burke Company; Spartan Cote WB.
- c. Cormix Construction Chemicals; Sealco VOC.
- d. Or approved equal.

2. Acceptable Evaporation Control Manufacturers:

- a. Conspec Marketing and MFG. Company; Aquafilm.
- b. Euclid Chemical Company; Eucobar.
- c. L&M Construction Chemicals; E-Con.
- d. Or approved equal.

2.10 RELATED MATERIALS

- A. Integral Color: Integrally color concrete in colors, blending mixtures and application rates necessary to create colors, gradations, and variations to match Owner’s Representative’s mock-up.
- B. Color Hardener: Color concrete with color hardener in colors, blending mixtures and application rates necessary to create colors, gradations, and variations to match Owner’s Representative’s mock-up.
- C. Floor Hardener: Similar to Color Hardener buy a heavier duty color hardener used for additional wear and slip resistance.
- D. Color Stain: Stain the concrete with color stain in colors and blending mixtures to match Owner’s Representative’s mock-up. Stain shall be of same manufacturer as color hardener.
- E. Bonding Agent: Acrylic or styrene butadiene.
- F. Epoxy Adhesive: ASTM C 881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.
- G. Surface Retarder: Water-based surface retarder.
- H. Miscellaneous Materials: Miscellaneous specialty materials, acids, or other materials required to achieve the specialized effects indicated by Owner’s Representative’s mock-up or as required by Owner’s Representative.
- I. Acceptable Manufacturers: Subject to compliance with requirements, products that may be incorporated in Work include, but are not limited to, the following:
 - 1. Integral Color (dry pigment):
 - a. L.M. Scofield Company; Chromix®.
 - b. Admixtures; Colorfull Integral Concrete Color.
 - c. OC; Integral Color Hardener.
 - d. Or approved equal.
 - 2. Integral Color (liquid pigment):
 - a. Solomon Colors at www.sgs@solomoncolors.com.
 - b. Davis™ Colors at www.daviscolors.com.
 - c. Or approved equal.
 - 3. Color Hardener:
 - a. L.M. Scofield Company; Lithochrome Color Hardener.
 - b. Admixtures; Colorfull Color Hardener.
 - c. Master Builders; Color Hardener.
 - d. Or approved equal.
 - 4. Heavy Duty Floor Hardener:

- a. L.M. Scofield Company; Emerchrome Floor Hardener.
 - b. Or approved equal.
- 5. Chemical Stain:
 - a. L.M. Scofield; Lithochrome Chemstain.
 - b. Or approved equal.
- 6. Releasing Agents:
 - a. L.M. Scofield; Antiqueing Release.
 - b. Colorful; Antiqueing Hardener.
 - c. Superstone; Antiqueing Hardener.
 - d. Or approved equal.
- 7. Clear Penetrating Sealer (water based):
 - a. L.M. Scofield; Cementone Clear Sealer.
 - b. Superstone; Clear Sealer.
 - c. Lambert; Clear Sealer.
 - d. Or approved equal.

2.11 CONCRETE

- A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified under ACI 301.
 - 1. A field quality control testing agency will be provided by Owner's Representative.
- B. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength at 28 days: 2,500 psi.
 - 2. Maximum Water-Cement Ratio at Point of Placement: 0.61.
 - 3. Slump Limit at Point of Placement: 5-inches.
 - 4. Air Entrainment Content: 2 percent.
- C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, project conditions, weather, test results, or other circumstances warrant.

2.12 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements of ASTM C 94.
 - 1. Reduce mixing and delivery time when air temperature is between 85 degrees F and 90 degrees F and reduce mixing and delivery time from 1-1/2 hours to 75 minutes.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Verify that paving subgrade consists of a minimum of 4-inches of compacted washed concrete sand, passes less than 7% through a #200 sieve, and is compacted to at least 95% of the materials ASTM D 1557 maximum dry density for its full depth, or as specified in the geotechnical soils report.
- B. Verify that paving subgrade extends 1-foot beyond the outside edge of paving or curbing and has a positive outfall for trapped water.
- C. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
- D. Remove loose material from compacted subbase surface immediately before placing concrete.
- E. Provide necessary chairs or supports, and maintain position of reinforcing bars.
- F. Wet surface of sand subgrade prior to placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations.
- B. Install forms to allow continuous progress of Work and so that forms can remain in place at least 24 hours after placing concrete.
- C. Check completed formwork and screeds for grade and alignment to following tolerances:
 - 1. Top of Forms: Not more than 1/8-inch in 10-feet.
 - 2. Vertical Face on Longitudinal Axis: Not more than 1/4-inch in 10-feet.
- D. Clean forms after each use and coat with form release agent to ensure separation from concrete.

3.3 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute’s recommended practice for “Placing Reinforcing Bars” for placing and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover over reinforcement.

3.4 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to facilitate installation of their work.
- B. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes and other utility structures until they are at the required finish elevation and alignment.
- C. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.
- D. Deposit and spread concrete in a continuous operation between construction joints.
- E. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309 R.
 - 1. Consolidate concrete along face of forms with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Prevent dislocating reinforcing and dowels.
- F. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- G. Hot-Weather Placement: Place concrete complying with ACI 305R when hot weather conditions exist.
 - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement 90 degrees F and below. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water.
 - 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, or soft or dry areas.
- H. Cold Weather Placement: Adhere to ACI 306R - Cold Weather Concreting for installing concrete paving during cold weather.

3.5 CONCRETE FINISHING

- A. General:
 - 1. All finishes as shown on the Architectural Drawings.
 - 2. Paving finishes to match approved Mock-Up finishes.

B. Broom Finish:

1. Broom finish paving to match approved mock-up.
2. After surface water disappears and floated surface is sufficiently hardened, produce a transverse scored texture perpendicular to direction of traffic by drawing a broom across its surface.

C. Sandblast Finish:

1. Sandblast finish paving to match approved mock-up.
2. Perform sandblasting in as continuous an operation as possible, utilizing same work crew to maintain finish continuity.
3. Provide sandblasting to a finish as indicated on Drawings.
4. Depth of Etch: Use an abrasive sand of the required gradation and grit to expose paving surface to achieve specified etch:
Light Sand Blast: Approximately 1/32 to 3/32-inches deep.
5. Medium Sand Blast: Approximately 1/16 to 1/8-inches deep.
6. Heavy Sand Blast: Approximately 3/32 to 5/32-inches deep.
7. Carefully blast corners and edges of paving using appropriate backup boards, in order to maintain a uniform corner or edge finish as well as prevent blast damage to adjacent surfaces and landscaping.
8. Use same nozzle, nozzle pressure and blasting technique as used to prepare initial paving mock-ups. Exercise care to provide even and consistent strokes with air nozzle to minimize pockmarking of paving surface.
9. Cleanup and remove expended sand particles, concrete dust, loose aggregate, and other work-related debris at end of each day's blasting operations.

D. Acid Finish:

1. Acid finish paving to match approved mock-up.
2. Ensure that paving surfaces receiving an acid finish are hard-troweled before final concrete set.
3. Conform acid washing procedures to CAL OSHA/MSDS standards for application and clean-up.
4. Provide for containment and/or neutralization of Muriatic acid during finishing procedures.
5. Wrap adjacent improvements that may be etched during operations such as metalwork, stone, plant material, etc. with plastic sheeting.
6. Wet adjacent plant material prior to acid washing.
7. Use lime and/or water to neutralize acid during clean-up operations.
8. Match approved paving sample. It is recommended that a 2-foot x 2-foot test sample be poured from same field mix and finished as same for each finish specified. Apply acid to test sample first to determine etching level prior to etching field pour.
9. Use Muriatic acid for providing an acid finish.
10. Use an airless-type sprayer to apply acid.

11. Use a soft-bristled broom to embed acid.
12. Once acid is applied to surface of paving, immediately work into surface with broom worked in both directions.
13. Do not apply acid to more than 100 square feet of surface area before brooming and washing.
14. Use a 2,500 psi pressure washer to remove spent acid. Take precautions not to etch concrete surface more than what acid had performed.
15. Acid Finishes:
 - a. Light:
 - 1) Light acid finish paving to match approved mock-up.
 - 2) After 1 day of normal cure time, apply acid at full strength to 2-foot square test pour. Clean sample and allow to dry. If surface matches approved light acid finish sample, continue acid operations on entire field pour.
 - 3) Thoroughly clean field pour and allow to dry.
 - 4) Check for “hard spots”. If present, spot-treat with full-strength acid, then clean and allow to dry.
 - b. Medium:
 - 1) Medium acid finish paving to match approved mock-up.
 - 2) Obtaining a medium acid finish requires acid-etching of previously light acid-etched paving.
 - 3) Ensure that paving areas set to receive a medium acid finish are clean and dry before applying full-strength acid.
 - 4) Follow steps as outlined above for a light acid finish.
 - c. Heavy:
 - 1) Heavy acid finish paving to match approved mock-up.
 - 2) Obtaining a heavy acid finish requires acid-etching of previously medium acid-etched paving.
 - 3) Ensure that paving areas set to receive a heavy acid finish are clean and dry before applying full-strength acid.
 - 4) Follow steps as outlined above for a light acid finish.

E. Steel Trowel Finish:

1. Steel trowel finish paving to match approved mock-up.
2. After surface water disappears and floated surfaces have sufficiently hardened, steel trowel then retrowel the surface to a smooth and consistent finish.
3. After concrete has set enough to provide edge troweling, retrowel edges to a smooth and uniform finish.
4. Avoid excessive troweling that may produce a “burnished” area.

3.6 JOINTING

- A. Construct contraction, construction, and isolation joints to match irregular edge pattern of stamping tools with faces perpendicular to surface plane of concrete.
- B. Contraction Joints: Provide contraction joints as indicated on Drawings (or to not exceed 10-feet in either direction), to minimize random surface cracking and as indicated on Drawings. Construct contraction joints for a depth equal to at least one fourth of concrete thickness, as follows:
 - 1. Hand-tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each joint edge with a radiused jointer tool.
 - 2. Machine-Sawn Contraction Joints: Provide machine-sawn contraction joints as soon as concrete has sufficient strength to support sawing equipment.
 - 3. Do not exceed 1/4-inch in joint width.
- C. Doweled Construction Joints: Construct doweled construction joints at end termination's of paving where paving operations are stopped for more than 1/2 hour, unless paving terminates at an isolation joint and at all edges of different paving types.
 - 1. Diamond Dowels: Any reason not to make these our standard?
 - 2. Steel Dowels:
 - a. Provide steel dowels across construction joints to reduce differential movement across the joint. Utilize steel dowels based upon the following:
 - 1) 6-inch Thick Pavement:
 - a) Diameter: 1/2-inch.
 - b) Length: 24-inches.
 - c) On-center Spacing: Per reinforcing schedule.
 - 2) 4-inch Thick Pavement:
 - a) Diameter: 1/2-inch.
 - b) Length: 24-inches.
 - c) On-center Spacing: Per reinforcing schedule.
 - b. To assist in correct alignment of steel dowels along construction joints use Speed Dowel™ plastic dowel alignment sleeves:
 - 1) Insure that wood edge forms are true to line and grade prior to installing plastic dowel alignment sleeves.
 - 2) Install plastic dowel sleeves on wood forms at the specified on-center dowel spacing, centered between top and bottom of wood form.
 - 3. Do not continue tie-reinforcement through sides of strip paving.
 - 4. Use a bond breaking agent on cured concrete edges that will be joined with fresh concrete.
 - 5. Immediately before new concrete is placed, wet construction joint and remove standing water.
 - 6. Tool edges of construction joints to match decorative field jointing.

- D. Isolation Joints: Provide isolation joints to permit horizontal and vertical movement between slab and fixed vertical edges such as building walls, steps, columns, and other vertical restraints.
 - 1. Provide 1/4-inch thick polyethylene foam and caulking along edges of isolation joints.
 - 2. Joints for Non-Stamped Special Flooring: Tool to profile and dimensions detailed; fill with specified grout, tool grout to a concave profile.

3.7 CONCRETE PROTECTION AND CURING

- A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 305R for hot weather and ACI 306R for cold weather protection during curing.
- B. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture retaining cover curing, curing compound, or a combination of following:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with following materials:
 - a. Water.
 - b. Continuous water fog spray.
 - c. Absorptive cover, water saturated, kept continuously wet.
 - 2. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
 - 3. Curing Compound:
 - a. Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions.
 - b. Recoat areas subjected to heavy rainfall within 3 hours after initial application.
 - c. Maintain continuity of coating and repair damage during curing period.

3.8 FIELD QUALITY CONTROL TESTING

- A. Owner's Representative will employ a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:
 - 1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.

- a. Compression Test Specimens: ASTM C 31. One set of four (4) standard cylinders for each compressive strength test. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
 - b. Compressive-Strength Tests: ASTM C 39. One (1) set for each day's pour of each concrete class exceeding 1/2 cu. yd. but less than 25 cu. yd., plus one (1) set for each additional 50 cu. yd. Test one (1) specimen at 7 days, test two (2) specimens at 28 days, and retain one (1) specimen in reserve for later testing.
 - c. Slump: ASTM C 143. One (1) test at point of placement for each compressive strength test but not less than one (1) test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
 - d. Air Contact: ASTM C 231, pressure method. One (1) test for each compressive strength test but no less than one (1) test for each day's pour of each type of air-entrained concrete.
 - e. Concrete Temperature: ASTM C 1064. One (1) test performed hourly when air temperature is 40 degrees F and below and when 80 degrees F and above. One (1) test for each set of compressive strength specimens.
2. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.
 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing concrete.
 4. Strength level of concrete will be considered satisfactory if averages of sets of three (3) consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
- B. Test results will be reported in writing to Owner's Representative, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive strength tests will contain project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in paving, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7 day and 28 day tests.
- C. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but not be used as the sole basis for acceptance or rejection.
- D. Additional Tests: The testing agency will make additional tests of concrete when test results indicate slump, air entertainment, concrete strengths, or other requirements have not been met. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42.

3.9 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, defective, or does not meet the requirements of this Section.
- B. Protect concrete from damage until Final Payment. Exclude traffic from paving for at least 28 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material until Final Payment.

3.10 CLEANUP

- A. At completion of Work, remove concrete stains from adjacent work, including but not limited to dissimilar paving types, walls, columns, railing posts, light fixtures, plant materials, to satisfaction of Owner’s Representative.

END OF SECTION 32 33 13

SECTION 328400 – IRRIGATION - RECYCLED

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.

1.2 SCOPE OF WORK

The work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for and incidental to performing all operations in connection with furnishing, delivery, and installation of a complete functioning "irrigation system," complete as shown on the drawings and as specified herein.

1.3 RELATED SECTIONS

A. LANDSCAPING - SECTION 32 84 00

1.4 QUALITY ASSURANCE

- A. It is the intention of this specification to accomplish the work of installing an automatic irrigation system, which will operate in an efficient and satisfactory manner according to the workmanlike standards established for landscape installation and sprinkler irrigation operation as set forth by the California Landscape Contractors Association (CLCA). The specification can only indicate the intent of the work to be performed rather than a detailed description of the performance of the work. It shall be the responsibility of the Contractor to install said materials and equipment in such a manner that they shall operate efficiently and evenly and support optimum plant growth and health.
- B. The Landscape Architect and/or his or her consultant shall be the sole judge of the true intent of the drawings and specifications and of the quality of all materials furnished in performance of the contract.
- C. In the event of any discrepancies between the plans and the specifications, the final decision as to which shall be followed shall be made by the Landscape Architect and/or his or her consultant. The Contractor shall be compelled to act on this decision as directed. In the event the installation is contradictory to the direction of the Landscape Architect, the installation shall be rectified by the Contractor at no additional cost. The Contractor shall immediately bring any such discrepancies to the attention of the Landscape Architect.
- D. It shall be distinctly understood that no oral statement of any person shall be allowed in any manner to modify any of the contract provisions. Changes shall be made only on written authorization of the Landscape Architect - except in an emergency endangering life or property.

- E. Make use of all data in all of the contract documents including manufacturer's catalogs and verify the information on site prior to bidding on this work and also at the time of installation.

1.5 INTENT OF CONSTRUCTION DRAWINGS

- A. Irrigation piping and related equipment are drawn diagrammatically. Scaled dimensions are approximate only. Before proceeding with work, carefully check and verify dimensions and immediately notify the Owner's Representative and the Landscape Architect of discrepancies between the drawings or specifications and the actual conditions. Although sizes and locations of plants and of irrigation equipment are drawn to scale wherever possible, it is not within the scope of the drawings to show all necessary offsets, obstructions, or site conditions. The Contractor shall be responsible to install his or her work in such a manner that it will be in conformance to site conditions, complete, and in good working order.
- B. Piping and equipment is to be located within the designated planting areas wherever possible unless specifically defined or dimensioned otherwise.

1.6 SUBMITTALS AND SUBSTITUTIONS

- A. Prior to installation of any irrigation work, the Contractor shall submit for approval by the Landscape Architect, a list of all materials and equipment proposed for use. Submit as a minimum the following catalog cut sheets to the Landscape Architect for approval:
 - 1. Main line pipe, lateral line pipe, pipe sleeves
 - 2. Solvent cement
 - 3. Isolation valves (gate valves, ball valves, etc)
 - 4. Remote control valve
 - 5. Drip valve assembly
 - 6. Quick coupler valve
 - 7. Valve boxes
 - 8. Control wire
 - 9. Air relief valves
 - 10. Flush valves
 - 11. Anti-drain valves
 - 12. Waterproof wire connectors
 - 13. Sprinkler heads (for each type)
 - 14. Drip emitters / drip distribution tubing (for each type)
 - 15. Paint products
- B. Upon fifteen (15) days after the Contractor has received the Owner's notice to proceed, the Contractor shall submit to the Landscape Architect three (3) typewritten lists of all materials proposed, along with the manufacturer, model number, cut sheets, and source.

- C. No substitutions of material or procedures shall be made concerning these documents without the written consent of an accepted equivalent by the Landscape Architect.
- D. Equipment or materials installed or furnished without prior approval of the Landscape Architect, may be rejected by the Landscape Architect or the Owner’s Representative and the Contractor shall be required to remove such materials from the site at his or her own expense.
- E. Approval of substitution of material and/or products, other than those specified, shall not relieve the Contractor from complying with the requirements of the contract documents and specifications. The Contractor shall be responsible at his or her own expense for all changes by approved substitutions, which affect other items of his or her own work and/or the work of other contractors.
- F. Samples of the equipment may be required at the request of the Landscape Architect if the equipment is other than that specified.

1.7 GUARANTEE

- A. Contractor guarantees all equipment, materials, and labor furnished or performed under the contract (unless furnished by the Owner) against defects in design, materials, and workmanship for a period of one (1) year, unless otherwise specified, from the date of final acceptance of work.
- B. Neither the final certificate for payment nor any provision in the contract documents shall relieve the Contractor of responsibility for faulty materials or workmanship, and he or she shall remedy any defects due thereto and pay for any damage to other work resulting there which may appear within a period of one (1) year from the date of final acceptance of work.

1.8 EXAMINATION OF SITE

The Contractor shall be held to have examined the project site and to have compared it with the drawings and specifications, to have carefully examined all of the contract documents and to have satisfied himself or herself as to the conditions under which the work is to be performed before entering into his or her contract for this work. No allowance shall subsequently be made on behalf of the Contractor on account of an error on his or her part or his or her negligence or failure to acquaint himself or herself with the conditions of the site, existing utility locations and easements, or of the streets or roads approaching the site. Submit any questions in writing prior to commencement of job.

1.9 PROTECTION OF WORK AND PROPERTY

- A. All materials and equipment shall be stored properly and protected as required by the Contractor. The Contractor shall be entirely responsible for damages or loss by weather or

other cause to work under the contract. Materials shall be furnished in ample quantities and at such times as to ensure uninterrupted progress of the work.

- B. The Contractor shall continuously maintain adequate protection of all his or her work from damage, destruction, or loss, and shall protect the Owner's property from damage arising in connection with this contract. Contractor shall make good any such damage, destruction, loss or injury. Contractor shall adequately protect adjacent property as provided by law and the contract documents.
- C. Prior to excavation for irrigation piping or equipment, Contractor shall locate underground utilities and related systems, and take proper precautions to avoid damage to such improvements. In the event of a conflict between such utilities, related systems, lines, irrigation piping, and/or equipment locations, Contractor shall notify the Owner's Representative and arrangements will be made for relocation as necessary. The Contractor assumes responsibility for making repairs for damages resulting from work as herein specified.
- D. The Contractor shall maintain sufficient safeguards, such as railings, temporary walks, lights, etc., against the occurrence of accidents, injuries or damage to any person or property resulting from his or her work, and shall alone be responsible for the same if such occurs.

1.10 PROTECTION OF EXISTING PLANT MATERIAL

- A. All existing plant material to remain which are within the project limits shall be tagged and identified by the Contractor prior to start of work. Contractor shall provide the required maintenance to maintain the vegetation in a healthy and growing condition, including supplemental irrigation if needed.
- B. All existing plant material shall be protected at all times from damage by personnel and equipment. All damages to existing plant materials shall be repaired at the Contractor's expense.
- C. Damage to a tree or shrub, which results in death or permanent disfiguration, shall result in the Contractor's complete removal of said tree or shrub, including roots, from the site. The Contractor shall replace the plant material as established by the Landscape Architect with one of equal value at his or her own expense or shall reimburse to the Owner the cost of said replacement. The Landscape Architect shall be the sole judge of the replacement of any plant material.

1.11 POINTS OF CONNECTION

- A. The Contractor shall verify with the Owner's Representative the most appropriate location and source for the water and electrical points of connection.

- B. The electrical point of connection shall be made by an appropriately licensed Electrical Contractor per governing codes.

1.12 TEMPORARY UTILITIES

- A. All temporary piping, wiring, meters, panels and other related appurtenances required between source of supply and point of use shall be provided by the Contractor and coordinated with the Owner's Representative. Existing utilities may be used with the written permission of the Owner's Representative.
- B. The Contractor shall meter and pay for the furnishing of all electricity and water for his or her use unless otherwise stated. All water used for construction purposes shall be separated from the potable domestic water supply by a reduced pressure principle device (RP) backflow preventer approved by the Landscape Architect.

1.13 CUTTING, PATCHING, TRENCHING, AND DIGGINGS

- A. The Contractor shall do all cutting, fitting, trenching or patching of his or her work that may be required to make its several parts come together properly and fit them to receive or be received by work of other contractors shown upon, or reasonably implied by, the drawings and specifications for the completed project. Contractor shall do all that is necessary to accomplish the joining of said several parts in a neat and workman-like manner to the satisfaction of the Owner's Representative.
- B. Trenching shall be performed only during the period when beneficial and optimum results may be obtained. If the moisture content of the soil should reach a level that working it would destroy the soil structure, digging and trenching operations shall be suspended until the moisture level is increased or reduced to acceptable levels and the desired results are likely to be obtained.
- C. The Contractor shall not endanger any work by cutting, digging or otherwise, and shall not cut or alter the work of any other contractor without the consent of the Owner's Representative.

1.14 SPECIMEN TREES

All specimen trees twenty-four-inch (24") box and larger shall be installed prior to the location of the irrigation system. The layout of the irrigation system shall be adjusted to accommodate all specimen trees with the approval of the Owner's Representative.

1.15 USE OF PREMISES

The Contractor shall confine his or her apparatus, the storage of materials and the operations of his or her personnel to limits indicated by the law, ordinances, or permits and shall not unreasonably encumber the premises with his or her materials.

1.16 PERMITS AND REGULATIONS

The Contractor shall give all notices and pay all fees necessary for completion of work under this contract, and shall obtain and pay for all permits, certifications, and licenses (except permanent easements) over all or any part of the work as drawn and specified.

1.17 APPLICABLE CODES AND STANDARDS

- A. Wherever references are made in the contract to standards or codes in accordance with which work is to be performed or tested, the edition or revision of the standards and codes current on the effective date of this contract shall apply, unless otherwise expressly set forth. Unless otherwise specified, reference to such standards or codes is solely for implementation of the technical portions of such standards and codes.
- B. In case of conflict among any referenced standards or codes or between any referenced standards and codes and the specifications, the Landscape Architect shall determine which shall govern.

1.18 DRAWINGS AND SPECIFICATIONS AT THE WORK SITE

The Contractor shall keep one copy of all drawings and specifications on the work site, in good order, available to the Landscape Architect and to his or her representatives at the project site.

1.19 AS-BUILT RECORD DRAWINGS

- A. The Contractor shall be responsible for completion of “As-Built” Record Drawings, and the following procedure shall be adhered to:
 - 1. Contractor shall maintain a redline “As-Built” Record Drawing on-site at all times during construction, and shall update drawing on Friday of every week.
 - 2. The Contractor shall not request inspection of any work installed contrary to the drawings until noted on the red-line Record Drawings.
 - 3. Before the final request for payment is made and final approval obtained, pre-As-Built Drawings shall be completed. One copy set of the drawings shall be delivered to the Landscape Architect with all as-built indications and changes noted, marking out all items which are not as-built conditions. The drawings shall present the final as-built information clearly. Equipment such as valves and backflow preventers shall be referenced and dimensioned from two fixed points on the site, to triangulate their location.
 - 4. After pre-As-Built Drawings have been approved by the Landscape Architect, the Contractor shall obtain, at his or her own expense, mylar transparencies of the original drawings and transfer the as-built information onto them. Drafting shall be of equal quality to the working drawings. All as-built indications shall be made on the transparencies by an experienced draftsman. All as-built changes shall be drafted in black India ink. All items, which have changed and are not as-built shall be bubble/cloud encircled and clearly labeled.

5. The Contractor shall sign and certify on the original drawings as to the accuracy of the completed As-Built Drawings. All damages due to inaccurate As-Built Drawings shall be repaired within twenty-four (24) hours after notification to the satisfaction of the Owner’s Representative and at no cost to the Owner.

1.20 CONTROLLER CHARTS

- A. Provide one controller chart for each automatic controller installed. Controller chart shall be blackline print of actual "As-Built Drawing" showing the area covered by that controller and reduced to fit in the controller cabinet. Keep reduction to maximum size possible to retain full legibility.
- B. Identify the area of coverage of each remote control valve, using a distinctly different pastel color, drawn over the entire piping system of the area of coverage.
- C. Following approval of charts by the Landscape Architect, hermetically seal chart between two layers of 20 mil. thick plastic sheeting.
- D. Charts must be completed and approved prior to final walk-through of irrigation system.
- E. The charts shall be affixed to the inside of the controller cabinet doors using an approved mastic or fastening system and also in the maintenance room area, if applicable.

1.21 SITE OBSERVATIONS

- A. Site observations herein specified shall be made by the Landscape Architect during office working hours on each of the steps or conditions listed below. The Contractor or his or her authorized representative shall be on the site at the time of each observation. The Contractor will not be permitted to initiate the succeeding step of work until he or she has received approval to proceed by the Landscape Architect. The Contractor shall notify the Landscape Architect of a requested site observation at least three (3) business days in advance of an observation.
- B. All changes and deviations to the plans and specifications by the Landscape Architect to the Contractor shall be confirmed in writing.
- C. The Contractor shall have sufficient work personnel available during normal working hours to correct deficiencies immediately upon request of the Landscape Architect. Such repair or re-work services are to be performed without interference of regular project schedule.
- D. Site observations will be required for the following parts of the work:
 1. PRE-CONSTRUCTION MEETING: Immediately prior to the commencement of work of this section, the Owner’s Representative, Landscape Architect, and the Contractor shall meet for approval of the materials specified, equipment, schedule of work and the method of installation.

2. TRENCHING AND SLEEVING REVIEW: Completion and installation of all trenching and sleeving.
 3. PRESSURE MAIN LINE TEST: Completion of installation and testing, prior to backfilling.
 4. LATERAL LINE TEST: Completion and testing, prior to backfilling.
 5. ADJUSTMENT AND COVERAGE TEST: Adjust and test the operating performance of all installed irrigation systems prior to commencement of planting operations with the exception of specimen tree planting.
 6. PRE-MAINTENANCE OBSERVATION: Entire irrigation system shall be completely installed and operational. All discharge ends of drip emitters shall be exposed under operation for observation to demonstrate that all emitters are performing and installed as designed, prior to placing bark mulch over emitter discharge ends. This observation shall be coordinated with the pre-maintenance observation of the planting installation. A written “punch list” indicating all items to be corrected and the beginning date of the Maintenance Period will be sent to the Contractor. This is not Final Acceptance and does not relieve the Contractor from any of the responsibilities in the contract documents.
 7. FINAL SITE OBSERVATION AND ACCEPTANCE: At the conclusion of the Maintenance Period, a final site observation will be made. The Contractor shall show evidence that the Owner’s Representative has received all charts, records, drawings, and extra equipment as required before Final Acceptance. The Contractor shall show all corrections made from the written “punch list” previously generated by the Landscape Architect. Any items deemed not acceptable shall be reworked and the Maintenance Period will be extended.
 8. The Contractor will be notified in writing that the contract work and Maintenance Period has been accepted or that the Maintenance Period has been extended to correct any deficiencies remaining. Final Acceptance shall establish the beginning date for the Guarantee Period.
- E. Site observation of the work shall not relieve the Contractor of the obligation to fulfill all conditions of the contract.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials shall be of standard, approved, and first grade quality and shall be new and in perfect condition when installed and accepted.
- B. The use of a manufacturer's name and model or catalog number is for the purpose of establishing the standard of quality and configuration desired only. Other manufacturer's equipment may be submitted for approval with written approval by the Landscape Architect. Only upon submittal and subsequent written approval of the material list shall these items be permitted. Changes to hydraulics brought about by the use of other equipment than that specified shall be recalculated by the Contractor and submitted to

the Landscape Architect for written approval. Such work shall not be installed prior to receipt by the Contractor of the written approval.

- C. Whenever such terms as "in accordance with manufacturer's specifications" is used, it shall mean in strict accordance with the manufacturer's printed directions. If those directions conflict with this specification, the matter shall be brought to the attention of the Landscape Architect for clarification prior to proceeding with work.
- D. Approval of any items or substitutions indicates only that the product(s) apparently meet the requirements of the drawings and specifications on the basis of the information or samples submitted. The Contractor shall be responsible for the performance of substituted items. If the substitution proves to be unsatisfactory, the Contractor shall replace said items with the originally specified items, including all necessary work and modifications to replace the items, at no cost to the Owner.

2.2 PIPING MATERIAL

- A. Individual types of pipe and fittings supplied are to be of compatible manufacturer unless otherwise approved. Pipe sizes shown are nominal inside diameter unless otherwise noted.
- B. Brass pipe and fittings: Brass pipe shall be 85% red brass, American National Standard Institute (ANSI), Schedule 40-screwed pipe.
 - 1. Fittings shall be medium brass, screwed 125-pound Class.
- C. Hard copper tube and fittings: Copper tube (pipe) shall be ASTM B 88, Type L, water tube, drawn temper.
 - 1. Fittings shall be ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings for 2-1/2 inch size and smaller pipe.
 - 2. Cast brass fittings shall be used for pipe over 2-1/2 inch size.
 - 3. Bronze Flanges: ASME B 16.24, Class 150, with solder-joint end.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- D. Plastic pipe and fittings:
 - 1. All pipes shall be free of blisters, internal striations, cracks, or any other defects or imperfections. The pipe shall be continuously and permanently marked with the following information: manufacturer's name or trade mark, size, class and type of pipe, pressure rating, quality control identifications, and date of extrusion.
 - 2. Pressure mainline for piping upstream of remote control valves and quick coupling valves:

- a. 4” diameter pipe and larger: Shall be manufactured rigid virgin polyvinyl chloride PVC CLASS 200, conforming to ASTM D 2241. Pipe shall have an integral bell end with a locked-in factory installed gasket. Bell shall meet requirements of ASTM D 2672, gasket shall meet requirements of ASTM D 3139, and gasket material shall meet requirements of ASTM F 477. Pipe sizes shall be installed as shown on plans. **Pipe shall be purple in color.**
 - b. 2” to 3” diameter pipe: Plastic pipe for use with solvent weld or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride PVC 1120, ASTM D 1784, conforming to ASTM D 2241, class 315, SDR 13.5. **Pipe shall be purple in color.**
 - c. 3/4” to 1-1/2” diameter pipe: Plastic pipe for use with solvent weld and/or threaded fittings. Shall be manufactured rigid virgin polyvinyl chloride PVC 1120, ASTM D 1784, conforming to ASTM D 1785, designated as Schedule 40. **Pipe shall be purple in color.**
3. Non-pressure lateral line for piping downstream of remote control valves shall be plastic pipe for use with solvent weld or threaded fittings, shall be manufactured rigid virgin polyvinyl chloride (PVC) 1220 (Type 1, Grade 2) conforming to ASTM D 1785, designated as Schedule 40, three-quarter-inch (3/4”) minimum size. **Pipe shall be purple in color.**
4. Identification: Furnish plastic pipe continuously and permanently marked with following information: Manufacturer's name or trade mark, size, class and type of pipe, working pressure at 73.4 F and National Sanitation Foundation (NSF) rating. **Pipe shall be purple in color.**
5. Polyethylene tubing for drip systems shall be constructed of linear, low density, polyethylene resin manufactured under ASTM Standards.
6. Fittings and connections:
 - a. Fittings for 4” diameter pipe and larger: Fittings shall be ductile iron, deep-bell, gasketed fittings manufactured by Leemco, Inc., or approved equal.
 - b. Fittings for 3” diameter pipe and smaller shall be plastic manufactured rigid virgin polyvinyl chloride (PVC) 1220, (Type 2, Grade 1), conforming to ASTM D 2464 or D 2466, Schedule 40, high impact molded suitable for either solvent weld or threaded connections as required.

2.3 PIPE CONNECTION MATERIALS

- A. Threaded connections: Teflon tape or approved equivalent, UL listed.
- B. Gasketed fittings: Lubricant per manufacturer’s recommendations.
- C. Solvent weld connections - primer and adhesive solvent shall be type as recommended by manufacturer of pipe and fittings:
 1. All cans of solvents and primers shall have labels intact and shall be stamped with the date and manufacturer. No cans dated over two (2) years old will be permitted.

2. No thinning of solvent or primer in any manner will be permitted.

D. Nipples and risers:

1. Metallic: red brass, standard pipe size, schedule 40, ASTM b43. Composition: nominal copper content to be 85 percent (min. 83%, max. 86%), nominal zinc content to be 15 percent. Maximum allowable lead and iron content to be 0.05 percent each.
2. Plastic: plastic nipples and risers shall be manufactured rigid virgin polyvinyl chloride PVC, (Type 1, Grade 1), conforming to ASTM D 1784 or D 2464, designated as Schedule 80 with molded threads.

2.4 ISOLATION VALVES (Gate Valves / Ball Valves / Globe Valves, etc)

- A. Isolation valves for three-quarter-inch (3/4”) through two-and-one-half-inch (2-1/2”) size shall be Nibco #T-580 ball valves of bronze and brass construction.
- B. Isolation valves for three-inch (3”) and larger size shall be Nibco P-619-RW w/ square operating nut, with iron body, brass or bronze mounted AWWA gate valves, and shall have a clear waterway equal to the full nominal diameter of the valve, and shall be rubber gasket, flanged or mechanical joint only, and shall be able to withstand a continuous working pressure of 150 psi. Valve shall be equipped with a square-operating nut.
- C. All isolation valves located in a remote control valve manifold shall be the same size as the largest remote control valve in the manifold, one-and-one-half-inch (1-1/2”) size minimum. Provide pipe-reducing adapters downstream of valves, as required.
- D. All in-line isolation valves shall be the same size as the mainline pipe.
- E. See irrigation legend for manufacturer and model type.

2.5 CHECK VALVES

- A. Swing check valves 2" and smaller shall be 200 lbs., W.O.G., bronze construction with replaceable composition, neoprene or rubber disc and shall meet or exceed Federal Specification WW-V- 5Id, Class A, Type IV.
- B. Anti-drain valves shall be of heavy-duty virgin PVC construction, with soft composition neoprene disc and stainless steel internal parts. Anti-drain valves shall be field adjustable to compensate for elevational changes up to 32 feet. Anti-drain valves shall be Hunter “HCV”, or approved equal.

2.6 REMOTE CONTROL VALVES

- A. Remote control valves shall be electrically operated, single seat, normally closed configuration, equipped with flow control adjustment and capability for manual operation.
- B. Valves shall be actuated by a normally closed low wattage solenoid using 24 volts, 50/60 cycle solenoid power requirement. Solenoid shall be epoxy encased. A union shall be installed on the discharge end.
- C. Valves shall be wired to controller in same numerical sequence as indicated on plans.
- D. Remote control valves shall have a recycled water identification tag installed on the top portion of each assembly.
- E. See irrigation legend for manufacturer and model type.

2.7 QUICK COUPLING VALVES

- A. Quick coupling valves shall be a two-piece unit consisting of a coupler seal valve assembly and a removable quick connecting coupler key. A positive, watertight connection shall be made between the coupler key and the valve unit.
- B. Quick coupling valve shall be double-lugged type, one-inch (1”) size, designed to withstand a working pressure of 150 psi, heavy-duty red brass construction with built in flow control and a self-closing valve.
- C. Quick coupling valve shall be equipped with a lockable, hinged cover with springs for positive closure upon key removal. Covers shall be red brass with a permanently bonded rubber-like vinyl cover, purple in color.
- D. Quick coupler key shall be brass or bronze with an attached hose bib assembly. Key size shall be compatible with quick coupler and of same manufacturer. See irrigation legend for manufacturer and model type.

2.8 VALVE BOXES AND MATERIALS

- A. Valve boxes: valve boxes shall be constructed of ABS (acrylonitrile butadiene styrene) plastic, purple in color, with rigid base and sides and shall be supplied with bolt lock cover secured with stainless steel bolts. Cover shall be identified as shown on plans, purple in color. Provide box extensions as required.
- B. For gate valves, dripline, flush valves, emitters and wire stub boxes use ten-and-one-half-inch (10.5”) diameter box, purple in color. For remote control valves three-quarter-inch to two-inch (3/4" - 2"), use Carson #1419 - 13b box, purple in color. For drip assemblies use #1419 - 13b, purple in color.

- C. Install in accordance with the details shown on the plans.

2.9 SPRINKLERS / DRIP IRRIGATION

- A. All sprinklers shall be as indicated on the irrigation legend on the drawings, with purple caps.
- B. Riser nipples for all sprinkler heads shall be the same size as the riser opening in the sprinkler body and fabricated in accordance with the details shown on the plans.
- C. Drip emitters and drip irrigation distribution tubing shall be as indicated on the irrigation legend on the drawings, appropriately marked for recycled water use.

2.10 ELECTRICAL CONTROL WIRING

- A. Low voltage
 - 1. The electrical control wire shall be direct burial type UF, No. 12 AWG, solid, single conductor, copper wire, U.L. approved. Wire shall be larger size gauge, if required to operate system as designed.
 - 2. Color code wires to each valve. Common wire shall be white. All master control valve or fill valve wires to be blue. All spare wires to be solid red.
 - 3. If multiple controllers are being utilized, and wire paths of different controllers cross each other, both common and control wires from each controller to be of different colors.
 - 4. Control wire connections and splices shall be made with Rainbird Pentite connectors, or similar dry splice method. Control wire splices allowed only on runs of more than three-hundred feet (300'). Provide pull boxes for control wiring where wire runs exceed three-hundred feet (300') in length, and at all changes in direction greater than forty-five (45) degrees. In-line wire splices shall be made only in pull-boxes, with waterproof connectors.
- B. High voltage:
 - 1. Shall be of type as required by local codes and ordinances.
 - 2. Shall be of proper size to accommodate needs of equipment it is to serve.
- C. Wire markers: white, self-laminating, vinyl-impregnated cloth with printed letters and numerals. Legend color shall be black. Background color shall be white. Minimum dimension of complete marker: 3/4" by 1-1/2". Markers shall be Insta-Code PCM series as manufactured by Panduit Corporation, or approved equal.
- D. Tracer wires: shall be direct burial type UF, No. 12 AWG, solid, single conductor, plastic coated copper wire, U.L. approved.

2.11 TRENCH MARKER TAPE

- A. Marker tape for pressure pipe shall be an inert plastic film with metallic backing specifically formulated for prolonged underground use. Minimum thickness shall be 4 Mils, minimum width shall be three-inches (3”). Marker tape shall be blue in color and shall have two-inch (2”) black lettering with the inscription "CAUTION: WATER LINE BURIED BELOW". Marker tape shall be Alarmatape as manufactured by Paul Potter Warning Tape, Inc., or approved equal.
- A. Marker tape for direct burial control wire shall be an inert plastic film specifically formulated for prolonged underground use. Minimum thickness shall be 4 mils, minimum width shall be three-inches (3”). Marker tape shall be red in color and shall have two-inch (2”) black lettering with the inscription "CAUTION: ELECTRICAL LINE BELOW". Marker tape shall be as manufactured by Allen Marking Tape, or approved equal.

2.12 CONCRETE THRUST BLOCKS

Size for average safe soil-bearing load of 700-lbs/square feet.

2.13 EQUIPMENT TO BE FURNISHED TO OWNER

- A. As a part of the contract, the Contractor shall supply the following extra equipment to the Owner's Representative at the conclusion of the Maintenance Period. A signed receipt of the following items by the Owner's Representative will be required at the time of final acceptance.
 - 1. Two (2) forty-eight-inch (48") tee wrenches appropriately-sized, for operating any below-grade gate valves.
 - 2. Three (3) sets of special tools required for removing, disassembling and adjusting each type of sprinkler and valve supplied on this project.
 - 3. Four (4) quick coupler keys to match manufacturer type of quick coupler.
 - 4. Four (4) sprinklers and nozzles of each type used.

2.14 INCIDENTAL MATERIALS AND EQUIPMENT

Furnish all materials and equipment not specified above which are necessary for completion of the work as intended.

2.15 MAINLINE BEDDING SAND

Sand shall consist of natural or manufactured granular material, free of organic material, mica, loam, clay or other substances not suitable for the intended purpose.

PART 3 - EXECUTION

3.1 PREPARATION AND SITE REVIEW

- A. Contractor shall consult all other relevant specification sections to determine the extent and character of work specified elsewhere but related to the irrigation system.
- B. Contractor shall be responsible for scheduling and coordinating to facilitate the most expeditious completion of the project in a professional and workmanlike manner, including all required irrigation utility connections with other project trades.
- C. Contractor shall obtain all information pertaining to locations of all existing and proposed utilities, lines, and appurtenances prior to any irrigation installation.
- D. State of California Law: Section 4216/4217 of the Government Code requires a Dig-Alert identification number be issued before a “permit to excavate” will be valid. For a Dig-Alert identification number, call Underground Service Alert toll free at (800) 227-2600, two working days before you dig.

3.2 LAYOUT AND VERIFICATION

- A. Locations and drawings are diagrammatic and approximate only. Actual work shall be changed and adjusted as necessary and as directed to meet existing conditions and obtain complete water coverage.
- B. Contractor shall stake out locations of all pipe, valves, equipment, and irrigation heads and emitters using an approved staking method and maintain the staking of the approved layout in accordance with the drawings. Verify all horizontal and vertical site dimensions prior to staking of heads. Do not exceed spacing shown on drawings for any given area. If such modified spacing demand additional or less material than shown on the drawings, notify the Landscape Architect before beginning any work in the adjacent area.
- C. Minor changes in locations of the above from locations shown shall be made as necessary to avoid existing specimen tree planting or proposed piping, utilities, structures, etc. At the Contractor's expense or when directed by the Landscape Architect.
- D. The Contractor shall be held responsible for relocation of any items without first obtaining the Landscape Architect's approval. The Contractor shall remove and relocate such items at his or her expense if so directed by the Landscape Architect.
- E. Before starting work on irrigation system, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths. The Contractor shall be aware of the fact that the drawings are based on horizontal dimensions. Actual measurements taken along the slope of a bank will differ from those shown on the drawings. Mow curbs and specimen trees shall be installed and in-place before installation of irrigation system.

- F. No fittings shall be installed on pipe underneath pavement or walls. If such a need should occur, the Contractor shall notify the Landscape Architect before beginning any work.
- G. All changes shall be recorded on the redline "As-Built Drawing" on Friday of every week.

3.3 TRENCHING

- A. Perform all trenching and excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins.
- B. Make trenches for mains, laterals and control wiring straight and true to grade and free of protruding stones, roots or other material that would prevent proper bedding of pipe or wire.
- C. Excavate trenches wide enough to allow a minimum of four-inches (4") between parallel pipe lines and eight-inches (8") from lines of other trades. Do not install irrigation lines directly parallel or vertically over one another. Maintain three-inches (3") vertical clearance between irrigation lines. Minimum transverse angle is forty-five (45) degrees. All pipes shall be serviced or replaced without disturbing the other pipes.
- D. Trenches for pipelines shall be made of sufficient depth to provide the minimum cover from finished grade as follows:
 - 1. Pressurized mainlines: eighteen-inches (18") below finish grade to top of pipe, and twenty-four inches (24") below paved areas to top of pipe, in Schedule 40 PVC sleeves.
 - 2. Non-pressurized lateral lines: twelve-inches (12") below finish grade to top of pipe, and eighteen-inches (18") below paved areas to top of pipe, in Schedule 40 PVC sleeves.
 - 3. Control wiring: to the side of the pressurized mainline, and twenty-four-inches (24") below paved areas in Schedule 40 PVC sleeves.
- E. Trenching within "drip line" of existing trees shall only be by written approval of the Landscape Architect prior to start of trenching operations.
- F. When trenching through areas where imported soil has been spread, deposit imported soils on one side of trench and subsoil on opposite side. Replace imported soil as the top cover when backfilling trench.
- G. Trenches through paved areas shall be resurfaced with same material of same quality as existing material as part of contract.

3.4 PIPING ASSEMBLY

- A. General:

1. Install assemblies and pipe to conform to respective details and where shown diagrammatically on drawings, using first class workmanship and best standard practices as approved. All fittings that are necessary for proper connections such as swing joints, offsets, and reducing bushings that are not shown on details shall be installed as necessary and directed as part of the work.
2. Do not install multiple assemblies on plastic lines. Provide each assembly with its own outlet.
3. Dielectric bushings shall be used in any connections of dissimilar metals.

B. Plastic pipe:

1. Gasketed plastic pipe: pipe-to-pipe joints or pipe to fittings shall be made in accordance with manufacturer's specifications.
2. Solvent weld or threaded plastic pipe:
 - a. Installation of all pipe and fittings shall be in strict accordance with manufacturer's specifications.
 - b. Because of the nature of plastic pipe and fittings, exercise caution in handling, loading and storing, to avoid damage. All pipe and fittings shall be stored under cover until used. Any pipe that has been dented or damaged shall be discarded until damaged section is cut out and rejoined with coupling.
 - c. Pipe shall be cut using approved PVC pipe cutters only. Sawed joints are disallowed. All field cuts shall be beveled to remove burrs and excess before gluing.
 - d. Pipe ends and fittings shall be wiped with MEK or equal, before welding solvent is applied. Welded joints shall be given a minimum of 15 minutes to set before moving or handling. Excess solvent on the exterior of the joint shall be wiped clean immediately after assembly.
 - e. Plastic to metal connections shall be made with plastic adapters and if necessary, short (not close) brass threaded-nipples. Connection shall be made with two (2) wraps of Teflon tape and hand tightened, plus one turn with a strap wrench.
 - f. Pipe shall be assembled and welded on the surface. Cure all joints according to manufacturer's specifications before placing into trench. All joints must cure at least twenty-four (24) hours before permitting water through pipe.
 - g. Snake pipe horizontally in trench to allow one-foot (1') of expansion and contraction per one-hundred feet (100') feet of straight run.
 - h. Threaded pipe joints shall be made using Teflon tape. Solvent shall not be used with threaded joints. Pipe shall be protected from tool and equipment damage during assembly. All damaged pipe shall be removed and replaced immediately. Take up threaded joints with light wrench pressure.

- i. No close nipples or risers are allowed. Cross connections in piping is not allowed.
- j. Center load pipe with small amount of backfill to prevent arching and slipping under pressure. Other than this preliminary backfill, all pipe joints, fittings and connections are to remain uncovered until successful completion of hydrostatic testing and written approval is achieved.
- k. Concrete thrust blocks shall be constructed behind all pipe four-inches (4”) diameter and larger with sufficient bearing to resist the thrust of water at all changes of direction of forty-five (45) degrees or more. Construct thrust blocks for quick couplers as per detail.

3.5 FLUSHING AND TESTING

A. Flushing:

- 1. Openings in piping system during installation are to be capped or plugged to prevent dirt and debris from entering pipe and equipment. Remove plugs when necessary to flush or complete system.
- 2. After completion and prior to the installation of any terminal fittings, the entire pipeline system shall be thoroughly flushed to remove dirt, debris, and/or other material.

B. Testing:

- 1. After flushing, the following tests shall be conducted in the sequence listed below. The Contractor shall furnish all equipment; materials and labor necessary to perform the tests and all tests shall be conducted in the presence of the Landscape Architect or Owner's Representative.
- 2. Water pressure tests shall be performed on all pressurized mainlines and non-pressurized lateral lines before any couplings, fittings, valves and the like are concealed.
- 3. Immediately prior to testing, all irrigation lines shall be purged of all entrapped air or debris by adjusting control valves and installing temporary caps forcing water and debris to be discharged from a single outlet.
- 4. Test all pressurized mainline at 150 psi for a minimum time period of four (4) hours with an allowable loss of five (5) psi. Pressure and gauges shall be read in psi and calibrated such that accurate determination of potential pressure loss can be ascertained. Pump used to energize system for pressure test shall be completely removed from the system prior to start of time period, and not reactivated at any time during the pressure test.
- 5. Test all non-pressurized lateral line at one-hundred (100) psi for a minimum time period of two (2) hours with an allowable loss of five (5) psi. Pump used to energize system for pressure test shall be completely removed from the system prior to start of time period, and not reactivated at any time during the pressure test.

6. Test all non-pressure drip pipe at forty (40) psi for a minimum time period of one (1) hour with an allowable loss of 3 psi.
7. Re-test as required after making appropriate revisions until the system meets the requirements. Any leaks, which occur during test period, will be repaired immediately following the test. All pipe shall be re-tested until final written acceptance is achieved.
8. All materials and installation procedure used for making corrections are to be the same as specified herein.

3.6 PIPE BACKFILLING AND COMPACTING

- A. Irrigation trenches shall be carefully backfilled with material approved for backfilling and free of rocks and debris one-inch (1”) in diameter and larger.
- B. Under no circumstance is pipe to rest on concrete, rock, wood blocks, or other potential deleterious items.
- C. Backfill shall be compacted with approved equipment to ninety-percent (90%) maximum density. Finish grade of all trenches shall conform to adjacent grades without clips or other irregularities. Dispose of excess soil or debris off site at Contractor's expense.
- D. Install appropriate trench marker tape on a continuous run of all pressurized line (mainline pipe) trenches, at a depth of nine-inches (9”) below finish grade.
- E. Restore all surfaces and repair existing underground installations damaged or cut as a result of the excavation to their original condition, satisfactory to the Owner's Representative.
- F. Any settling of backfill material during the maintenance or warranty period shall be repaired at the Contractor's expense, including any replacement or repair of soil, lawn, and plant material or paving surface. Surface drainage flows shall be maintained by design.

3.7 INSTALLATION OF EQUIPMENT

- A. Isolation Valves (Gate Valves / Ball Valves / Globe Valves, etc):
 1. Install as required at locations designated on drawings within an appropriate valve box.
- B. Check Valves / Anti-Drain Valves:
 1. Install as shown on details at locations necessary to prevent low head run off.
 2. Install in-line anti-drain valves as warranted by site conditions to alleviate low head drainage.

C. Remote Control Valves and Valve Manifolds:

1. Install as shown on detail at locations designated on plans and house each valve in an individual box. Group valves together where practical and locate in shrub areas.
2. Remote control valves shall have a recycled water identification tag installed on the top portion.
3. Remote control valve manifolds and quick-coupling valves shall be connected separately on the mainline, allowing use of a quick coupler with all remote control valves shut off.
4. Review all valve box locations with Owner's Representative prior to installation of valves. Install boxes no farther than twelve-inches (12”) from edge of paving and perpendicular to edge of paving and parallel to each other. Allow six-inches (6”) clearance between adjacent boxes.

D. Quick Coupling Valve:

1. Install quick coupling valve as shown in detail with thrust block and locate where indicated on plans. Install within valve box, and in accordance with plans and details.
2. Quick coupling valves shall have a recycled water identification tag installed on the top portion.
3. In turf areas, such equipment shall be installed in a valve box set to finish grade.

E. Valve Boxes:

1. Install one valve box for each type of valve installed as per the details. No more than one valve shall be installed in any single valve box.
2. All valve boxes shall be set two-inches (2”) above finish grade in shrub and groundcover areas, and flush with finish grade in turf areas.
3. All valve boxes shall be set parallel with each other and with adjacent hardscape element (walkways, curbs, vehicular drives, buildings, fences, etc).
4. Gravel sump shall be installed after compaction of all trenches. Final portion of gravel shall be placed inside valve box after valve is backfilled and compacted.
5. All valve boxes shall have proper base support with unmortared bricks, and any necessary extensions to provide proper access and prevent any settling of boxes. Provide extensions as required. Fill in any settling adjacent to boxes.
6. Boxes shall be installed so that all valve handles and other components operate freely and function properly within the box (open/close, etc).
7. Heat-brand valve number and controller letter on top of valve box lid, in one-and-one-half-inch (1-1/2”) size letters.

F. Sprinklers / Drip Irrigation:

1. All mainlines and lateral lines, including risers, shall be flushed and pressure tested before installing sprinkler heads, after which a water coverage test shall be performed.
2. Install specified sprinkler heads as shown in details at locations shown on the plans. Adjust layout for full coverage, spacing of heads shall not exceed the maximum spacing recommended by the manufacturer.
3. Drip emitters and drip irrigation distribution tubing shall be installed per detail, in subterranean emitter boxes.
4. Drip irrigation distribution tubing: Install a minimum depth of eight-inches (8”) below finish grade of soil (not finish grade of bark mulch), from the emitter box throughout the entire length of the tubing. Do not lay distribution tubing along the soil surface. The distribution tubing shall be brought to the surface (daylighted) only within twelve-inches (12”) of the root ball or plant location. Extend distribution tubing two-inches (2”) above finish grade at the exit point.
5. Drip irrigation: Stake all surface emitters and distribution tubing with approved tubing stakes. Install bug cap at discharge end per detail as shown on plans.

G. Wiring:

1. Low voltage wiring:
 - a. Control wiring between controller and electrical valves shall be installed in the same trench as the mainline where practical. The wire shall be bundled and secured to the lower quadrant of the trench at ten-feet (10’) intervals with plastic electrical tape.
 - b. When the control wiring cannot be installed in same mainline trench it shall be installed a minimum of 18-inches (18”) below finish grade and a bright colored plastic ribbon with suitable markings shall be installed in the trench six-inches (6”) below grade directly over the wire.
 - c. An expansion loop shall be provided every five-hundred-feet (500’) in a box and inside each valve box. Expansion loop shall be formed by wrapping wire at least eight (8) times around a three-quarter-inch (3/4”) pipe and then withdrawing pipe from the coiled wire.
 - d. Provide one control wire to service each remote control valve in the system.
 - e. Provide one common wire per controller.
 - f. Run two (2) spare #12 wires from controller along entire mainline to last electric remote control valve on each, and every leg of mainline. Label spare wires at controller and wire stub to be located in a box.
 - g. All control wire splices not occurring at control valve shall be installed in a separate splice valve box.
 - h. Wire markers (sealed, 1” to 3” square) are to identify control wires at valves and at terminal strips of controller. At the terminal strip mark each wire clearly indicting valve circuit number.
2. High voltage wiring for Automatic Controller Assembly:

- a. All electrical work shall conform to any and all local codes, ordinances, and any authorities having jurisdiction.
 - b. All high voltage electrical work shall be performed by a State of California Licensed Electrician.
 - c. The Contractor shall provide 120-volt power connection to the Automatic Controller Assembly, unless noted otherwise on plans.
3. Tracer Wire:
 - a. Tracer wire shall be installed with non-metallic plastic irrigation mainlines where controller wires are not buried in the same trench as the mainline.
 - b. The tracer wire shall be placed on the bottom of the trench under the vertical projection of the pipe with spliced joints soldered and covered with insulation type tape.
 - c. Tracer wire shall be of a color not used for valve wiring. Terminate wire in a valve box. Provide enough length of wire to make a loop and attach wire marker with the designation "tracer wire".

3.8 ADJUSTMENT AND COVERAGE TEST

A. Adjustment:

1. The Contractor shall flush and adjust all sprinkler heads, valves and all other equipment to ascertain that they function according to the manufacturer's data.
2. Adjust all sprinkler heads so as to not overspray onto walks, roadways, buildings, and other hardscape elements when under maximum operating pressure and during times of normal prevailing winds.
3. All sprinkler heads shall be set perpendicular to finish grade unless otherwise designated on the plans or details.

B. Coverage test:

1. The Contractor shall perform the coverage test for the Landscape Architect or Owner's Representative after all sprinkler heads have been installed, flushed and adjusted. Each section is tested to provide uniform and adequate coverage of the areas serviced.
2. Any systems that require adjustments for full and even coverage shall be done by the Contractor prior to final acceptance at the direction of the Landscape Architect or Owner's Representative at no additional cost. Adjustments may also include realignment of pipes, addition of extra heads, and changes in nozzle type or size.
3. The Contractor shall immediately correct all unauthorized changes or poor installation practices at no additional cost.
4. The entire system shall be operating properly with written approval prior to any planting operations.

3.9 CLEAN-UP AND SAFE ENVIRONMENT

As project progresses, Contractor shall maintain all areas in a neat and safe manner, and remove unsightly debris as necessary. After completion of project each day, Contractor shall remove all debris and containers used in accomplishing work. Contractor shall be responsible for disposing of, off site, at no additional expense, any trash or debris generated by the installation of the work.

3.10 GENERAL MAINTENANCE AND THE MAINTENANCE PERIOD

- A. General maintenance shall begin immediately after installation of irrigation system. The general maintenance and the maintenance period shall include the following:
 - 1. On a weekly basis the Contractor shall keep the irrigation system in good running order and make inspections on the entire system for proper operation and coverage. Contractor shall continue to adjust sprinkler nozzles as necessary to obtain optimum coverage and minimum overspray of water on hardscape elements throughout the Maintenance Period. Repair and cleaning shall be done as necessary to keep the system in full operation.
 - 2. Drip irrigation: Flush lateral systems one (1) time per month minimum during the Maintenance Period.
 - 3. Records of all timing changes to control valves from initial installation to time of final acceptance shall be kept and turned over to the Owner's Representative at the time of final acceptance.
 - 4. During the last week of the Maintenance Period, provide equipment familiarization and instruction on the total operations of the system to the Owner's Representative and to the personnel who will assume responsibility for running the irrigation system. A signed receipt by the Owner's Representative that the equipment familiarization and instruction occurred will be required at the time of final acceptance.
 - 5. At the end of the Maintenance Period, turn over all operations logs, manuals, instructions, schedules, keys and any other equipment necessary for operation of the irrigation system to the Owner's Representative, who will assume responsibility for the operations and maintenance of the irrigation system. A signed receipt by the Owner's Representative that these items are received will be required at the time of final acceptance.
- B. The Maintenance Period for the irrigation system shall coincide with the ninety (90) day Maintenance Period for the landscape materials.

SECTION 329000 – LANDSCAPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including general and supplementary conditions and Division I specifications, apply to work of this section.

1.2 SUMMARY

- A. Section includes (not all inclusive):
 - 1. Plants.
 - 2. Planting soils, soil amendments, and fertilizers.
 - 3. Tree stabilization.
 - 4. Erosion control matting and fiber rolls.
 - 5. Landscape boulders.
 - 6. Rock cobble mulch.
 - 7. Bark mulch.
 - 8. Root barriers.
 - 9. Filter fabric.

1.3 SCOPE OF WORK

- A. The work includes all labor, materials, appliances, tools, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of "landscaping," complete as shown on the drawings and as specified herein.

1.4 RELATED SECTIONS

- A. 328400 – Irrigation Systems.

1.5 DEFINITIONS

- A. ANSI Z60.1-2014: The *American Standard for Nursery Stock*, published by American Horticulture Industry Association d/b/a AmericanHort, 2130 Stella Court, Columbus, OH 43215, and approved by American National Standards Institute (ANSI); approved April 14, 2014.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- C. Brown Trunk Height (BTH): Palm height measurement. Measured from finish grade to lowest viable frond petiole. Note: Differs from ANSI Z60.1-2014 definition for “trunk height”.

- D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1-2014 for type and size of plant required.
- E. Finish Grade: Elevation of finished surface of planting soil.
- F. Imported Soil: Soil brought into the project from a source outside the limits of the project, to be used as a planting soil in a planting area.
- G. Pest: Living organisms that occur where they are not desired, or that cause damage to plants, animals, property, or people. These include (not all inclusive) insects, mites, scale, thrips, grubs, mollusks (snails and slugs), rodents and unwanted animals (gophers, rats, squirrels, moles, mice, oposums, rabbits, snakes), unwanted plants (weeds), algae, fungi, bacteria, and viruses.
- H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes (not all inclusive) insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, palms, ground covers, turfgrasses, ornamental grasses, annual color, perennial color, bulbs, corms, tubers, or herbaceous vegetation.
- J. Planting Area: Area to be planted.
- K. Planting Soil: Existing on-site cut soil, existing on-site fill soil, existing on-site native undisturbed soil, imported soil, manufactured topsoil, or surface soil, modified with soil amendments to become topsoil in planting areas.
- L. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees or shrubs below the soil surface.
- M. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- N. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- O. Trunk Flare: See root flare.

1.6 VERIFICATION OF EXISTING CONDITIONS

- A. All scaled dimensions on the drawings are approximate. Before proceeding with any work, the Contractor shall carefully check and verify all dimensions, quantities, and grade elevations, and shall immediately inform the Owner's Representative of any discrepancies.
- B. Prior to the excavation for planting or placing of plant materials, the Contractor shall verify the location of all underground utility lines and other improvements, and take proper precautions to avoid damage to such improvements. In the event of conflict between such improvements and plant locations, the Contractor shall notify the Owner's Representative, and arrangements will be made for relocation as necessary. Failure to follow this procedure places upon the Contractor the responsibility for making any and all repairs for damage resulting from work as herein specified at his own expense.
- C. The specified soil amendments and their rates of application are for bidding purpose only. The Contractor shall verify the soil conditions through soil testing.

1.7 SUBMITTALS AND SUBSTITUTIONS

- A. Upon 15 days after the Contractor has received the Owner's notice to proceed, the Contractor shall submit to the Landscape Architect 3 typewritten lists of all materials proposed with quantities, size, quality, and source.
- B. Prior to installation of any landscape elements, the Contractor shall submit for approval by the Landscape Architect, a list of all materials and equipment proposed for use. Submit product data, catalog cut sheets, and/or other types of pertinent information to the Landscape Architect for approval, such as (not all inclusive):
 - 1. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod, person, or other measuring device in each photograph. For species where more than twenty plants are required, include a minimum of 3 photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant (genus, species, subspecies, variety, cultivar, etc), plant size, and name of the growing nursery. Photographs shall be submitted to Landscape Architect after completion of rough grading.
 - 2. Tree standpipe components, including PVC drainpipe, filter fabric, and drain grates.
 - 3. Staking and tying materials.
 - 4. All soil conditioners, soil amendments, fertilizers, and other chemicals.
 - 5. Imported soil (reference Imported Soil in this section).
 - 6. All hydroseed materials, including High Performance-Flexible Growth Medium (HP-FGM).
 - 7. Root barrier.
 - 8. Filter fabric.
 - 9. Landscape boulders.
 - 10. Bark mulch.

11. Rock mulch
12. Erosion control matting.
13. Fiber rolls.
14. Pesticides: Include copies of sample label, Material Safety Data Sheet (MSDS), and manufacturer's application instructions specific to the Project.

C. Samples for verification for each of the following:

1. Bark Mulch: 1 quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
2. Rock Cobble Mulch: 15 lb minimum of mulch required, labeled with source of material. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.
3. Filter fabric: 12 by 12 inches.
4. Root barrier: Width of panel by 12 inches.
5. Actual samples of the soil amendments shall be submitted to the Landscape Architect, only if requested by the Landscape Architect after approval of the soil test.

D. Qualification Data: For Landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

E. Soil Test with Written Recommendations on Planting Soil:

F. Certificates, trip slips, and invoices for all soil amendments, plant materials, rock products, and bark mulch shall be provided to the Owner's Representative prior to Final Acceptance of the work.

G. Substitutions for the indicated materials will only be permitted provided the substitute materials are approved in writing, in advance, by the Landscape Architect and the Owner's Representative. All substitute materials shall conform to the requirements of these specifications. If accepted substitute materials are of less value than those indicated or specified, the contract price will be adjusted in accordance with the provisions of the contract.

H. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a typical calendar year. Submit before expiration of required Maintenance Period.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

2. Experience: Five years' minimum experience in professional landscape installation in addition to requirements in Section 014000 "Quality Requirements."
 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Pesticide Applicator: State licensed, commercial.
- C. All soil samples shall go to an approved and qualified soil-testing laboratory. Laboratory shall be qualified for performing soil analyses, with demonstrated academic research including scientific publications in peer-reviewed journals on soil science, plant nutrition, trace minerals, environmental stresses, and site restoration, and membership in national agronomic and soil science organizations. Approved soil-testing laboratory:
- a. Wallace Laboratories, 365 Coral Circle, El Segundo, CA 90245, Phone: (310) 615-0116, Fax: (310) 640-6863, www.bettersoils.com, no known equal.
- D. Soil Test Requirements For Existing On-Site Cut Soils, Existing On-Site Fill Soils, and Existing On-Site Native Undisturbed Soils Used As Planting Soil: Soil test shall be submitted to an approved and qualified soil-testing laboratory. Testing methods shall comply with the United States Department of Agriculture Handbook Publication No. 60, Methods of Soil Analysis published by the Soil Science Society of America and peer-reviewed methods published in scientific journals. Evaluations and recommendations shall be based on University of California publications and peer-reviewed articles published in scientific journals.
1. The Owner's Representative shall appoint a representative to oversee soil sampling that may be required. The time, depth, location, and number of samples to be taken as per instructions from the Owner's Representative. A minimum of 3 representative samples shall be taken from random and varied locations of the project site that will receive landscaping installation after final finish grades have been achieved in all planter areas. Samples shall represent major conditions of existing on-site cut soils, existing on-site fill soils, and existing on-site native undisturbed soil. Sample from the top foot for ground cover and shrubs. Sample from the expected depth for large container stock. Label each sample for location/origin, type of soil condition visibly observed, and sampling depth. Laboratory report shall identify each sample with same information. All samples taken shall be split into 2 samples, one half will go to a qualified laboratory by the Contractor (at his or her expense) and the other half will be retained by the Owner's Representative. All samples shall be at least one pint in volume.
 2. The Contractor shall provide the Owner's Representative and the Landscape Architect with a copy of the written report by the approved laboratory. All soil samples shall be analyzed for:
 - a. pH measurement in the saturated extract paste.
 - b. Determination whether limestone is present or not.
 - c. Percent water in saturation extract.
 - d. Electrical conductivity of the saturated extract (salinity ECe)/soluble salts.
 - e. Saturation extract analysis for the major soluble ions: calcium, magnesium, sodium, potassium, chloride, nitrate and sulfate.
 - f. Measurement of sodicity (Sodium Adsorption Ratio).

- g. Concentration of boron in saturation extract.
 - h. Extractable nutrients and minerals, including:
 - 1) Potassium.
 - 2) Phosphorus.
 - 3) Sulfur.
 - 4) Magnesium.
 - 5) Iron.
 - 6) Manganese.
 - 7) Zinc.
 - 8) Copper.
 - 9) Boron.
 - 10) Sodium.
 - 11) Molybdenum.
 - i. Problem minerals which may be present including:
 - 1) Aluminum.
 - 2) Arsenic.
 - 3) Barium.
 - 4) Cadmium.
 - 5) Chromium.
 - 6) Cobalt.
 - 7) Lead.
 - 8) Lithium.
 - 9) Vanadium.
3. The extraction methods utilized by the laboratory must be standard methods. Interpretation of the data must be given. The laboratory shall also provide an estimate of the soil texture and soil organic matter.
4. Each soil test shall include written recommendations (by the approved laboratory that conducted the soil test) for soil treatments and soil amendments to be added based upon test results. These recommendations shall include:
- a. Volume of soil amendment per 1,000 sq.ft. and per cu.yd. of backfill mix.
 - b. Pounds of gypsum per 1,000 sq.ft. and per cu.yd. of backfill mix.
 - c. Pounds of soil sulfur per 1,000 sq.ft. and per cu.yd. of backfill mix.
 - d. Pounds of iron sulfate per 1,000 sq.ft. and per cu.yd. of backfill mix.
 - e. Pounds of pre-plant fertilizer per 1,000 sq.ft. and per cu.yd. of backfill mix.
 - f. Pounds of soil polymers per 1,000 sq.ft. and per cu.yd. of backfill mix.
 - g. Recommendation for soil leaching.
 - h. Recommendation for tree drain installation.
 - i. Pounds of maintenance fertilizer per 1,000 sq. ft. and analysis.
 - j. Recommendation for soil wetting agent and application rate.

- k. Percent of site soil-to-soil amendment in backfill mix.
- l. Whether or not soil polymers need to be added to soil.

If any of the above listed items are not recommended, the recommendation shall call for zero volume or zero poundage per 1,000 square feet.

5. Contractor shall be responsible for all fees associated with soil-testing and soil analysis.

- C. Soil Test Requirements for Imported Soil: Reference approved soil testing laboratory above and reference Imported Soil in this section. Soil test shall be submitted to an approved and qualified soil-testing laboratory. Testing methods shall comply with the United States Department of Agriculture Handbook Publication No. 60, Methods of Soil Analysis published by the Soil Science Society of America and peer-reviewed methods published in scientific journals. Evaluations and recommendations shall be based on University of California publications and peer-reviewed articles published in scientific journals.

1.9 WARRANTEES AND REPLACEMENTS

- A. Special Warrantee: All plant material 15-gallon size and larger shall be guaranteed to live and grow in a healthy condition during the Contract Period, Maintenance Period, and for a 1 year period from the date of Final Acceptance. The Contractor shall not be held responsible for failure due to neglect by the Owner, vandalism, etc. during the guarantee period. Report such conditions to the Owner's Representative immediately in writing.
- B. All plant material smaller than 15 gallon size shall be guaranteed to live and grow in vigorous, healthy, and upright condition for a minimum of 90 days after Final Acceptance of work (excluding seasonal color).
- C. Replacement: All plants not healthy and in a vigorous growing condition as determined by the Owner's Representative shall be replaced immediately. Plants used for replacement shall be the same kind and size as specified in the plant legend as shown on the drawings. They shall be furnished, planted, and fertilized as originally specified at no cost to the Owner.

1.10 PROTECTION OF EXISTING IMPROVEMENTS

- A. During the construction and Maintenance Period, the Contractor shall take every precaution to protect and avoid damage to sprinkler heads, irrigation lines, drainage lines, existing underground facilities, paving, structures, fixtures, and existing plantings. The Contractor shall be held responsible for any and all damage to such improvements and shall completely repair or replace the same at no cost to the Owner.

1.11 PROTECTION OF EXISTING AND NEW LANDSCAPE

- A. It is the intent of the project that certain of the existing plant material shall be retained. Prior to clearing and grubbing, the Contractor shall identify to the Owner's Representative those plants that are to remain.

- B. All existing plants that are to remain in the project shall be tagged and identified by the Contractor prior to start of work. Contractor shall provide maintenance for existing material during construction, including the assurance of adequate irrigation applications. Contractor shall not hinder or inhibit maintenance and irrigation coverage of existing and surrounding vegetation during construction.
- C. Damage to a plant that results in death or permanent disfiguration shall result in the complete removal of the plant, including roots from the site by the Contractor. The Contractor at his or her own expense shall replace the plant with one of equal value as established by the Landscape Architect or reimburse the Owner the cost of said replacement if a replacement cannot be obtained. The Landscape Architect shall be the sole judge of the replacement of the plant.
- D. All existing plant material to remain shall be protected at all times from damage by personnel and equipment. All damage by the Contractor to existing vegetation shall be repaired and/or replaced with equal material of the same species at his or her own expense.
- E. The Contractor shall ensure that no foreign or deleterious material and/or liquid (such as, but not all inclusive: paint, paint washout, concrete slurry, concrete washout, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, or the like) be deposited or allowed to be deposited in any soil within any planting area, or within 6 feet of the trunk of a vine in a planting pocket. Should any such pollution of the soil occur, the Contractor shall remove the soil and included pollution a minimum depth of 6 inches below the material and replace with clean on-site fill soil or imported soil at no expense to the Owner.
- F. Where it is necessary to excavate in close proximity to any existing plant material, all possible caution shall be exercised to avoid injury to existing roots and trunk. Excavation within the drip line (a line drawn directly under the tips of its outermost branches) on any existing tree or large shrub shall be done only by careful hand digging, tunneling (water jetting), and/or pneumatically underneath or around existing roots 1 inch and larger in diameter. Keep any exposed roots in open trenches shaded with moist burlap or moist canvas at all times. Cutting of any roots 1 inch and larger in diameter shall be done only under the approval of the Owner's Representative, and shall be recorded in a Tree Root Pruning Log (TRP Log) that shall be presented to the Owner's Representative upon completion of the project. The TRP Log shall identify for each affected tree: tree species, accurate description of the tree location within the site, approximate trunk diameter at breast height (DBH), root pruning description, and the date of root pruning. The root pruning description within the TRP Log shall give an accurate description of each root pruned for each affected tree, including the diameter size of the root at the pruning cut, the distance away from the trunk where the root was pruned, and the relative side (north, east, west, south) on the affected tree. Do not treat cut roots with sealing type paints.

1.12 DELIVERING AND INVOICING OF MATERIALS

- A. The Contractor shall notify the Landscape Architect in advance when material is scheduled for each delivery, in order to ensure satisfactory coordination of delivery and to expedite the

required observation at the point of delivery. The delivery of the material shall include invoices certifying that subject material has been inspected as required by the State Agricultural Code prior to acceptance or installation. Particular care, using approved equipment, shall be exercised to ensure safe loading, unloading, shipping and handling for all material from source to in place locations indicated on the drawings.

- B. The Contractor shall furnish the Landscape Architect with 3 copies of signed, legible certificates and/or invoices stating the quality and quantity of all items herein specified at time of delivery. Recommendation shall be made by the Landscape Architect to the Owner to stop work progress until certificates are received and reviewed by the Landscape Architect.
- C. Upon delivery of materials and/or completion of all soil amending and with the heretofore specified signed copies of required certificates, trip slips and invoices for soil preparation materials the Landscape Architect shall invoice such material, comparing the total quantities of each material furnished against the total area of each operation. If the minimum rates of application have not been met, the Landscape Architect will require the distribution of additional quantities of these materials to fulfill the minimum application requirements specified.
- D. After installation of plant material, but prior to the pre-maintenance site observation, the Landscape Architect, with the heretofore specified signed copies of the required certificates and related items, shall invoice such material, comparing the total area and/or the amounts specified. If the minimum amounts have not been furnished, the Landscape Architect will require the installation of additional materials to fulfill the minimum requirements specified.

1.13 SITE OBSERVATIONS

- A. Site observations herein specified shall be made by the Landscape Architect during regular business hours. The Contractor or his authorized representative shall be on the site at the time of each observation. The Contractor will not be permitted to initiate the succeeding step of work until he has received approval to proceed by the Landscape Architect. The Contractor shall notify the Landscape Architect of a site observation at least 3 business days in advance of an observation.
- B. All changes and deviations to the plans and specifications shall be communicated to the Construction Manager, and shall be confirmed in writing.
- C. The Contractor shall have sufficient work personnel available during normal working hours to correct deficiencies immediately upon request of the Landscape Architect. Such repair or re-work services are to be performed without interference of regular project schedule.
- D. Site observations will be required for the following parts of work:
 - 1. Pre-Construction Meeting: Immediately prior to the commencement of work of this section, the Owner's Representative, Contractor, and Landscape Architect shall meet for the approval of the materials specified, equipment, schedule of work and the method of installation.

2. Layout of Specimen Trees: When trees are spotted in place for planting, but before planting holes are excavated.
3. Incorporation of Soil Amendments: Specified soil amendments are for bidding purposes only. A final soil test performed by an approved laboratory shall be submitted and paid for by the Contractor for agricultural suitability recommendations and approved by the Landscape Architect before planting begins.
4. Finish Grading: Upon completion of soil amending, the finish grading and layout for planter edging shall be approved in the field by the Landscape Architect prior to installation of plants and planter edging.
5. Approval of Plant Material Delivered On-Site: Shrub and tree samples, three (3) each of all varieties and sizes (for shrubs and trees 15-gallon and under) shall be submitted for approval by the Landscape Architect at the site a minimum of fifteen (15) days prior to planting operations for quality, size, variety, health, vigor, and rooting characteristics. Approved samples shall remain on the site and shall be maintained, by the Contractor as standards of comparison for plant material to be furnished.
6. Layout of Plant Material: When material is spotted in place for planting, but prior to excavation of planting pits.
7. Pre-Maintenance Period Observation: When planting and all specified work has been installed and completed, the Landscape Architect will prepare a written “punch list” indicating all items to be corrected. These items must be completed prior to initiating the beginning date of the Maintenance Period. The Landscape Architect will inform the Owner and Contractor of the actual date of the start of the Maintenance Period in writing. This observation is not the Final Acceptance of the project, and does not relieve the Contractor from any of the responsibilities in the contract documents.
8. Final Site Observation and Final Acceptance of the Project: At the conclusion of the Maintenance Period a final site observation will be made. The Contractor shall show all corrections made from the “punch list.” Any items deemed not acceptable shall be reworked and the Maintenance Period will be extended. The Contractor will be notified in writing that the contract work and Maintenance Period has been accepted or that the Maintenance Period has been extended to correct any deficiencies remaining. When Final Acceptance of the project is achieved and confirmed in writing, then it shall establish the beginning date for the guarantee period.

- E. Site observations of the work shall not relieve the Contractor of the obligation to fulfill all conditions of the contract.

1.14 SUSPENSION OF WORK

- A. The Landscape Architect shall recommend to the Owner’s Representative any necessity to suspend the work wholly, or in part, for such period or periods as he/she may deem necessary due to unsuitable weather, or such other conditions as are considered unfavorable for the reasonable performance of the work, or for such time as is necessary due to the failure on the part of the Contractor to carry out orders given or to perform any or all provisions of the contract.

- B. If it should become necessary to stop work for an indefinite period, the Contractor shall store all materials in such a manner that they will not become an obstruction nor become damaged in any way, and he shall take every precaution to prevent damage or deterioration of the work performed. The Contractor shall cover all open excavations and shall provide suitable drainage by opening ditches, planting pits, etc., and erect temporary structures where necessary.
- C. Grading, soil preparation, and planting work shall be performed only during periods when beneficial and optimum results may be obtained. Excessive soil moisture that would destroy the soil structure, soil spreading, grading, and/or tilling operations shall be suspended until the moisture content reaches acceptable levels and the desired results are attainable. Moisten excessively dry soil that is not workable and which is too dusty before working the soil.

PART 2 - PRODUCTS

2.1 QUALITY

- A. All materials shall be of standard, approved, and first grade quality and shall be in prime condition when installed and accepted. All commercially processed and/or packaged materials shall be delivered to the site in the original unopened containers bearing the manufacturer's guaranteed analysis.

2.2 SOIL AMENDMENTS AND FERTILIZERS

- A. Soil Conditioner: Shall be a product that aids the structure of the soil consisting of rapidly decaying, slowly decaying and non-decaying material. The rate of decomposition of this amendment is very important.
 - 1. The humus material shall have an ash content of no less than 8% and no more than 50%.
 - 2. The pH of the material shall be between 6 and 7.5.
 - 3. The salt content shall be less than 10 millimho/cm @ 25° C. (ECe less than 10) on a saturated paste extract.
 - 4. Boron content of the saturated extract shall be less than 1.0 parts per million.
 - 5. Silicon content (acid-insoluble ash) shall be less than 30%.
 - 6. Calcium carbonate shall not be present if to be applied on alkaline soils.
 - 7. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, sludges, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
 - 8. Composted wood products are conditionally acceptable (stable humus must be present). Wood based products are not acceptable which are based on redwood or cedar.
 - 9. Sludge-based materials are not acceptable if the soil already has a high level (toxic level) of zinc, copper or other heavy metals based on soil analysis.
 - 10. Carbon:nitrogen ratio is less than 25:1.
 - 11. The compost shall be aerobic without malodorous presence of decomposition products.

12. The maximum particle size shall be 0.5 inch, 80% or more shall pass a No. 4 screen. Maximum total permissible pollutant concentrations in amendment in parts per million on a dry weight basis:
- | | |
|----------------|-----|
| a. arsenic: | 20 |
| b. cadmium: | 15 |
| c. chromium: | 300 |
| d. cobalt: | 50 |
| e. copper: | 150 |
| f. lead: | 200 |
| g. mercury: | 10 |
| h. molybdenum: | 60 |
| i. nickel: | 100 |
| j. selenium: | 50 |
| k. silver: | 10 |
| l. vanadium: | 50 |
| m. zinc: | 300 |
13. The commercial grade product used shall be Loamex, or equal.
- B. Agricultural Grade Gypsum: Shall be a ($\text{CaSO}_4 - 2\text{H}_2\text{O}$) calcium sulfate product – minimum 92% grade. Ninety-percent (90%) shall pass a 50-mesh screen. Control of dust during application is mandatory. The commercial grade product used shall be U.S. Gypsum, Sof'n'Soil, Dolmar, or equal.
- C. Sulfur (Soil Sulfur): Shall be elemental sulfur (99.5%) commercially manufactured so that a pure sulfur product is used. Sulfur is a constituent of three amino acids (cystine, methionine and cysteine) and is essential for protein synthesis. Sulfur is also supplied by gypsum. Sulfur is not effective until it is oxidizes. The bacteria are specific for this and are not common in alkaline soils. The oxidization may require months or years. Gypsum is rapid in its actions. The sulfur used shall be 99.5% elemental. Sizing on stacked screen shall be approximately: 8-mesh 4.3 %; 20-mesh 7.8 %; 50-mesh 46.9 %; 100-mesh 39.3 %; 200-mesh 1.7%. The commercial grade product used shall be Wil-Gro; Union Chemicals, Baker Industries, or equal.
- D. Iron Sulfate: Derived from sulfate-deep green ($\text{FeSO}_4, 7\text{H}_2\text{O}$), a minimum analysis of iron shall be expressed as metallic is 20.0%. The commercial grade product used shall be Wil-Gro, Bandini, Wilson & Geo. Meyer, or equal.
- E. Chelated Iron: Shall be Becker Underwood Sprint 138 Fe or other equal commercial FeEDDHA for dicots and woody plants, and shall be Becker Underwood Sprint 330 Fe or other equal commercial FeDTPA for grasses and monocots.
- F. Pre-Plant Starter Fertilizer (1-10-10): Analysis shall be a commercial grade flowable fertilizer with 1% nitrogen; 10% phosphorous pentoxide, and 10% potassium oxide. No potassium chloride shall be used. Organic nitrogen shall be from cottonseed meal and urea. Phosphorous from superphosphate and cottonseed meal. Potassium (potash) from sulfate of

potash and cottonseed meal. Screen analysis 74% to be retained on a 20-mesh screen. 0% to pass a 4-mesh screen, and 2 % to pass a 48-mesh screen. The commercial grade product used shall be Wil-Gro, Gro-Power, Bandini, Kellogg, or equal.

- G. Prilled Post-Plant Fertilizer (14-7-3) for Maintenance - All Planter Areas: A maintenance fertilizer shall be used that is granular and homogeneous. Iron and zinc shall be in chelated form and sizing of granules during manufacture is very important. A regular maintenance program using this product for at least the first year is recommended. The homogeneous fertilizer granules used shall contain a fertilizer analysis of 14% nitrogen of which 4% is ammoniac sulfate. Remainder of nitrogen shall be 8.75% water soluble and 1.25% water insoluble. Available phosphorous pentoxide shall be 7%. Potassium oxide shall be 3%. Minor elements shall be chelated 25% by volume consisting of iron 2.0%; zinc 0.15% and manganese 0.15%. By-product calcium shall be 2.0%. Organic nitrogen is derived from urea and cottonseed meal. Phosphate from superphosphate and cottonseed meal. Potash from sulfate of potash and cottonseed meal. No potassium chloride is to be used. Sulfur from sulfate of ammonia. Calcium from superphosphate, iron from ferrous sulfate and mixed sulfides. Zinc and manganese are expressed as metallic and in their elemental form. Screen analysis (% retained) approximately: 4-mesh 1.3%; 8 mesh = 24.2%; 20-mesh = 74.0%; and 48-mesh = 0.05%. The commercial grade product used shall be Wil-Gro Fairway, Gro-Power, Bandini, Kellogg, or equal.
- H. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
1. Size: 7-gram or 21-gram.
 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.
 3. Time Release: 24 months.

The commercial grade product used shall be Agriform, Gro-Power, or equal.

2.3 WETTING AGENT

- A. An adjuvant (helping agent) is needed to make water penetrate difficult to wet soils. Also, organic soil amendments are more receptive to increased water holding capacity. Soil water repellence resulting from compaction will be overcome with multiple applications of a soil penetrant in the irrigation water.
- B. Product used shall have the following functioning agents: 2- hydroxyethyl ammonium-alkyl benzene sulfonate = 8.77%; alkyl phenoxy poly - (ethylene oxy) ethanol = 4.49%; di (2 hydroxy ethyl)- ammonium cis-9 otadecenoate-octyl alkylidamide = 2.50 %; dimethyl silicone = 1.00 %; carrier = 83.24 %. Adjuvant used shall be a commercial grade product and manufactured by Naiad/Wil-Gro, Dow, Dupont, or equal.

2.4 PLANTING BACKFILL FOR TREES AND SHRUBS

- A. Planting backfill shall be a thoroughly blended mixture of site soil and soil amendments at the following mixtures:

1.	soil conditioner	0.15 cu.yd.
2.	site soil from excavated planting pit	0.85 cu.yd.
3.	gypsum	10 lbs. per cu.yd. of mix.
4.	iron sulfate	5lbs. per cu.yd. of mix.
5.	pre-plant (1-10-10)	5lbs. per cu.yd. of mix.

2.5 IMPORTED SOIL FOR PLANTER AREAS

- A. General:

1. Imported soil shall be from a source outside the limits of the project selected by the Contractor and in compliance with the requirements specified herein. Imported soil shall be screened, fertile, friable soil from well-drained aerated land, and shall be free of roots, clods, heavy clay, pockets of coarse sand, stones larger than 1 inch in the greatest dimension, paint, paint washout, asphaltic concrete, cement, concrete, concrete washout, plaster, plaster washout, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid or the like, noxious or invasive weeds (such as, but not all inclusive: Quackgrass, Johnsongrass, Poison ivy, Nutsedge, Nimblewill, Canada thistle, Bindweed, Bentgrass, Wild garlic, Ground ivy, Creeping woodsorrel, Bermuda buttercup, Spurge, and Bromegrass), sticks, lumber, brush, other litter and/or refuse, or any material that might be deleterious to healthy plant growth. Imported soil shall not be infested with nematodes or other undesirable organisms, such as insects and disease-causing plant pathogens. Imported soil shall be friable and have sufficient structure in order to give good tilth and aeration to the soil. Continuous, air-filled pore space content on a volume/volume basis shall be at least 5 percent (5%) when moisture is present at field capacity. Imported soil shall have a field capacity of at least 15 percent (15%) on a dry weight basis.
2. At least 15 days before scheduled use, the proposed source and associated soil test on the actual imported soil to be used on the project shall be submitted to the Landscape Architect for approval. The Contractor shall submit a written request for approval, accompanied by a recent written report from an approved soil-testing laboratory registered by the State of California for agricultural soil evaluation, which states that the proposed imported soil to actually be installed on the project complies with the specifications below. Reference Part 1 of this section for a listing of approved soil-testing laboratories. Imported soil shall meet the following requirements:

- B. Gradation Limits: Soil shall be sandy loam, loam, or clay loam. The sand, clay and silt gradation limits shall be as defined by the USDA classification scheme. Gravel over 1/4 inch in diameter shall be less than 15 percent (15%) by weight.
- C. Permeability Rate: Hydraulic conductivity rate shall be 5 to 10 inches per hour when tested in accordance with the USDA Handbook Number 60, method 34b or other approved methods.

- D. Agricultural Suitability: The soil shall be suitable to sustain the growth of the plants specified as per USDA specs.
- E. Fertility: The range of the essential elemental concentration in soil shall be as follows:
- Ammonium Bicarbonate/DTPA Extraction
Parts per million (mg/kilogram) dry weight basis:
1. phosphorus 2 - 40
 2. potassium 40 - 220
 3. iron 2 - 35
 4. manganese 0.3 - 6
 5. zinc 0.6 - 8
 6. copper 0.1 - 5
 7. boron 0.2 - 1
 8. magnesium 50 - 150
 9. sodium 0 - 100
 10. sulfur 25 – 500
 11. molybdenum 0.1 - 2
- F. Acidity: The soil pH range measured in the saturation extract (Method 21a, USDA Handbook Number 60) shall be 6.0 – 7.9.
- G. Salinity: The salinity range measured in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 0.5 - 2.5 dS/m. If calcium and if sulfate ions both exceed 20 milliequivalents per liter in the saturation extract, the maximum salinity shall be 4.0 dS/m.
- H. Chloride: The maximum concentration of soluble chloride in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 150 mg/l (parts per million).
- I. Boron: The maximum concentration of soluble boron in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 1 mg/l (parts per million).
- J. Sodium Absorption Ratio (SAR): The maximum SAR shall be 3 measured per Method 20b, USDA Handbook Number 60.
- K. Aluminum: Available aluminum measured with the Ammonium Bicarbonate/DTPA Extraction shall be less than 3 parts per million.
- L. Soil Organic Matter Content: Sufficient soil organic matter shall be present to impart good physical soil properties but not be excessive to cause toxicity or cause excessive reduction in the volume of soil due to decomposition of organic matter. Desirable range of 3-5 percent. The carbon:nitrogen ratio shall be about 10. A high carbon:nitrogen ratio can indicate the presence of hydrocarbons or non-humified organic matter.
- M. Calcium Carbonate Content: Free calcium carbonate (limestone) shall not be present.

- N. Heavy Metals: The maximum permissible elemental concentration in the soil shall not exceed the following:

Ammonium Bicarbonate/DTPA Extraction
parts per million (mg/kilogram)
dry weight basis:

1.	arsenic	1
2.	cadmium	1
3.	chromium	10
4.	cobalt	2
5.	lead	30
6.	mercury	1
7.	nickel	5
8.	selenium	3
9.	silver	.05
10.	vanadium	3

If the soil pH is between 6 and 7, the maximum permissible elemental concentration shall be reduced 50%. If the soil pH is less than 6.0, the maximum permissible elemental concentration shall be reduced 75%. No more than three metals shall be present at 50% or more of the above values.

- O. Phytotoxic Constituent, Herbicides, Hydrocarbons: Germination and growth of monocots and dicots shall not be restricted more than 10% compared to the reference soil. Total petroleum hydrocarbons shall not exceed 50 mg/kg dry soil measured per the modified EPA Method No. 8015. Total aromatic volatile organic hydrocarbons (benzene, toluene, xylene and ethylbenzene) shall not exceed 0.5 mg/kg dry soil measured per EPA Methods No. 8020.
- P. The extraction methods utilized by the laboratory must be standard methods for regional soils. Interpretation of the data must be given.
- Q. Soil Texture/Organic Matter: Provide information on the soil texture and soil organic matter.
- R. Each soil test shall include written recommendations (by the approved laboratory that conducted the soil test) for soil treatments and soil amendments to be added based upon test results. These recommendations shall include:
1. Volume of soil amendment per 1,000 sq.ft. and per cu.yd. of backfill mix.
 2. Pounds of gypsum per 1,000 sq.ft. and per cu.yd. of backfill mix.
 3. Pounds of soil sulfur per 1,000 sq.ft. and per cu.yd. of backfill mix.
 4. Pounds of iron sulfate per 1,000 sq.ft. and per cu.yd. of backfill mix.
 5. Pounds of pre-plant fertilizer per 1,000 sq.ft. and per cu.yd. of backfill mix.
 6. Pounds of soil polymers per 1,000 sq.ft. and per cu.yd. of backfill mix.
 7. Recommendation for soil leaching.
 8. Recommendation for tree drain installation.

9. Pounds of maintenance fertilizer per 1,000 sq. ft. and analysis.
10. Recommendation for soil wetting agent and application rate.
11. Percent of site soil-to-soil amendment in backfill mix.
12. Whether or not soil polymers need to be added to soil.

If any of the above listed items are not recommended, the recommendation shall call for zero volume or zero poundage per 1,000 sq. ft.

- S. Contractor shall be responsible for all fees associated with soil-testing and soil analysis.

2.6 CONCRETE MOW CURBS

- A. Concrete mow curbs shall be composed of poured-in-place concrete with ultimate compression strength of 2,500 psi at 28 days, natural gray color.

2.7 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, subspecies, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1-2014 (unless noted otherwise); and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.
 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1-2014 for types and form of plants required (unless noted otherwise). Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1-2014. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name (including genus, species, subspecies, variety, cultivar, etc.). for the plant as shown on Drawings. However, final determination of plant species and variety will be made by the Landscape Architect and whose decision will be final. All patented plants required by the plant list shall be delivered with a proper plant patent label attached.

- E. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- F. **Quality:** Quality of all plants shall conform to ANSI Z-60.1-2014. Plants shall be vigorous or normal growth, free from disease, insects, insect eggs, insect larvae, and other pests. Plant materials shall not contain any deleterious, obnoxious, or invasive weeds such as (not all inclusive): Quackgrass, Johnsongrass, Poison ivy, Nutsedge, Nimblewill, Canada thistle, Bindweed, Bentgrass, Wild garlic, Ground ivy, Creeping woodsorrel, Bermuda buttercup, Spurge, and Bromegrass. All plants shall equal or exceed any measurements specified and shall be supplied from the source indicated when a source is specified.
- G. **Container-Grown Stock:** Shall have grown in containers for at least 6 months and through 1 full growing season, but not over 2 years. Samples shall be shown to prove that no girdled roots, circled roots, and/or root-bound conditions are present. Any such trees or shrubs shall be deemed as not acceptable. All container plants or trees that have a cracked or broken rootball when taken from the container shall not be planted except on special approval from the Owner's Representative or the Landscape Architect.
- H. **Pruning:** At no time shall the plant materials be pruned, trimmed, or topped prior to delivery, and any alteration on the site of their shape shall be conducted only with the approval and in the presence of the Landscape Architect.
- I. Inspection of plant materials required by city, county, state, and/or federal authorities, and/or other regulatory agencies, shall be the responsibility of the Contractor. When necessary, the Contractor shall have secured permits or certificates prior to delivery of plants at site.
- J. **Observation of Plant Materials:** Plants shall be subject to observation with approval or rejection at the project site at any time before or during progress of work for size, variety, condition, latent defects, pests, and injuries. Rejected plants shall be removed from the project site immediately.
- K. **Rejection and Substitution:** All plants not conforming to the requirements herein specified and/or as indicated on the drawings shall be considered defective, and such plants, whether in place or not, shall be marked as rejected and be immediately removed from the site of the work and replaced with acceptable plant materials. Under no condition will there be any substitution of plant species, variety, or reduced size for those listed on the accompanying drawings, except with the express written consent of the Landscape Architect.
- L. **Right to Changes:** The Landscape Architect reserves the right to change the plant species, plant variety, and/or sizes of plant material to be furnished, provided that the cost of such plant changes does not exceed the cost of plants in the original bid. The Contractor shall be notified in writing 60 calendar days before planting operations have commenced. Field changes to the plant species, plant variety, and/or sizes of plant material might be required due to current availability, and shall be coordinated with the Landscape Architect. Changes in the size and/or variety of any plant to be furnished which involves a reduction or addition in cost shall be adjusted in the contract cost.

- M. Root Condition: The Landscape Architect reserves the right to observe root condition of any species, particularly those grown from seed, and if found defective, to reject the plants represented by the defective sample.
- N. Protection: Plants shall be handled and stored so that they are adequately protected from drying out, wind burn, and all other injury. Plants determined by the Landscape Architect or Construction Manager to be wilted, burned, or dried out shall be rejected, whether in the ground or not. Do not handle plants by the trunk or stem. Plants shall be handled solely by their containers. Plants that have been handled by the trunk or stem shall be rejected and removed from the site immediately. The Contractor's on-site plant storage area shall be approved by the Construction Manager prior to the delivery of any plant materials.
- O. Specimen Tree Selection:
 - 1. Electronic photos of each tree variety and size, as called out on the drawings, 15 gallon size and larger shall be submitted to the Landscape Architect for approval prior to delivery to the project site and prior to installation.
 - 2. After delivery to the project site, the Contractor shall immediately remove any trees not approved.
 - 3. The Owner's Representative at their option and at their own expense, can retain the services of the Landscape Architect to review trees 15 gallon or larger tagged at the nursery and/or at its place of growth.

2.8 GROUNDCOVER

- A. Groundcover plants shall be grown in 1 gallon pots, 4 inch pots, 2 inch pots, flats, or other approved containers, variety and sizes indicated on the planting plan and legend. Flat grown plants (rooted cuttings) shall remain in those flats until transplanting. The soil in the flats shall contain sufficient moisture so that it will not fall apart when lifting the plants. Flat grown plants shall be fully rooted, with top vegetation that is not overgrown in relation to the size of the flat. Plants shall be protected at all times to prevent drying of the root ball.

2.9 TURFGRASS

- A. Turfgrass Sod: Certified or approved turfgrass sod, complying with “Specifications for Turfgrass Sod Materials” in Turfgrass Producers International “Guideline Specifications To Turfgrass Sodding”. Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted. Sod shall be free from disease, insects, insect eggs, insect larvae, and other pests. Sod shall have a permeable and well-drained base.
- B. Turfgrass Species: All turfgrass areas shall be sodded *Paspalum vaginatum* ‘Sea Spray’ (Sea Spray Seashore Paspalum).
- C. Sod shall not contain any deleterious, obnoxious, or invasive weeds such as (not all inclusive): Quackgrass, Johnsongrass, Poison ivy, Nutsedge, Nimblewill, Canada thistle, Bindweed,

Bentgrass, Wild garlic, Ground ivy, Creeping woodsorrel, Bermuda buttercup, Spurge, and Bromegrass.

2.10 HYDROSEED MATERIALS

- A. Water - water must be free of impurities, excess chlorine, and salts. The use of purified water or filters may be required when directed. General precautions shall be observed when drawing water from sources other than irrigation main line.
- B. Seeds: All seed used shall be clearly labeled showing type of seed, test date, name of supplier and percentage of the following: pure seed, crop seed, inert matter, weed seed, noxious weeds, and total germination content. All commercial process or packaging material shall be delivered to the site in their original unopened containers bearing the manufacturer's guaranteed analysis.
- C. High Performance-Flexible Growth Medium (HP-FGM): A hydraulically-applied, 100% biodegradable, growth medium that is manufactured in the United States. The HP-FGM is phytosanitized, free from plastic netting, requires no curing period, and upon application forms an intimate bond with the soil surface to create a continuous, porous, absorbent and flexible erosion resistant blanket that allows for rapid germination and accelerated plant growth.
 1. Product Composition:
 - a. Thermally processed (within a pressurized vessel) wood fibers – 80% (+/- 3%), 100% recycled, heated to a temperature greater than 380 degrees Fahrenheit (193 degrees Celsius) for 5 minutes at a pressure greater than 50 psi (345 kPa).
 - b. Cross-linked biopolymers and water absorbants – 10% (+/- 1%).
 - c. Crimped, man-made biodegradable interlocking fibers – 5% (+/- 1%).
 - d. Micro-pore granules – 5% (+/- 1%)
 - e. No chemical additives with the exception of fertilizer, soil pH modifiers, extended-term dyes, and biostimulant materials shall be added to this product.
 2. The HP-FGM shall conform to the following property values when uniformly applied at a rate of 3,500 pounds/acre (3,900 kilograms/hectare) under laboratory conditions:

Property	Test Method	Req. Value (English)	Req. Value (SI)
Physical			
Mass Per Unit Area	ASTM D6566 ¹	12 oz/yd ² minimum	407 g/m ² minimum
Thickness	ASTM D6525 ¹	0.22 inch minimum	5.6 mm. minimum
Wet Bond Strength	ASTM D6818 ¹	9 lb/ft	131 N/m
Ground Cover	ASTM D6567 ¹	99% minimum	99% minimum
Water Holding Capacity	ASTM D7367	1700% minimum	1700% minimum
Material Color	Observed	Green	Green
Performance			
Cover Factor ²	Large Scale Testing ⁴	0.01 maximum	0.01 maximum
% Effectiveness ³	Large Scale Testing ⁴	99 % minimum	99 % minimum
Cure time	Observed	0 - 2 hours	0 - 2 hours
Vegetation Establishment	ASTM D7322 ¹	800 % minimum	800 % minimum
Yield ⁵	Calculated	2.6 minimum	2245 minimum
Kinetic Energy Absorption Potential ⁶	Calculated	2.0 minimum	734 minimum
Environmental			
Functional Longevity ⁷	ASTM D5338	Up to 18 months	Up to 18 months
Ecotoxicity	EPA 2021.0	96-hr LC50 > 100%	96-hr LC50 > 100%
Effluent Turbidity	Large Scale Testing ⁴	100 NTU maximum	100 NTU maximum
Biodegradability	ASTM D5338	100% minimum	100% minimum

1. ASTM test methods developed for Rolled Erosion Control Products and have been modified to accommodate Hydraulically-Applied Erosion Control Products.

2. Cover Factor is calculated as soil loss ratio of treated surface versus an untreated control surface.

2. % Effectiveness = One minus Cover Factor multiplied by 100%.

4. Large scale testing conducted at Utah Water Research Laboratory. For specific testing information please contact a Profile technical service representative at 866-325-6262.

5. Yield = (Mass per Unit Area)*(Thickness)*(Ground Cover Percentage).

6. Kinetic Energy Absorption Potential = (Wet Bond Strength)*(Thickness)

7. Functional Longevity is the estimated time period, based upon ASTM D5338 testing and field observations, that a material can be anticipated to provide erosion control and agronomic benefits as influenced by composition, as well as site-specific conditions, including; but not limited to – temperature, moisture, light conditions, soils, biological activity, vegetative establishment and other environmental factors.

3. Packaging:

- Bags: Net weight 50 lb, UV and weather-resistant plastic film.
- Pallets: Weather-proof, stretch-wrapped with UV resistant pallet cover.
- Pallet Quantity: 40 bags/pallet or 1 ton/pallet.

4. Acceptable Manufacturer:

- PROFILE Products LLC, 750 Lake Cook Road, Suite 440, Buffalo Grove, IL 60089, (800) 508-8681 (no known equal).

D. Fertilizer - The fertilizer shall be in pelleted or granular form and shall comply with the chemical analysis specified. The fertilizer shall be thoroughly mixed and incorporated in the hydro-mulching slurry.

E. Hydroseed mix:

Refer to construction plans (drawings) for seed types and application rates. Refer to table below for additional non-seed mix components.

- | | | |
|----|---|---|
| 1. | <u>Hydroseed Slurry Component:</u> | <u>Total lbs./acre at Slope Gradient:</u> |
| a. | High Performance-
Flexible Growth Medium | 2,500 lb/ac at $\leq 4H$ to 1V
3,000 lb/ac at $> 4H$ to 1V and $\leq 3H:1V$
3,500 lbs/ac at $\geq 3H$ to 1V and $\leq 2H$ to 1V
1,500 lbs/ac below Erosion Control Blanket |

- | | | |
|----|---|-----------------------|
| 2. | <u>Other Components:</u> | <u>Quantity/Acre:</u> |
| | a) Commercial fertilizer (16-20-0 or 16-6-8 plus Iron) | 300 lbs/ac |
| | b) Gypsum | 1,000 lbs/ac |
| | c) Monoammonium phosphate (11-48-0) | 100 lbs/ac |
| | d) Potassium sulfate (0-50-0) | 150 lbs/ac |
| | e) Ureaformaldehyde (38-0-0) | 300 pounds/ac |
| | f) Humus (humus soil conditioning
with 100% passing a 4-mesh screen) | 2,000 lbs/ac |

- F. Note: Fertilizer, gypsum, monoammonium phosphate, potassium sulfate, ureaformaldehyde, and humus rates of application are for bidding purposes only. Final rates of application shall be based on written soil analysis recommendations from approved soil laboratory, submitted by Contractor, and approved by Landscape Architect.

2.11 EROSION CONTROL MATTING

- A. Erosion control matting shall be a fiber mat product composed of 70% wheat straw and 30% mattress grade coconut fiber, mechanically bound and covered on both sides with netting.
- B. The bottom netting shall be a lightweight photodegradable polypropylene with mesh openings of approximately 3/8 inch by 3/8 inch.
- C. The top netting shall be a lightweight photodegradable polypropylene with mesh openings of approximately 5/8 inch by 5/8 inch.
- D. Typical roll length = 120 feet, typical roll width = 7-1/2 feet.
- E. Product to have a minimum observed functional longevity of 1 year for non-shredding or decomposition.
- F. Erosion control matting shall be Landlok BonTerra CS2 by Propex, or equal.
- G. Contractor must supply a sample of product for review as part of submittal prior to ordering and installation.
- H. Pins or staples for anchoring matting to the soil shall be in accordance with manufacturer's recommendations.

2.12 FIBER ROLLS

- A. Fiber rolls will be composed of biodegradable straw fibers stuffed in a photodegradable open weave netting.
- B. Fiber rolls shall be manufactured from rice straw and be wrapped in tubular-type plastic netting.
- C. The plastic netting shall have a strand thickness of 0.03 inch, a knot thickness of 0.055, and a weight of 0.35 ounce per foot (each +/- 10%). Plastic netting shall be made from 85% high-density polyethylene, 14% ethyl vinyl acetate, and 1% color for UV inhibition.
- D. Fiber rolls shall be 9 inches in diameter (+/- 1 inch), 25 feet long (+/- 0.5 feet), and weigh approximately 35 pounds (+/- 10%).
- E. Fiber rolls shall be manufactured by California Straw Works, or equal.
- F. Contractor must supply a sample of product for review as part of submittal prior to ordering and installation.
- G. Stakes shall be fir or pine, and shall be a minimum of 1 inch x 1 inch x 24 inches in length. Chromated copper arsenate (CCA) treated wood stakes are not acceptable.

2.13 BARK MULCH

- A. Bark mulch shall be a blend of shredded pine and douglas fir bark with some sapwood allowed, free from pathogens and weeds.
- B. Particles shall be 1/2 inch to 3 inches in size.
- C. Dyed bark mulch is not acceptable (red, brown, etc.).
- D. Bark mulch shall be Organic Ground Cover as supplied by A-1 Soils, Lehigh Hanson, 9229 Harris Plant Road, San Diego, CA 92145, 858-715-5600, or equal.
- E. Contractor shall submit a 1-lb. representative sample to the Landscape Architect for review and approval prior to purchase and installation.

2.14 LANDSCAPE BOULDERS

- A. Landscape boulders shall be “Desert Sand” as supplied by Southwest Boulder & Stone, 5002 2nd Street, Fallbrook, California 92028, (760) 451-3333, or equal.
- B. Shape: Rounded in character with no sharp edges.
- C. Size: Shall be as indicated on the Plans and Drawings.
- D. Contractor shall submit photograph of representative samples for review and approval by the Landscape Architect prior to ordering and installation.

2.15 RIVER ROCK COBBLE MULCH

- A. River rock cobble mulch shall be “Dos Rios” as supplied by Southwest Boulder & Stone, 5002 2nd Street, Fallbrook, California 92028, (760) 451-3333, or equal.

Size: Shall be 4 to 8 inches.

- B. Contractor shall submit photographs of representative samples for review and approval by the Landscape Architect prior to ordering and installation.

2.16 TREE STAKING MATERIALS

- A. Tree Stakes: Stakes shall be of non-pressure-treated Lodgepole Pine. Stakes treated with Chromated Copper Arsenate (CCA) are not acceptable. Stakes shall have straight shafts, shaved and cut clean, and bare of branches and stubs. Stakes shall be of uniform thickness throughout length, with a minimum diameter of 2 inches, free of loose knots, splits, or bends. One end tip shall be tapered to allow ease of installation.

- B. Tree Ties: Ties shall be manufactured of virgin, flexible vinyl meeting ASTM-D-412 standards for tensile and elongation strength. Material shall be black for ultraviolet resistance. Tree ties shall be manufactured with a double-back locking configuration. Tree ties shall be of sizes required to adequately support tree and shall elongate with the tree growth, thus preventing damage to the tree. Tree ties shall be “Cinch Tie,” or equal.

2.17 PESTICIDES

- A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.18 ROOT BARRIER

- A. Root barrier shall be molded modular panels manufactured with 50% recycled polyethylene plastic with ultraviolet inhibitors, 85 mil. Thickness, black in color.
- B. Each panel shall have vertical root deflecting ribs, protruding out 3/4 inch dimension out away from panel. Ribs shall be at 90 degree angle to panel (perpendicular to panel length) and shall be spaced at 6 inches apart.

- C. Panels shall have an integrated, self-interlocking joining system that slide into each other.
- D. Panel height shall be 24 inches.
- E. Root barrier product shall be CP-Series, manufactured by Century Products, or equal.

2.19 TREE DRAIN STANDPIPE

- A. Tree drain standpipes shall be 4 inch rigid, perforated PVC pipe wrapped with filter fabric, filter fabric tied with wire, and topped with a drain grate.
- B. Pipe shall be Hancor Dual Wall perforated pipe, or equal.
- C. Filter fabric at tree drain standpipes shall be non-woven polypropylene with a weight of 4.5 ounces per square yard, grab strength of 120 pounds, tensile elongation of 55%, burst strength of 210 psi, tear strength of 50 pounds, and puncture strength of 70 pounds.
- D. Caps for tree standpipes shall be plastic, flat-type drain grates, tan color, 4 inch size. Drain grates shall be manufactured by National Diversified Sales (NDS), or equal.
- E. Gravel for tree drain standpipes shall be clean, thoroughly washed, crushed rock or gravel, 3/4 inch in size, and free from sticks, sand, silt, debris, or other deleterious materials.
- F. Tree drain standpipe components are to be listed as part of the product submittals and shall be approved prior to installation.

2.20 GEOTEXTILE FILTER FABRIC

- A. Geotextile filter fabric shall be a nonwoven geotextile composed of polypropylene fibers, formed into a stable network such that fibers retain their relative position.
- B. Geotextile filter fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.
- C. Geotextile filter fabric shall have the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value	
			MD	CD
Grab Tensile Strength	ASTM D4632	lbs (N)	205 (912)	205 (912)
Grab Tensile Elongation	ASTM D4632	%	50	50
Trapezoid Tear Strength	ASTM D4533	lbs (N)	80 (356)	80 (356)
CBR Puncture Strength	ASTM D6241	lbs (N)	500 (2224)	
Apparent Opening Size (AOS) ¹	ASTM D4751	U.S. Sieve (mm)	80 (0.18)	
Permittivity	ASTM D4491	sec ⁻¹	1.4	
Flow Rate	ASTM D4491	gal/min/ft ² (l/min/m ²)	95 (3870)	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	70	

¹ ASTM D4751: AOS is a Maximum Opening Diameter Value

Physical Properties	Unit	Typical Value	
Roll Dimensions (width x length)	ft (m)	12.5 x 360 (3.8 x 110)	15 x 300 (4.5 x 91)
Roll Area	yd ² (m ²)	500 (418)	500 (418)
Estimated Roll Weight	lb (kg)	255 (116)	255 (116)

- D. Geotextile filter fabric shall be Mirafi #180N, as manufactured by TenCate Geosynthetics North America, 365 South Holland Drive, Pendergrass, Georgia 30567, (706) 693-2226, www.mirafi.com, or equal.

PART 3 - EXECUTION

3.1 SITE REVIEW

- A. Examine proposed planting areas and conditions of installation. Do not start planting work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. General: The areas to receive trees, shrubs, groundcovers, sodded turfgrass, seed planting, and other vegetation and their respective requirements for imported soil, fertilizer applications, soil amendments, and other treatments shall be as defined on the drawings. Equipment necessary for preparation of the ground surface and for handling and placing all required material shall be readily available and in proper working condition. Work shall be performed only during periods when beneficial results can be obtained.
- B. Clearing and Grubbing: Prior to ripping and tillage operations, all existing vegetation in the area to be planted shall be grubbed, raked, and cleared from the site, unless noted otherwise on the drawings. The subsoil and ground surface shall be cleared of all material which has accumulated during construction activities, and all material which might hinder proper grading, tillage, planting, future plant health, and subsequent maintenance operations. The Contractor shall lawfully dispose of all grubbed materials and debris off the site at his or her expense. The Contractor shall completely remove any masonry, asphaltic concrete, paint, paint washout, cement, concrete, concrete washout, plaster, plaster washout, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid or the like from planting areas, and

shall lawfully dispose of off the site at his or her expense. Do not bury any of the aforementioned materials or other deleterious substances within any planting area on the project. Where any paint, paint washout, concrete washout, plaster washout, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, or the like are found in any planting area, remove the soil a minimum depth of 6-inches below the material and replace with clean on-site fill soil or imported soil at no expense to the Owner.

- C. Underground Obstructions: All subsurface rocks over 2 inches in diameter and other underground obstructions shall be removed to the depth necessary to permit proper fine grading, tilling, or planting according to plans and specifications, a minimum depth of 6 inches. All abandoned utility lines uncovered or severed shall be cut below grade and capped or plugged with concrete. Explosives shall not be used for removal. When the location of utility lines is shown on the plans or has been made known to the Contractor, all damage to these lines shall be repaired by the Contractor in a manner approved by the Owner's Representative and affected utility purveyor.
- D. Deep Ripping: All areas to receive trees, shrubs, groundcover, hydroseeding, and turfgrass shall be deep-ripped and loosened to a depth of 12 inches in all directions. Access roads used during construction activities within planting areas shall be deep-ripped and loosened to a depth of 3 feet in all directions.

3.3 SOIL AMENDMENTS, FERTILIZING, AND ROTOTILLING

- A. The following specified soil amendments and fertilizers are guidelines for bidding purposes only. At the time of rough grade, the Contractor shall meet with the Owner's Representative to determine quantity and locations of soil samples to be taken. The soil tests/analysis are the responsibility of the Contractor. The Contractor shall submit soil samples from the site to an approved soil-testing laboratory for agricultural suitability analysis. The Contractor shall submit the results of the soil tests/analysis to the Landscape Architect for interpretation and recommendations. If the test results reduce or increase the quantities specified, then the Owner's Representative shall be notified. The contract prices shall be adjusted to reflect any differences between the amendments as specified below and the recommendations of the soil-testing laboratory.
- B. After the areas have been deep ripped, the following rates of soil amendment materials shall be evenly spread over all planting areas and shall be thoroughly scarified to an average depth of 8 inches by rototilling a minimum of 2 alternating passes. Amendment must be intimately blended with soil.
 - 1. Soil Conditioner: 4 cu.yd. per 1,000 sq. ft.
 - 2. Gypsum: 100 lbs. per 1,000 sq. ft.
 - 3. Soil Sulfur: 20 lbs. per 1,000 sq. ft.
 - 4. Iron Sulfate: 20 lbs. per 1,000 sq. ft.
 - 5. Triple superphosphate (0-45-0) 4 pounds per 1,000 sq. ft.
 - 6. Potassium sulfate (0-0-50) 8 pounds per 1,000 sq. ft.

- C. Leaching shall be done prior to the application of soil conditioner, gypsum, soil sulfur, iron sulfate, and pre-plant fertilizer.
- D. The wetting agent shall be sprayed on the soil amendments and soil prior to rototilling the amendments into the soil. The rate of application shall be as specified by the manufacturer.
- E. The thoroughness and completeness of the rototilling and incorporation of the soil amendments shall be acceptable to the Owner's Representative. Adjust soil amendments and fertilizers on all slopes with gradients of 2:1 and steeper, or as indicated on the drawings.
- F. Deep Water Leaching And Follow-Up Soil Testing:
 - 1. After rototilling in soil amendments, the area shall be deep water leached a minimum of 3 times. Apply water slowly and avoid runoff. Allow the soil to drain thoroughly and partially dry out between applications. The total amount of water applied may be between 3 to 12 inches depending on the depth and degree of improvement. The soil type (sand, silt, or clay) will determine the amount of time required for the soil to dry out between leaching processes. Do not apply more water if the soil saturation exceeds 50% between applications. Treat and/or remove weeds that germinate.
 - 2. One day after final application of water, the soil shall be tested for content of soluble salts (electrical conductivity or E.C.). The Owner's Representative and the Contractor shall take several soil samples from the top 6 inches of soil or the depth of planting for that particular area, and deliver the samples to an approved soil testing laboratory for testing of soluble salts. The E.C. test reading shall not be above 3.0 millimho/cm.
 - 3. If soil test reading for E.C. for a particular area tested is above 3.0 millimho/cm, the soil amending, tilling and deep watering procedure shall be repeated until test readings are not above 3.0 millimho/cm.
 - 4. Care shall be taken that the rate of application of water does not cause erosion, sloughing of soils, damage to paving, damage to hardscape elements, or damage to structures. Contractor assumes all responsibility for monitoring of all areas during leaching period.
 - 5. All depressions, voids, erosion scars and settled trenches generated by the deep watering shall be filled with amended soil and brought to finish grade.

3.4 IMPORTED SOIL

- A. Subgrades of all planting areas as noted on the plans to receive imported soil, shall be established at below finish grade in order to accommodate imported soil.
- B. The subgrade shall be scarified a minimum depth of 2 inches before placement of the imported soil. Compacted subgrade shall be ripped. Place 2 inches of imported soil and till to 4 inches depth, to form a 50/50 (fifty-fifty) blend 4 inches in depth to avoid a sharp interface of soil types.
- C. Placement: of the imported soil shall be smooth and even in all planting areas. Finish grades in lawn areas shall be 1 inch below adjacent finished paving surfaces and 2 inches in shrub areas

without abrupt changes in gradient, not only in the surface of the soil but also where soil meets walks, curbs, pavement or other features, unless otherwise indicated on the drawings.

3.5 EARTH MOUNDS

- A. The Landscape Architect shall approve all layout and grading of earth mounds prior to final placement and installation of any plant material.

3.6 CONCRETE MOW CURBS

- A. Install per plan and detail.
- B. Smooth trowel finish.
- C. Install a No. 3 rebar continuous along length of mow curb. Rebar shall be centered both vertically and horizontally within mow curb, with 12 inches overlap at all splices.
- D. Install expansion joints at 15 feet on-center.

3.7 SOIL PREPARATION AND FINISH GRADING

- A. Rough Grade: Site to be received by Landscape Contractor to within one-tenth-of-a-foot (0.1'), plus or minus, by others based on Civil Engineer's drawings.
- B. Finish Grade: Finish grading to consist of grading, raking, watering-in, and mechanically compacting and settling to achieve desired contour and flow line patterns resulting in evenly finished surface.
- C. All undulations and irregularities in the planting surfaces resulting from tillage, rototilling and all other operations shall be leveled and floated out before planting operations are initiated.
- D. Finish grades shall insure positive drainage of the site with all surface drainage away from buildings, walls, over mow curbs, and toward roadways, drains and catch basins. Planting surfaces shall be graded with no less than two-percent (2%) surface slope for positive drainage.
- E. Contractor shall take every precaution to protect and avoid damage to existing sprinkler heads, irrigation lines, and other underground utilities during soil amending and fertilizing operations.
- F. All rocks, debris, and other deleterious materials shall be removed from planting areas and Project site. Rocks in accordance with the following criteria: 1/2 inch diameter in hydroseed areas; 1 inch diameter in turfgrass areas and groundcover areas; and 2-inches diameter in shrub areas to a minimum depth of 6 inches. Remove gravel over 3/8 inch from the top 2 inches in turfgrass areas.

- G. Final finish grade shall be 1 inch below finish paving surface in adjacent lawn areas and 2 inches in shrub areas, and decomposed granite areas. Final grades shall be acceptable to the Owner before planting operations begin.
- H. Ease top and toe of all existing slopes.

3.8 PLANTING INSTALLATION - GENERAL

- A. Timing: Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally acceptable practice.
- B. Layout of Trees: All trees 24 inch box size and larger (including any specimen bare-root palms) shall be placed in the landscape per the direction of the Landscape Architect and prior to installation of irrigation system. The trees shall be moved and positioned per direction of the Landscape Architect. For those trees located within tree grates, the layout shall be in direct coordination with the installation of the tree grates, with the center of the trunk installed directly within the center of the tree grate cutout, equidistant on all sides of the tree grate cutout.
- C. Layout of Planting: Locations shall be approved by the Landscape Architect. All container plants shall be set by the Contractor in their final location in their respective containers prior to digging holes and/or planting. All plant locations shall be checked for possible interference with existing underground utility lines.
- D. Backfill for Trees and Shrubs: As specified in this section. If artificial drainage is directed, then drains shall be installed first, then backfilled with soil.
- E. Disposal of Excess Soil and Debris - All excess excavated subsoil, rocks, and debris shall be legally disposed off the site by the Contractor at his or her cost or utilized on the site as directed by and at the option of the Owner. Use the more suitable soil excavated from the planting pit, and dispose the less suitable soil. Do not place unamended soil over amended soil.

3.9 EXCAVATION FOR PLANT MATERIALS

- A. Revise size and cross section of tree and shrub planting pits and trenches in first paragraph below to suit Project. Excavated planting pits shall be wide at top with sides tapered to base, to be set on an undisturbed subgrade. Revise descriptions if required and supplement with drawing details.
- B. Planting Pits and Trenches: Excavate planting pits to match container shape with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate minimum 2 times the diameter of root ball for boxed and container-grown stock.
 2. Do not excavate deeper than depth of the root ball, with root ball depth being measured from the root flare down to the bottom of the root ball.
 3. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
 4. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
 5. Excavation shall include the stripping and stacking of all acceptable soil encountered within the areas to be excavated for plant pits and planting beds. Protect all areas that are to be trucked over and upon which soil is to be temporarily stacked pending its re-use for the filling of holes, pits, and beds.
 6. Maintain supervision of excavations during working hours.
 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- C. Subsoil and topsoil removed from excavations may be used as planting soil.
- D. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6 inch diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- E. Drainage: Notify Landscape Architect if subsoil conditions show evidence of unexpected water seepage or retention in tree or shrub planting pits.
- F. Fill excavations with water, and allow to percolate away before positioning trees and shrubs.
- 3.10 PLANTING TREES, SHRUBS, ORNAMENTAL GRASSES, AND VINES
- A. Soil moisture level in planting areas at time of planting shall be no less than horticulturally acceptable. The Contractor shall request approval of moisture, and if found to be insufficient for planting, the planting pits shall be filled with water and allowed to drain before starting any planting operations.
 - B. Before planting, verify that root flare of plant is visible at top of root ball according to ANSI Z60.1-2014, Figure 8, and Paragraph 1.5.3 – Root Ball Depths. If root flare is not visible, then remove soil in a leveling manner from the top of the root ball down to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements and reject those that do not comply.
 - C. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

- D. Set container-grown stock plumb and in center of excavated planting pit or trench with root flare 1-inch above adjacent finish grades.
1. Carefully remove root ball from container without damaging root ball or plant.
 2. Use planting soil with specified amendments for backfill.
 3. Install backfill material around root ball in layers from the bottom up, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 4. Do not cover the top of the rootball with backfill soil, which might create soil interface conflicts and inhibit aeration and gaseous exchange.
 5. Place planting tablets in each planting pit when pit is approximately half filled, in quantities shown below. Place tablets on the sides of the root ball; do not place tablets in bottom of the hole. See below for application rates.
 6. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- F. Create rootball drainage for all boxed trees by removing the bottom of the box before planting, or cutting drainage holes in the bottom of the box, or separating the boards on the bottom after planting, or other approved method.
- G. Contractor shall be responsible for all surface and subsurface drainage required which may affect his / her guarantee of the trees, shrubs, ornamental grasses, and vines.
- H. Planting tablets shall be placed in each planting hole at the following rates and per the manufacturer's recommendations (soil reports from soil-testing laboratory supersede application rates in this section if different):
1. One 5-gram tablet per individual liner and flat size plant.
 2. One 21-gram tablet per 1 gallon container.
 3. Three 21-gram tablets per 5 gallon container.
 4. Four 21-gram tablets per 15 gallon container.
 5. One 21-gram tablet per each 4 inches of box size.

Random testing to verify planting tablet installation shall be conducted by the Owner.

- I. Tree trunks shall be set vertical and plumb, unless noted otherwise on the drawings or at the direction of the Landscape Architect.
- J. Immediately after planting, install a soil berm around the perimeter of each root ball to create an enclosed water basin, except in turfgrass locations. The height of the soil berm shall be 4 inches for trees and 3 inches for shrubs. All plants shall be thoroughly watered to the full depth of each planting hole.

- K. Staking and tying: All trees and any other plants indicated on the plans shall be staked per detail. Stakes shall be driven into the ground of the windward side of the tree. The stakes shall be driven in plumb and secure. Special care shall be taken that the driving in of the stake does not damage the tree bark, tree roots, or root ball. Tree ties shall be wrapped around the tree trunk and the stake, twisting to form a figure-eight. The tree ties shall be long enough to provide for 3-inches of slack to permit the tree trunk limited movement in any direction. Secure the tree tie with the double-back locking configuration. Secure each tree tie with one galvanized nail driven through the tree tie and into the stake to prevent slippage (see Drawings). Staking shall be accomplished by the Contractor in such a manner as to ensure the proper and healthy growth and the safety of the plants, property, and the public.
- L. Pruning after planting shall be required on all trees, shrubs, and vines when necessary to provide the specified or approved standard shapes, form and/or sizes characteristic to each plant. Also, pruning shall be required when necessary to provide horizontal and vertical sight line clearances. In addition, pruning may include thinning and/or cutting. All pruning shall be under the direction of the Landscape Architect. Do not paint pruning cuts with tree paints and/or sealants.

3.11 PLANTING GROUNDCOVER

- A. Groundcovers shall be planted in the areas indicated on the plans, and shall be installed only after all debris and surface rocks 1 inch diameter and larger have been removed from the planting area.
- B. If the top 4 inches of soil in the area to be planted in groundcover is not sufficiently moist (horticulturally acceptable standards), the area shall be thoroughly irrigated and no less than 12 hours shall pass before planting.
- C. Groundcovers shall be planted in even, triangularly spaced rows, at the intervals called out for in the legend on the drawings, unless otherwise noted.
- D. The size of planting excavation for groundcover shall be at least twice the width of the root ball.
- E. For rooted cutting plants supplied in flats, each plant shall be planted in a manner that will ensure minimum disturbance of the root system, but in no case shall this depth be less than 2 nodes.
- F. Each groundcover plant shall be planted with one 5-gram planting tablet incorporated into the root zone. Planting area shall be hand-smoothed after planting to provide an even and smooth final finished grade. To avoid drying out and damaging groundcover, plants must be irrigated after planting. This may be done manually or by using the installed irrigation system. Repeated applications may be required, especially on a sloping site. This initial irrigation procedure shall continue until the soil profile is thoroughly moistened to field capacity a minimum depth of twice the depth of each planting hole.

3.12 SODDING OF TURFGRASS AREAS

- A. All turfgrass areas indicated on the plans shall be sodded solid.
- B. Prior to placement of sod, all turfgrass areas shall be leached with water and rototilled with soil amendments. Remove all weeds with included roots, or treat with approved systemic weed control prior to sodding application. Remove stones larger than 1/2 inch in any dimension and sticks, roots, trash, and other extraneous matter.
- C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish grade to accommodate depth of installed sod base. Finish grade shall be 1 inch below adjacent walks, curbs, and all other paving surfaces. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- D. Restore planting areas if eroded or otherwise disturbed after finish grading.
- E. Before planting sod, obtain Landscape Architect or Owner's acceptance of finish grading.
- F. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- G. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- H. Laying of sod shall be same day it is delivered. Sod shall not be left on pallets in the hot sun or wind and allowed to dry out. Do not place on hot surfaces such as pavement.
- I. Starter Strip: the first row of turfgrass sod shall be laid in a straight line with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to insure that the pieces are not stretched or overlapped and that all joints are butted tightly to prevent voids that would cause air-drying of the roots.
- J. Sloping Surfaces: On three-to-one (3:1) or steeper slope gradients, turfgrass sod shall be laid across the angle of the slope, with staggered joints. Anchor sod with steel staples spaced as recommended by sod manufacturer, but not less than 2 anchors per sod strip to prevent slippage.
- K. Do not install sod within a 2 feet circular radius away from the edge of the trunk on any new and existing trees. Cleanly cut sod to create the circular radius of turfgrass. Install bark mulch within this radius area (see “Bark Mulch” in this Section).
- L. Watering and Rolling: Contractor shall water the turfgrass sod immediately after transplanting to prevent excessive drying during progress of the work. As sodding is completed in any one section, the entire area shall be lightly rolled. It shall then be thoroughly watered to a depth sufficient that the underside of the new sod pad and soil minimum depth of 1-1/2 inches below the pad are thoroughly wet. The Contractor shall be responsible for having adequate water available at the site prior to and during installation.

- M. Re-Sodding: Sodded areas which do not show a proper or healthy growth of grass within ten (10) days after installation shall be re-sodded until an acceptable strand of grass is assured. Determine the cause of failure and make corrections as necessary to correct the problem(s) prior to re-sodding.
- N. Legally dispose of waste material, including grass clippings, vegetation, and turfgrass chunks, off of Owner’s property.

3.13 HYDROSEEDING OF SEED MIXES

- A. Inspection of conditions: Before proceeding with any work, the Hydroseeding Contractor shall carefully check planting area conditions. Examine substrates and conditions where materials will be applied. Do not proceed with installation until unsatisfactory conditions are corrected, only apply product to geotechnically stable slopes that have been designed and built to divert the water shed away from the face of the slope, therefore eliminating surface flow energy from above from damaging the slope face. Contractor shall immediately inform the Owner’s Representative and the Landscape Architect of any discrepancies between the drawings and actual conditions. No work shall be done on any area where there are such discrepancies or where conditions are unsuitable for successful plant material establishment until the Owner’s Representative has given approval.
- B. Quality of Work: The hydroseeding work shall be performed by a competently trained individual or hydroseeding company in accordance with the best standards and practices related to the profession.
- C. Planting preparation for slopes:
 - 1. Slope texturing:
 - a. Cut slopes: these surfaces shall be roughened in a horizontal direction following the contour of the slope. The roughened texture shall be made by hand-chopping or similar mechanical means.
 - b. Fill slopes: these surfaces shall be compacted and finished and also roughened in a horizontal direction following the contour of the slope. The roughened texture shall be made by hand-chopping or similar mechanical means.
- D. Weed Eradication Procedures for Irrigated Slopes Only:
 - 1. Manually remove all existing vegetation and dispose of it off site.
 - 2. Fertilize all planting areas. Add any soil amendments required per soil analysis.
 - 3. Begin watering process to activate fertilizer and additive chemicals and germination of weed seeds.
 - 4. Water all planting areas thoroughly and continuously for a period of 2 weeks or until a dense weed cover is evident.
 - 5. Discontinue watering process for 2 days, and then apply contact herbicide as per the pest control advisor’s recommendations.
 - 6. Allow sufficient period of time per herbicide manufacturer's specifications to insure that all weeds are dead. Rake and remove all dead vegetation.

7. Water all planting areas thoroughly and continuously for a period of 2 to 4 weeks. Discontinue the watering process for 1 day prior to the second application of the herbicide spraying. Re-apply the spraying operation with a straight contact weed killer, as per the pest control advisor's recommendations.
 8. Clear all desiccated weeds from the slopes to the finished grade.
 9. Installation of hydroseed material shall not proceed until written notification by the Landscape Architect that the weed control is successful.
- E. Soil Preparation for Hydroseeding:
1. The hydroseeded area shall be pre-soaked with water by the irrigation system to a depth of 3 inches, 48 hours prior to the hydroseeding installation.
 2. Allow planting area soil surface to dry out for 1 day only prior to the hydroseeding application. Care must be taken to not allow the soil surface to be super saturated with water prior to the hydroseeding installation. At the same time the soil surface shall not be bone dry. There shall be some residual moisture within the first 1/2 inch (13 mm) of the soil surface.
- F. Application:
1. Strictly comply with all current manufacturer's installation instructions and recommendations.
 2. Use approved hydro-spraying machines.
 3. Do not exceed maximum slope length of 35 feet when slope gradients are steeper than four-to-one (4:1).
 4. Equipment: mixing shall be performed in a tank with a built-in continuous agitation and re-circulation system of sufficient operating capacity to produce a homogenous slurry of fiber, fertilizer and water in the designed unit proportions and a discharge system which will apply the slurry to the areas to be treated at a continuous and uniform rate.
 5. Preparation: the slurry preparation shall take place at the site of work and shall begin by adding water to the tank when the engine is at half throttle. When the water level has reached the heights of the agitator shaft, good circulation shall be established and at this time the seed shall be added. Fertilizer shall then be added, followed by High Performance-Flexible Growth Medium (HP-FGM). The High Performance-Flexible Growth Medium (HP-FGM) shall only be added to the mixture after the seed and when the tank is at least one-third filled with water. All High Performance-Flexible Growth Medium (HP-FGM) shall be added by the time the tank is two-thirds to three-fourths full. Spraying shall commence immediately when the tank is full.
 6. Add 30 to 50 pounds of High Performance-Flexible Growth Medium (HP-FGM) material per 100 gallons of water when hydroseeding; confirm loading rates with equipment manufacturer.
 7. Time limit: the hydromulching slurry components are not to be left in the hydromulch machine for more than 4 hours. If slurry components are left for more than 4 hours in the machine, the slurry will be rejected and disposed off-site by the Contractor at his or her expense.
 8. Two-step Application:

- a. First Step of Two-Step Process: the operator shall spray the area with a uniform visible coat of the required seed, fertilizer, and organic amendments, along with 500lbs/acre of cellulose fiber as a visual guide. Apply from opposing directions to soil surface, reducing the “shadow effect” and assuring complete soil surface coverage. The seed and fertilizer shall be applied in a downward drilling motion via a fan stream nozzle. The spray operation must be so directed that the first spray application containing the seed and fertilizer will also penetrate the soil surface as to drill and mix the components into the soil, thus ensuring maximum impregnation and coverage. Do not exceed maximum slope length of 100 feet when slope gradients are steeper than four-to-one (4:1).
 - b. Second and Final Step of Two-Step Process: the operator shall spray the area with a uniform visible coat of High Performance – Flexible Growth Medium (HP-FGM) using the dark color of the cellulose fiber as a visual guide at the rate specified on chart in this Section. Apply from opposing directions as to cover the first seed and fertilizer application. The slurry shall be applied with a rain-like motion via a fan stream nozzle to ensure a cap like coat over the seed and fertilizer. When hydraulically sprayed onto the soil, the mulch shall not form a blotter like material. The spray operation must be so directed that the slurry spray will completely cover the first application, thus ensuring maximum impregnation and coverage. Do not exceed maximum slope length of 100 feet when slope gradients are steeper than four-to-one (4:1).
- G. Protection: hydroseeded areas shall be protected against foot traffic and other use immediately after hydroseeding is completed by placing warning signs and temporary twine and flagging around the areas.
- H. Clean up: special care is to be exercised by the Contractor to prevent any of the slurry from being sprayed onto any adjacent property, etc. Any slurry sprayed onto these areas shall be thoroughly cleaned off at the Contractor's expense.
- I. Hydroseed area maintenance (this is not to be confused with the general Landscape Maintenance requirements):
1. Hydroseed area maintenance shall be the responsibility of the Landscape Contractor. It is the responsibility of the Contractor to provide an irrigation system as shown on the irrigation plans. After the hydromulch has been applied, the mulch shall be allowed to set for one day before irrigation begins. The hydroseeded areas can then be irrigated. Number of gallons to be applied to the hydroseeded areas will vary from day to day and system to system, depending on the rate of growth and climatic conditions encountered. The soil surface must be kept moist but not wet at all times, particularly during the seeding germination period.
 2. Any erosion or slippage of the soil during the Maintenance Period caused by watering shall be repaired as specified.
 3. All hydroseeded areas shall be kept free of weeds and debris during the Maintenance Period. Such weeds and debris shall be disposed of off the property.
 4. Hydroseeded areas shall receive an application of one of the following fertilizers every 30 days, depending on the season:

- a. Summer Season: 16-6-8 at 30-lbs/per acre.
 - b. Winter Season: Ammonium sulfate at 24 lbs/per acre, or calcium nitrate at 33-lbs/per acre.
- J. Guarantee and Replacement:
 - 1. Guarantee will be made by the Contractor that a minimum of eighty-percent (80%) germination of hydroseed will be attained prior to the beginning of the Maintenance Period. Guarantee will be made by the Contractor that a minimum of seventy-percent (70%) soil coverage of permanent vegetation will be attained at the end of the Maintenance Period. The Contractor shall reseed any planting failure during this period.
 - 2. Seeds used for replacement shall be of the same kind and quantity ratio as specified in the seed formula. They shall be furnished, applied, and fertilized as specified.
- K. For bonded fiber matrix applied for temporary erosion control measures (after grading procedures but prior to any irrigation and landscape installation), see Civil drawings and also specifications Section 02230 31 10 00 Site Clearing.
 - 1. If bonded fiber matrix materials are applied to landscape areas for temporary erosion control measures, then they shall be completely grubbed, raked, and cleared from the site prior to application of permanent hydroseed seed mixes and/or High Performance-Flexible Growth Medium (HP-FGM). All grubbed material and debris shall be lawfully disposed of off-site by the Contractor at his or her expense. Contractor shall not remove any more of the temporary bonded fiber matrix materials than what they can adequately prepare and apply hydroseed within an appropriate time frame. Monitor changing weather conditions and be aware of potential rainstorms, always ensuring best management practices are employed to prevent soil erosion.

3.14 INSTALLATION OF EROSION CONTROL MATTING

- A. Erosion control matting shall be installed on all slope areas that are two-to-one (2:1) gradient or steeper, from 8 feet beyond the top of slope area and 8 feet beyond the toe of slope area, unless otherwise defined on plans.
- B. Install erosion control matting as per manufacturer's recommendations.
- C. Erosion control matting shall be installed after installation of trees, shrubs and ground cover. The manufacturer's recommendations take precedence over other specifications.
- D. The spacing distance and procedures for pins or staples for anchoring matting to the soil shall be in accordance with manufacturer's recommendations.

3.15 INSTALLATION OF FIBER ROLLS

- A. Install fiber rolls as per manufacturer's recommendations. The manufacturer's recommendations take precedence over other specifications.

- B. Erosion control/sediment control fiber rolls shall be installed on all slope areas with gradients of four-to-one (4:1) or steeper from top of slope area to toe of slope area.
- C. Fiber rolls shall be installed at the following vertical spacing approximately parallel along the contours of the slope (shown in gradients):
 - 1. One-to-one (1:1) slopes = 10 feet apart.
 - 2. Two-to-one (2:1) slopes = 20 feet apart.
 - 3. Three-to-one (3:1) slopes = 30 feet apart.
 - 4. Four-to-one (4:1) slopes = 40 feet apart.
- D. Fiber rolls shall be joined tightly together to form a single linear roll that is installed approximately parallel to the slope contour.
- E. Fiber rolls shall be installed before installation of hydroseed application.
- F. Furrows shall be constructed at a slight angle to the slope contour to a depth of 2 to 5 inches, and at a sufficient width to hold the fiber rolls. Soil from excavating the furrows can be placed on the uphill, or flow side, of the furrow to be used during installation.
- G. Fiber rolls shall be installed in the furrows, with the first row installed at the lowest point of disturbance. No daylight shall be seen under the fiber rolls. Pack soil from trenching the furrow against the fiber rolls on the uphill side.
- H. Individual fiber rolls shall be placed with adjacent ends butted firmly to each other to create a continuous linear roll.
- I. Fiber rolls shall be staked with 24-inch wood stakes at 4 feet on center, and 5 inches from the end of each individual roll. Stakes shall be driven through the middle of the fiber roll, leaving 2 to 3 inches of the stake protruding above the fiber roll. A heavy sediment load might pick up the fiber roll and pull it off the stakes if they are driven down too low.

3.16 BARK MULCH

- A. All planter areas shall be evenly covered with bark mulch to a uniform depth of 3 inches.
- B. Provide 4 inches of horizontal clearance away from the collar of tree trunks, 3 inches of horizontal clearance away from the collar of shrubs and ornamental grasses, and 2 inches of horizontal clearance away from the basal stem of groundcovers.
- C. Bark mulch is required on all planter areas with a slope gradient shallower than two-to-one (2:1).

3.17 LANDSCAPE BOULDERS

- A. Landscape boulders shall be installed within the project, at locations as shown on the Drawings.

- B. The burial depth of the boulders shall be approximately one-third (1/3) of the overall vertical dimension of each boulder to achieve a natural character in appearance. Reference project details.
- C. Contractor shall coordinate final placement and installation with the Landscape Architect and Owner's Representative.

3.18 ROCK COBBLE MULCH

- A. Rock cobble mulch shall be installed within the project, at locations indicated on the Drawings.
- B. Install rock cobble mulch over soil separator fabric, as shown on the details of the Drawings.
- C. Install rock cobble mulch at such uniform depth that one-hundred-percent (100%) of the soil separator fabric is covered in those areas where rock cobble is to be installed.
- D. Contractor shall coordinate final placement and installation with the Landscape Architect or Owner.

3.19 PESTICIDE APPLICATIONS

- A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations.
- B. Coordinate applications with Owner's operations and others in proximity to the Work.
- C. Notify Owner before each application is performed.
- D. No restricted pesticides shall be used.
- E. Preventative “blanket” applications of pesticides shall not be performed without prior written approval of Owner.
- F. Pre-Emergent Herbicides (Selective and Non-Selective): Do not apply to seeded areas.
- G. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.20 ROOT BARRIER

- A. Install root barrier as per manufacturer's recommendations.
- B. Root barrier shall be installed where trees are planted within 5 feet of paving or other hardscape elements (such as walls, curbs, walkways, etc.).
- C. Root barrier shall be aligned vertically and run in a linear fashion, along and directly adjacent to paving or other hardscape elements to be protected.

- D. Install root barrier along the edge of paving or hardscape element for a distance of 10 feet in each direction from the tree trunk, for a total of 20 feet per affected tree. Where trees are closer than 10 feet apart, a single continuous piece of root barrier shall be used.
- E. Root barrier shall not surround root ball of tree at any time.
- F. Tops of root barriers are to be flush with finish grade of soil, with no portion visible above finish grade.
- G. Do not distort or bend root barrier during construction activities.
- H. Overlap root barrier a minimum of 12 inches at splices.

3.21 TREE DRAIN STANDPIPE

- A. Install tree drain standpipes as per construction detail at all trees, on directly opposite sides of the tree root ball.
- B. For trees 24 inch box size and larger, install a minimum of 2 tree drain standpipes. For trees less than 24 inch box size, install a minimum of 1 tree drain standpipe.
- C. Ensure that standpipes are installed at the depth shown on the construction detail.
- D. Standpipe drain hole below tree rootball shall be augered to a 12 inch width minimum.
- E. Standpipes shall be set vertical (plumb) and centered in the augered hole.
- F. Wrap standpipes with filter fabric.
- G. Backfill hole around standpipe below tree rootball with gravel. Do not fill standpipe with gravel.
- H. Cap standpipes with tan color flat-type plastic drain grate. Install tan color atrium-type drain grates in shrub and groundcover areas, and install green color flat-type drain grates in turfgrass areas.
- I. Top of installed drain grate shall be at 2 inches above surrounding finish grade in shrub and groundcover areas and flush with surrounding finish grade in turfgrass areas.

3.22 CLEAN-UP AND SAFE ENVIRONMENT

- A. As project progresses, Contractor shall maintain all areas in a neat and safe manner, and remove unsightly debris as necessary. After completion of project each day, Contractor shall remove all debris and containers used in accomplishing work. Contractor shall sweep and clean all sidewalks, asphalt, and concrete areas adjacent to plantings. Contractor shall be responsible for disposing of, off site, at no additional expense, any trash or debris generated by the installation of the work.

3.23 MAINTENANCE AND THE MAINTENANCE PERIOD

- A. Maintenance operations shall begin immediately after each plant is planted.
1. Maintenance shall consist of watering, weeding, fertilizing, mulching, pruning, mowing, trimming, edging, pest control, pathogen and disease control, debris/litter control, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy viable plantings.
 2. Soil moisture content for plant root balls and surrounding soil shall be monitored and maintained to sustain healthy viable plant growth appropriate for each plant species. If issues are present, soil shall be checked with a soil coring probe (tube or auger) once a week to a depth of 12 inches minimum until issues are resolved.
 3. Apply treatments as required to keep plant materials, planted areas, and soils free of pests, pathogens, and disease. Use environmentally-sensitive Integrated Pest Management (IPM) practices whenever possible to minimize the use of pesticides and reduce hazards. IPM treatments include (not all inclusive): physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents. Planting areas shall be free of all pests including (not all inclusive) insects, mites, scale, thrips, grubs, mollusks (snails and slugs), rodents and unwanted animals (gophers, rats, squirrels, moles, mice, opossums, rabbits, snakes), unwanted plants (weeds), algae, fungi, bacteria, and viruses.
 4. Turfgrass Mowing, Trimming, and Edging: Turfgrass shall be mowed with professional quality mulch-mowing type equipment with sharp blades. Remove all litter and debris off of turfgrass prior to each mowing. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain a uniform height as required for each specific turfgrass species, free from scalping, without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Alternate mowing direction where feasible every mowing. Edges of turfgrass shall be trimmed and edged in a professional manner. Coordinate mowing and trimming schedules with Owner. Do not touch or nick trees, shrubs, groundcovers, and other vegetation with mowing, edging, or trimming equipment.
 5. Turfgrass installations shall meet the following criteria as determined by Landscape Architect:
 - a. Satisfactory Sodded Turf: At end of Maintenance Period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
 6. Mulch: Shall be replenished or replaced as necessary to maintain the specified depth in a uniform fashion throughout.
 7. Soil Subsidence and Soil Erosion: Fill in as necessary soil subsidence or soil erosion that may occur due to the following:
 - a. Depressions caused by vehicles, carts, bicycles, pedestrian traffic, etc.
 - b. Damage caused by gophers, moles, other animals.
 - c. Erosion due to irrigation runoff and rainfall events.

d. Soil settling.

Replace affected area with topsoil, compact and level as required, replace damaged/missing plants, and replace mulch on surface to match original installation.

8. Tree Staking: Tree stakes and tree ties shall be checked to prevent bark or trunk wounds caused by abrasion and corrected as needed. Tree ties shall be adjusted to prevent girdling of the trunk or branches. Any tree that is damaged due to improper staking or tying shall be replaced at the Contractor's expense
 9. All paving and walks shall be kept clear, safe, and clean.
 10. Weeding and Debris/Litter Control: All tree, shrub, groundcover, vine, ornamental grass, turfgrass, and hydroseeded areas shall be kept free of weeds, rocks over 1 inch in diameter, clods, trash, and debris on a weekly basis.
 11. Contractor is encouraged to use non-polluting devices such as rakes and hand brooms where feasible. If power equipment is used, Contractor is encouraged to use models with low-decibel noise levels, low fossil fuel consumption, and low-emissions output.
 12. Protection: The Contractor shall be responsible for providing adequate protection of all planting areas against traffic or other use by erecting fencing or other acceptable means immediately after the planting is completed. Warning signs and barricades shall be placed in various high traffic areas. Damaged areas shall be repaired or replaced immediately by the Contractor.
 13. Plant Replacement: Plants found to be dead, dying, unhealthy, impaired, or not in a vigorous condition within the Maintenance Period and Warranty Period shall be replaced within 14 days of evidence of such or formal notification of such, at the Contractor's expense. Plants used for replacement shall be the same kind and size as specified in the plant schedule. They shall be furnished, installed, and fertilized as originally specified. The expense of all repair work on existing improvements damaged during replacement shall be borne by the Contractor. No replacement of plantings shall be made in any season definitely unfavorable for planting.
 14. Fertilization:
 - a. Trees: Fertilizing shall occur 60 days after planting. Apply fertilizer at application rates as recommended by the manufacturer. Fertilizer shall be 14-7-3 or approved equal.
 - b. Shrubs, Ornamental Grasses, and Groundcover Areas: Fertilizing shall occur 45 days after planting. Apply fertilizer at application rates as recommended by the manufacturer. Fertilizer shall be 14-7-3 or approved equal.
 - c. Turfgrass Areas: Fertilizing shall occur 30 days after planting. Apply fertilizer at the rate of 7-lb per 1,000 square feet (i.e. 1-lb of actual nitrogen per 1,000 square feet) during the growing season. Fertilizer shall be 14-7-3, or approved equal.
- B. Maintenance Period: The Landscape Architect will inform the Owner and Contractor in writing of the start of the Maintenance Period, only if it is determined to do so after conducting the Pre-Maintenance Period observation. The Maintenance Period shall continue for no less than 90 continuous calendar days. If any plants are replaced during the Maintenance Period, then the 90 day Maintenance Period for those plants shall begin at the date of installation for that plant, if so directed by the Landscape Architect or the Owner. The Contractor shall contact the

Construction Manager a minimum of 2 weeks prior to the end date of the Maintenance Period to schedule a final walkthrough with the Landscape Architect. Maintenance Period operations shall extend past the outlined thresholds if Final Acceptance does not occur at the conclusion of the initial 90 day Maintenance Period.

- C. Extended Maintenance Period: When, in the opinion of the Landscape Architect, there is improper maintenance, and/or poor condition of plant materials, and/or unhealthy condition of plant materials, then the Contractor shall be responsible for additional maintenance of the work at no additional cost to the contract until all work is deemed acceptable by the Landscape Architect.
- D. End of Maintenance Period: Final Acceptance by the Owner in writing determines completion of the Maintenance Period.

END OF SECTION 329000

SECTION 33 11 00

WATER UTILITY DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for combined water service and fire-service mains.
- B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

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- D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- E. NFPA Compliance: Comply with NFPA 24 (2016 Edition) for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- F. NSF Compliance:
 - 1. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
 - 2. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify Construction Manager no fewer than 5 days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without Construction Manager's written permission.

1.7 COORDINATION

- A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A, water tube, annealed temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
- B. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A), water tube, drawn temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

- C. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 3. The internal surfaces of iron pipe and fittings shall be lined with a uniform thickness of cement mortar then sealed with a bituminous coating in accordance with AWWA C104.
 4. The outside surfaces of ductile iron pipe and fittings, including valves and appurtenances for buried service shall be coated with one of the following:
 - a. 24 mils minimum dry film thickness (MDFT) liquid epoxy coating in accordance with AWWA C210. Coal tar epoxies shall not be used.
 - b. 24 mils MDFT Fusion Bonded Epoxy coating in accordance with AWWA C213 and AWWA C116.
 - c. A cold applied three-part system, 80 mils petroleum Wax Tape coating in accordance with AWWA C217
 - d. 24 mils MDFT 100% solids Polyurethane coating in accordance with AWWA C222.
 5. Prior to coating, the iron surfaces shall be blast cleaned in accordance with the applicable National Association of Pipe Fabricators (NAPF) standard 500-03, “surface preparation standard for ductile iron pipe and fittings receiving special external coatings and/or special internal linings.” The entire coated surface shall be inspected with a holiday detector in accordance with National Association of Corrosion Engineers (NACE International) standard SP0188-2006, “Discontinuity (Holiday) testing of new protective coatings on conductive substrates.”
 6. The fitting shall be lined with cement mortar and tar (seal) in accordance with AWWA C104/A21.4. The Contractor shall provide double thickness lining and shall use cement conforming to ASTM C150 Type II. Coating on Interior bells shall be holiday free. The outside shall be asphalt-coated per AWWA C151. The fitting, when assembled, shall be polyethylene-encased in accordance with the requirements of AWWA C105.
 7. Loose polyethylene encasement for the protection of iron pipes, cast or ductile iron fittings, valves, and appurtenances shall be furnished and installed in accordance with the requirements of AWWA C 105.
- D. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 2. Gaskets: AWWA C111, rubber.
 3. The outside surfaces of ductile iron pipe and fittings, including valves and appurtenances for buried service shall be coated with one of the following:
 - a. 24 mils minimum dry film thickness (MDFT) liquid epoxy coating in accordance with AWWA C210. Coal tar epoxies shall not be used.
 - b. 24 mils MDFT Fusion Bonded Epoxy coating in accordance with AWWA C213 and AWWA C116.
 - c. A cold applied three-part system, 80 mils petroleum Wax Tape coating in accordance with AWWA C217
 - d. 24 mils MDFT 100% solids Polyurethane coating in accordance with AWWA C222.
 4. Prior to coating, the iron surfaces shall be blast cleaned in accordance with the applicable National Association of Pipe Fabricators (NAPF) standard 500-03, “surface preparation standard for ductile iron pipe and fittings receiving special external coatings and/or special internal linings.” The entire coated surface shall be inspected with a holiday detector in accordance with National Association of Corrosion Engineers (NACE International) standard SP0188-2006, “Discontinuity (Holiday) testing of new protective coatings on conductive substrates.”
 5. The fitting shall be lined with cement mortar and tar (seal) in accordance with AWWA C104/A21.4. The Contractor shall provide double thickness lining and shall use cement conforming to ASTM C150 Type II. Coating on Interior bells shall be holiday free. The outside shall be asphalt-coated per AWWA C151. The fitting, when assembled, shall be polyethylene-encased in accordance with the requirements of AWWA C105.
 6. Loose polyethylene encasement for the protection of iron pipes, cast or ductile iron fittings, valves, and appurtenances shall be furnished and installed in accordance with the requirements of AWWA C 105.
- E. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
1. The outside surfaces of ductile iron pipe and fittings, including valves and appurtenances for buried service shall be coated with one of the following:
 - a. 24 mils minimum dry film thickness (MDFT) liquid epoxy coating in accordance with AWWA C210. Coal tar epoxies shall not be used.
 - b. 24 mils MDFT Fusion Bonded Epoxy coating in accordance with AWWA C213 and AWWA C116.

- c. A cold applied three-part system, 80 mils petroleum Wax Tape coating in accordance with AWWA C217
 - d. 24 mils MDFT 100% solids Polyurethane coating in accordance with AWWA C222.
- 2. Prior to coating, the iron surfaces shall be blast cleaned in accordance with the applicable National Association of Pipe Fabricators (NAPF) standard 500-03, “surface preparation standard for ductile iron pipe and fittings receiving special external coatings and/or special internal linings.” The entire coated surface shall be inspected with a holiday detector in accordance with National Association of Corrosion Engineers (NACE International) standard SP0188-2006, “Discontinuity (Holiday) testing of new protective coatings on conductive substrates.”
- 3. The fitting shall be lined with cement mortar and tar (seal) in accordance with AWWA C104/A21.4. The Contractor shall provide double thickness lining and shall use cement conforming to ASTM C150 Type II. Coating on Interior bells shall be holiday free. The outside shall be asphalt-coated per AWWA C151. The fitting, when assembled, shall be polyethylene-encased in accordance with the requirements of AWWA C105.
- 4. Loose polyethylene encasement for the protection of iron pipes, cast or ductile iron fittings, valves, and appurtenances shall be furnished and installed in accordance with the requirements of AWWA C 105.
- 5. Grooved-End, Ductile-Iron Pipe Appurtenances:
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Anvil International, Inc.
 - 2) Victaulic Company of America.
 - 3) Or equal.
- F. PVC, AWWA Pipe: AWWA C900, Class 235 and Class 305, with bell end with gasket, and with spigot end.
 - 1. Comply with UL 1285 for fire-service mains if indicated.
 - 2. PVC Fabricated Fittings: AWWA C900, Class 235 and Class 305, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
 - 3. PVC Molded Fittings: AWWA C907, Class 235, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.

4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Gaskets: AWWA C111, rubber.
5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.2 JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8, BCuP Series.
- B. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

2.3 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Tubular-Sleeve Pipe Couplings:
 1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
 - a. Standard: AWWA C219.

2.4 GATE VALVES

- A. AWWA, Cast-Iron Gate Valves:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.

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- d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. East Jordan Iron Works, Inc.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
 - j. Mueller Co.; Water Products Div.
 - k. NIBCO INC.
 - l. U.S. Pipe and Foundry Company.
 - m. Or equal.
2. Nonrising-Stem, Resilient-Seated Gate Valves:
- a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
 - 3) End Connections: Mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
3. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
- a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 250 psig (1725 kPa).
 - 3) End Connections: Push on or mechanical joint.
 - 4) Interior Coating: Complying with AWWA C550.
4. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:

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- a. Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
 - 1) Standard: AWWA C509.
 - 2) Minimum Pressure Rating: 200 psig (1380 kPa).
 - 3) End Connections: Flanged.
- B. UL/FMG, Cast-Iron Gate Valves:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Cast Iron Pipe Co.; American Flow Control Div.
 - b. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).McWane, Inc.; Kennedy Valve Div.
 - e. McWane, Inc.; M & H Valve Company Div.
 - f. Mueller Co.; Water Products Div.
 - g. NIBCO INC.
 - h. U.S. Pipe and Foundry Company.
 - i. Or equal.
 - 2. UL/FMG, Nonrising-Stem Gate Valves:
 - a. Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
 - 1) Standards: UL 262 and FMG approved.
 - 2) Minimum Pressure Rating: 175 psig (1207 kPa).
 - 3) End Connections: Flanged.
 - 3. OS&Y, Rising-Stem Gate Valves:
 - a. Description: Iron body and bonnet and bronze seating material.
 - 1) Standards: UL 262 and FMG approved.

- 2) Minimum Pressure Rating: 175 psig (1207 kPa).
- 3) End Connections: Flanged.

C. Bronze Gate Valves:

- 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Div.
 - d. Hammond Valve.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Red-White Valve Corporation.
 - h. Or equal.
- 2. OS&Y, Rising-Stem Gate Valves:
 - a. Description: Bronze body and bonnet and bronze stem.
 - 1) Standards: UL 262 and FMG approved.
 - 2) Minimum Pressure Rating: 175 psig (1207 kPa).
 - 3) End Connections: Threaded.
- 3. Nonrising-Stem Gate Valves:
 - a. Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
 - 1) Standard: MSS SP-80.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - b. East Jordan Iron Works, Inc.
 - c. Flowserve.
 - d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - e. McWane, Inc.; Kennedy Valve Div.
 - f. McWane, Inc.; M & H Valve Company Div.
 - g. Mueller Co.; Water Products Div.
 - h. U.S. Pipe and Foundry Company.
 - i. Or equal.
2. Description: Sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

- B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

- C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 CORPORATION VALVES

- A. Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Amcast Industrial Corporation; Lee Brass Co.
 - b. Ford Meter Box Company, Inc. (The); Pipe Products Div.
 - c. Jones, James Company.
 - d. Master Meter, Inc.
 - e. McDonald, A. Y. Mfg. Co.
 - f. Mueller Co.; Water Products Div.
 - g. Red Hed Manufacturing & Supply.
 - h. Or equal.
- B. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
 1. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
 2. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
 3. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
- C. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
- D. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.
 1. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

2.7 WATER METERS

- A. Water meters will be furnished by contractor.

B. Manufacturers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AMCO Water Metering Systems.
 - b. Badger Meter, Inc.
 - c. Carlon Meter.
 - d. Hays Fluid Controls; a division of ROMAC Industries Inc.
 - e. McCrometer.
 - f. Mueller Co.; Hersey Meters.
 - g. Neptune Technology Group Inc.
 - h. Sensus Metering Systems.
 - i. Or equal.

C. Displacement-Type Water Meters:

1. Description: With bronze main case.
 - a. Standard: AWWA C700.
 - b. Registration: Flow in cubic feet (cubic meters).

D. Compound-Type Water Meters:

1. Description:
 - a. Standard: AWWA C702.
 - b. Registration: Flow cubic feet (cubic meters).

2.8 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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- a. Ames Fire & Waterworks; a division of Watts Regulator Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Water Technologies, Inc.
 - f. Wilkins; a Zurn company.
 - g. Or equal.
2. Standard: ASSE 1013 or AWWA C511.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) as noted maximum, through middle 1/3 of flow range.
5. Size: As noted.
6. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
 - c. 15.Approved by UCLA Cross Sections.
- B. Double-Check, Backflow-Prevention Assemblies:
 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - a. Ames Fire & Waterworks; a division of Watts Regulator Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Water Technologies, Inc.
 - f. Wilkins; a Zurn company.
 - g. Or equal.
4. Standard: ASSE 1015 or AWWA C510.
5. Operation: Continuous-pressure applications, unless otherwise indicated.
6. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
7. Size: As noted.
8. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
9. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
10. Configuration: Designed for horizontal, straight through flow.
11. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
12. Approved by UCLA Cross Connection.

2.9 WATER METER BOXES

- A. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 by 254 mm) square.

2.10 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.

2.11 FIRE DEPARTMENT CONNECTIONS

- A. Fire Department Connections:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire End & Croker Corporation.
 - c. Guardian Fire Equipment, Inc.
 - d. Kidde Fire Fighting.
 - e. Potter Roemer.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Or equal.
 - 2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
 - a. Standard: UL 405.
 - b. Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
 - c. Inlet Alignment: Inline, horizontal.
 - d. Finish Including Sleeve: Polished bronze.
 - e. Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE."

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Section 310000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80) shall be soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
- F. Underground water-service piping NPS 4 and NPS 6 (DN 100 and DN 150) shall be the following:
 - 1. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 235 pipe; PVC, AWWA Class 235 molded fittings; and gasketed joints.
- G. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50) shall be same as underground water-service piping.
- H. Aboveground and Vault Water-Service Piping NPS 3/4 to NPS 3 (DN 20 to DN 80) shall be hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) wrought-copper, solder-joint fittings; and brazed joints.
- I. Aboveground and vault water-service piping NPS 4 and NPS 6 (DN 100 and DN 150) shall be the following:
 - 1. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
- J. Underground Fire-Service-Main Piping NPS 4 to NPS 8 (DN 100 to DN 200) shall be the following:
 - 1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.

2. PVC, AWWA Class 305 pipe listed for fire-protection service; PVC Class 305 fabricated fittings; and gasketed joints.
- K. Aboveground and Vault Fire-Service-Main Piping NPS 4 to NPS 8 (DN 100 to DN 200) shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
- L. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 10 (DN 150 to DN 250) shall be the following:
 1. Ductile-iron, mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical joints.
 2. PVC, AWWA Class 305 pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
- M. Aboveground and Vault Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 10 (DN 150 to DN 250) shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

3.3 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
 2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
 3. Use the following for valves in vaults and aboveground:
 - a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, nonrising stem.
 - b. Gate Valves, NPS 3 (DN 80) and Larger: UL/FMG, cast iron, OS&Y rising stem.

3.4 PIPING INSTALLATION

- A. Water-Main Connection: Tap water main of size and in location indicated.
- B. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:

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1. Install tapping sleeve and tapping valve according to MSS SP-60.
 2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
 3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
 4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
- C. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
 2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
 3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
 4. Install corporation valves into service-saddle assemblies.
 5. Install manifold for multiple taps in water main.
 6. Install curb valve in water-service piping with head pointing up and with service box.
- D. Comply with NFPA 24 for fire-service-main piping materials and installation.
1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
- E. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- F. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
- G. Bury piping with depth of cover over top at least 36 inches (900 mm), with top at least 12 inches (300 mm) below level of maximum frost penetration.
- H. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
- I. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.5 JOINT CONSTRUCTION

A. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
3. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
4. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
5. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
6. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.6 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Concrete thrust blocks.
2. Locking mechanical joints.
3. Set-screw mechanical retainer glands.
4. Bolted flanged joints.
5. Heat-fused joints.
6. Pipe clamps and tie rods.
7. Or equal.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Fire-Service-Main Piping: According to NFPA 24.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- C. MSS Valves: Install as component of connected piping system.
- D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.8 WATER METER INSTALLATION

- A. Install water meters, piping, and specialties according to utility company's written instructions.
- B. Water Meters: Install displacement-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.
- C. Water Meters: Install compound-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.9 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.10 WATER METER BOX INSTALLATION

- A. Install water meter boxes in paved areas flush with surface.

3.11 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891.

3.12 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install protective pipe bollards on two sides of each fire department connection.

3.13 CONNECTIONS

- A. Connect water-distribution piping to existing water main. Use service clamp and corporation valve.
- B. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.14 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities. Contractor shall prepare a “Contractor’s Material and Test Certificate for Underground Piping” per Figure 10.10.1 per NFPA 24 for all private fire mains. Contractor shall submit to the Owner and Engineer of work a minimum of 30 days prior to the planned occupancy of the facility.

3.15 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 310000 "Earth Moving."

3.16 CLEANING

A. Clean and disinfect water-distribution piping as follows:

1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION

SECTION 33 31 00

FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Nonpressure and pressure couplings.
3. Expansion joints.
4. Cleanouts.
5. Encasement for piping.
6. Manholes.

1.2 ACTION SUBMITTALS

- A. Product Data: For expansion joints.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra-Heavy classes.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI-Trademark, Shielded Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. ANACO-Husky.
 - b. Dallas Specialty & Mfg. Co.
 - c. Fernco Inc.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Stant; a Tompkins company.
 - f. Tyler Pipe.
 - g. Or equal.
 - 3. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Shielded Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. ANACO-Husky.
 - b. Clamp-All Corp.
 - c. Dallas Specialty & Mfg. Co.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Stant; a Tompkins company.
 - f. Tyler Pipe.
 - g. Or equal.
3. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

1. Pipe: ASTM D 3034, SDR 18, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM D 3034, PVC with bell ends.
3. Gaskets: ASTM F 477, elastomeric seals.

2.4 NONPRESSURE-TYPE TRANSITION COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:

1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

D. Ring-Type, Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 EXPANSION JOINTS

A. Ductile-Iron, Flexible Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - a. EBAA Iron, Inc.
 - b. Romac Industries, Inc.
 - c. Star Pipe Products.
 - d. Or equal.
3. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

1. Top-Loading Classification(s): Heavy Duty.
2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping

2.7 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: ASTM A 536, Grade 60-40-18 ductile iron unless otherwise indicated.

2.8 CONCRETE

- A. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole minimum.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 8 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 310000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 2 percent unless otherwise indicated.
 - 2. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
 - 3. Install piping with 36-inch (915-mm minimum cover as shown on plans.
 - 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 6. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
 - 1. Hub-and-spigot, cast-iron soil pipe.
 - 2. Hubless cast-iron soil pipe and fittings.
 - 3. Expansion joints.

- H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 - 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 - 4. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 - 5. Join dissimilar pipe materials with nonpressure-type, flexible or rigid couplings.
- B. Pipe couplings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - 1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.4 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Install FRP manholes according to manufacturer's written instructions.
- D. Form continuous concrete channels and benches between inlets and outlet.

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- E. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 2 inches (50 mm) above finished surface elsewhere unless otherwise indicated.
- F. Install manhole-cover inserts in frame and immediately below cover.

3.5 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts and for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 - 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
- B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops flush with surrounding grade.
- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.7 CONNECTIONS

- A. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
 - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of

connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
4. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 IDENTIFICATION

- A. Materials and their installation are specified in Section 310000 "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 1. Use detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
 1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 1. Do not enclose, cover, or put into service before inspection and approval.
 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 4. Submit separate report for each test.
 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
 - b. Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
 7. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
 8. Contractor shall videotape interior of all pipes 6 inches or larger after installation. Videotaping shall occur after backfill but prior to installation of pavement, hardscape or landscape. Videotaping shall be performed in the presence of the Owner's Representative.
- C. Leaks and loss in test pressure constitute defects that must be repaired.

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- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.10 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION

SECTION 33 41 00

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and fittings.
2. Manholes.
3. Cleanouts.
4. Nonpressure transition couplings.
5. Expansion joints.
6. Catch basins.
7. Stormwater inlets.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Field quality-control reports.

1.4 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
1. Notify Construction Manager no fewer than five days in advance of proposed interruption of service.

2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252M, Type S, with smooth waterway for coupling joints.
 1. Watertight joints per D3212
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.
 1. Water tight joints per D3212

2.2 PVC PIPE AND FITTINGS

- A. PVC Corrugated Sewer Piping:
 1. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
 2. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
 3. Gaskets: ASTM F 477, elastomeric seals.

2.3 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings:
 1. Description: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

- D. Shielded, Flexible Couplings:

1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

E. Ring-Type, Flexible Couplings:

1. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
2. Top-Loading Classification(s): Heavy Duty.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Plastic Cleanouts:

1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.5 MANHOLES

A. Standard Precast Concrete Manholes:

1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.

6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated.

2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
1. Cement: ASTM C 150, Type II.
 2. Fine Aggregate: ASTM C 33, sand.
 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 2 percent through manhole.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 8 percent.
- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

2.7 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 2. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 3. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.
 4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 5. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
 6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.

7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
 8. Steps: Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).
 9. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.
 2. Grate Free Area: Approximately 50 percent unless otherwise indicated.
 3. Grates shall be ADA compliant.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 310000 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
 - 3. Install piping with 36-inch (915-mm) minimum cover.
 - 4. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
 - 5. Install PE corrugated sewer piping according to ASTM D 2321.
 - 6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 2. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 - 3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use PVC pipe fittings in sewer pipes at branches for cleanouts and for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
 - 2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
 - 3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
 - 4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops flush with surrounding earth grade.

- C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface.

3.6 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.7 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318.

3.8 CONNECTIONS

- A. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
 - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
 - 3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.

- a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- B. Pipe couplings and expansion joints with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Shielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 1. Use detectable warning tape over ferrous piping.
 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.
 1. Submit separate reports for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.

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- b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
- 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
- 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soil tight joints.
 - b. Option: Test plastic piping according to ASTM F 1417.
- C. Leaks and loss in test pressure constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION

SECTION 33 51 11
SITE GAS DISTRIBUTION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe and fittings for natural gas distribution on site outside buildings.

1.02 REFERENCE STANDARDS

- A. ANSI Z223.1 - National Fuel Gas Code; 2015.
- B. ASME B31.8 - Gas Transmission and Distribution Piping Systems; 2014.
- C. ASTM D2513 - Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings; 2014.
- D. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.

1.03 SUBMITTALS

- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.

PART 2 PRODUCTS

2.01 PIPE

- A. Polyethylene Pipe: ASTM D2513, SDR11:
 - 1. Fittings: ASTM D2513.
 - 2. Joints: Mechanical or compression fit.
- B. Trace Wire: Magnetic detectable conductor, clear plastic covering, imprinted with "Natural Gas Service " in large letters.

2.02 GAS COCKS AND VALVES

- A. Gas Cocks Up to 2 Inches (50 mm): 150 psig (1,040 kPa) Polyethylene body, and ball with Buna N seat. ANSI B16.40, ASTM D-2513 rated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that building service connection and utility gas main size, location and invert are as indicated.

3.02 TRENCHING

- A. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling.

3.03 INSTALLATION - PIPING

- A. Group piping with other site piping work whenever practical.
- B. Route piping in straight line.
- C. Install piping to conserve space and not interfere with use of site space.
- D. Install piping to allow for expansion and contraction without stressing pipe or joints.
- E. Install cocks and other fittings.
- F. Establish elevations of buried piping to ensure not less than 24 inches (600 mm) of cover in non-travelled areas and 36 inches (900 mm) of cover in driveways and parking areas.
- G. Install trace wire 6 inches (150 mm) above top of pipe_____.

3.04 FIELD QUALITY CONTROL

- A. Pressure test gas piping to 15 psi (100 kPa).

END OF SECTION