

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Retro-fit of existing irrigation system to new landscape layout.
- B. Installation of an electric solenoid controlled underground sprinkler system of PVC pipe and fittings with pop-up heads.
- C. Retro-fit of existing control wires at new shrub and lawn zones, and decommission of unused control wires.

1.2 RELATED REQUIREMENTS

- A. Section 01 56 39 - Temporary Tree and Plant Protection
- B. Division 26 – Electrical
- C. Division 31 – Earthwork
- D. Division 33 – Utilities
- E. Section 32 92 19 – Seeding
- F. Section 32 93 00 – Plants

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the work with other trades affecting and affected by Work of this Section.
- B. Pre-installation Meeting: Convene one week (minimum) prior to commencing work of this Section to coordinate utility marking procedures.

1.4 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures for submittal procedures.

1.5 INFORMATION SUBMITTALS

- A. Installer Qualifications:
 - 1. Company specializing in performing Work of this Section who has successfully completed a minimum of 5 comparable scale projects and have the following licenses:
 - a. For Irrigation Work:
 - 1) Valid Oregon Landscape Contractors license.
 - 2) Valid Oregon Landscape Business license.
 - b. For Plumbing Work:
 - 1) Valid Oregon Plumbing license.
 - 2) Valid Oregon Landscape Contractor license.
 - c. Successfully completed at least 5 comparable scale projects.
 - 1) Submit names, addresses, dates, owners and locations of previous projects if requested by Owner's Representative.
- B. Quality Assurance Data:
 - 1. Submit license information and project references including name and location of previous projects, date of installation, square footage of areas with irrigation work, description of irrigation system, and Owner's contact information.

- C. Controller Programming Schedule:
 - 1. Prepare a program for the irrigation controller for Spring/Summer-Summer-Summer/Fall. Indicate start times, watering duration, day of week, repeat cycle mode, program mode, precipitation rates in inches per hour, and application quantities. Coordinate operation and programming with Owner's Representative.
- D. Zoning Chart:
 - 1. Submit colored and laminated chart showing each zone and their actual precipitation rates.

1.6 ACTION SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings called for in the installation details. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to installation details.
- B. Product Data:
 - 1. Submit Manufacturer's catalog cut sheets, specifications, installation instructions, and warranties for all material as noted in this section and on drawings. Failure to do so may result in non-acceptance of materials already used or hauled to the site. Any removal or delays incurred will be at the expense of the Contractor

1.7 CLOSEOUT SUBMITTALS

- A. Record Drawings:
 - 1. Submit project record (as-built) drawings to Owner prior to system demonstration to Owner.
 - 2. Keep one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded.
 - 3. Record work which is installed differently than shown on the construction drawings.
 - 4. Record accurate reference dimensions, measured from at least two permanent reference points, of each irrigation system valve, each backflow prevention device, each sleeve end, each main line stub out, and other irrigation components enclosed within a valve box. Use red ink to legibly re-draft actual dimensions of installed work.
 - 5. Submit to Owner's Representative for approval.
 - 6. Completion of the Record Drawings will be a prerequisite for the Final Completion Review.
- B. Operation and Maintenance Data:
 - 1. Written instructions for operation and maintenance of system and controls, seasonal activation and shutdown, and manufacturer's parts catalog.

1.8 MAINTENANCE MATERIAL SUBMITTAL

- A. Provide the following for Owner's use in maintenance of project.
 - 1. Extra Valve Keys for Manual Valves: One.
 - 2. Extra Valve Box Keys: One.
 - 3. Wrenches: One for each type head core and for removing and installing each type head.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in original unopened packaging with legible manufacturer's identification.

- B. Comply with manufacturer's recommendations for storage and protection.
 - 1. Store in a cool, dry place out of direct sunlight.
 - 2. Protect from damage by the elements and construction procedures.
 - 3. Store plastic pipe on firm, level supports.
 - 4. Store plastic pipe cement in cool location.

1.10 ENVIRONMENTAL CONDITIONS

- A. Temperature of mating surfaces of plastic pipe and fittings to be between 40 degrees Fahrenheit and 100 degrees Fahrenheit. Perform no PVC Solvent welding in rainy weather except under cover.

1.11 REVIEWS

- A. Request the following reviews by the Owner's Representative two days (min.) in advance:
 - 1. Irrigation Head Layout Review
 - 2. Pressure Test and Mainline Installation Review
 - 3. Substantial Completion Review
 - 4. System Demonstration to Owner
 - 5. Final Completion Review
- B. Coordinate Reviews to coincide with regular progress meetings where possible.

1.12 MAINTENANCE

- A. During period between system installation and Final Completion Review provide maintenance to assure proper operation of the irrigation system.

1.13 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide one year warranty following Final Completion granted by Owner's Representative or one full growing season following Final Completion, whichever is later.
- C. Inspection: Visit work at least once a month during warranty period. Notify Owner's Representative and Owner in writing of any observed conditions requiring attention. Failure to provide such notification renders any deficiencies the Contractor's responsibility to rectify.
- D. At the end of the warranty period, as directed by Owner's Representative and at no additional cost to the Owner:
 - 1. Irrigation system must be in proper working condition.
 - 2. Replace work of this Section as necessary to restore system to proper working condition following the Contract Documents.
 - 3. Complete corrective warranty work within 30 days of warranty review.
- E. Contractor is not responsible for loss or damage to work of these section caused by unusually extreme weather, vandalism, or lack of Owner's maintenance during warranty period.

PART 2 - PRODUCTS

2.1 IRRIGATION SYSTEM MATERIALS

- A. Reuse existing equipment as indicated on drawings. If new equipment is needed, use only new materials of brands and types shown on Drawings or specified herein.

- B. Similar materials must be products of one manufacturer unless otherwise approved.
- C. Substitutions: See Section 01 33 00 – Submittal Procedures

2.2 PIPE MATERIALS

- A. Mainline Pipe, Lateral Line Pipe, and Irrigation Sleeves: Schedule 40 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D1785.
- B. Mainline Pipe, Lateral Line Pipe, and Irrigation Sleeves: Class 200 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D2241.
- C. Risers: One piece schedule 80 gray PVC Pipe, Type 1, threaded at both ends conforming to ASTM D1784 and ASTM D2464. No snap-risers.
- D. Fittings: Polyvinyl chloride type 1, white schedule 40 and gray schedule 80; ASTM D1784, ASTM D2466, or ASTM D2464, as applicable.
- E. Irrigation Sleeves: Class 200 PVC Pipe, Type 1, normal impact: IPS, NSF approved conforming to ASTM D1784, ASTM D2241.
- F. Swing Joint Assembly Pipe and Fittings: Double swing joint risers as detailed. Swing-Pipe, snap, and "Funny pipe" risers not acceptable.
- G. Flex Riser Assembly: 18 inch minimum, 3 feet maximum Swing-Pipe with transfer barb 90 degree ells at both ends and a marlex ell below the irrigation head.
- H. Electrical Conduit and Fittings:
 - 1. Underground: Plastic, Class 3, Federal Specification W-C-1094.
 - 2. Above Ground: Aluminum, Federal Specification WW-G-540.
- I. PVC Solvent Cement: NSF approved solvent for Class 1245-B&C PVC through 4 inches conforming to ASTM D 2564 for PVC pipe and fittings. Ensure that manufacturer's expiration date is not exceeded.
 - 1. IPS Corporation Weld-on #704 or #711.
 - 2. At main lines: IPS Corporation Weld-On #705 PVC.
 - 3. At lateral lines: IPS Corporation Weld-On #705 PVC or #721 PVC.
- J. PVC Cleaner and Primer:
 - 1. IPS Weld-on P-70 or as recommended by PVC Pipe manufacturer.
 - 2. Oatey Lo-V.O.C. Purple Primer #31903.

2.3 VALVES – REUSE EXISTING VALVES ON SITE WHERE POSSIBLE

- A. Isolation Valves: Threaded 2-piece, Std. Port, bronze ball valve sized to match mainline with lever grip handle.
 - 1. Approved Products:
 - a. Apollo Model 77F-200 Series, or approved equal
- B. Control Valve Assembly:
 - 1. Automatic Control Valve: Globe type, 200 psi rated, threaded connections with cross type operating handle designed to receive operating key. Size according to Valve Schedule on Drawing. **Provide threaded unions on both sides of the control valve. Isolation valve shall be installed on the mainline side of the control valve. – ADDENDUM #1 - 03/29/2019.**
 - a. Approved Products:

- 1) Hunter ICV-101G-FS with Hunter AS-ADJ Pressure Regulator.
2. Shut Off Valve: USA manufactured gate valve. 120 psi cold water rated, constructed of brass or bronze on 2 inch and under valves with bronze lever handle.
 - a. Approved Products:
 - 1) Apollo Model 77F-200 Series, or approved
- C. Quick Coupling Valves:
 1. Approved Products:
 - a. Hunter HQ44-LRC.
- D. Manual Drain Valve: Globe or angle brass manual valve with non-floating seat disk that allows positive drainage.
 1. Approved Products:
 - a. Manufactured by Arrowhead.
 - b. Nibco, Champion, or pre-approved equal.

2.4 VALVE BOXES – REUSE EXISTING VALVE BOXES ON SITE WHERE POSSIBLE

- A. Valve box of suitable size with tee top type lid .
 1. Black box and lid in plant bed areas.
 2. Green box and lid.
 3. Black box and green t-top lid at lawn areas.
 4. Black box and brown mulch t-top lid at plant bed areas.
- B. Install valves in the following valve boxes:
 1. Control Valve Assembly: (2) Carson 1419-12, T-Lid.
 2. Control Valve Assembly: (2) Standard 12" Pentek, Ametek, or pre-approved equal. T-Top Lid.
 3. Control Valve Assembly: (2) Rain Bird VB-STD, T-Lid.
 4. Quick Coupling Valves: Carson 910-10, T-Lid.
 5. Hose Bib: 10" round Pentek, Ametek, or pre-approved equal.
 6. Manual Drain Valves: 10" round Pentek, Ametek, or pre-approved equal.
 7. Manual Drain Valves: Carson 910-10.
 8. Isolation Valves: Carson 910-10.
 9. Battery Operated Control Valves: Brooks #38-PB Steel Cover.
 10. Traffic Rated Box: Brooks, No.37 MB - Body, No. 37 - T Cast Iron Cover.
 11. Traffic Rated Box: Brook's, Christy's, Oldcastle Precast, or pre-approved equal. Mark lids with permanent "Irrigation" label.
 12. Other Valves: Sized as applicable by Pentek, Ametek, or pre-approval equal.
 13. Other Valves: Sized as applicable by Carson.

2.5 IRRIGATION HEADS – REUSE EXISTING IRRIGATION HEADS ON SITE WHERE POSSIBLE

- A. Makes and models shown on Drawings, or approved.

2.6 WIRE

- A. Zone Control Wire (2-Wire):
 - 1. Approved products:
 - a. Zone Control Wire (2-Wire): Paige Electric, Model # P7350D, or equal. Install according to manufacturer's wire schedule for valve specifications.
- B. Surge Protection:
 - 1. Tucor SP-100 Surge Protector, resistance to ground 50 ohm max.
- C. Wire from Controller to Master Valve: Install according to manufacturer's wire schedule for valve specifications. 12 gauge minimum, type AWG, bearing U.S. approval, yellow in color.
- D. Communication Wire: Install according to manufacturer's central control requirements. Wire from controller to flow and soil sensor must be a single, un-spliced length.
 - 1. PE 39 or PE 89 cable, 6 pair.
- E. Wire Connections:
 - 1. Zone Control Wires: Direct bury splice Kit.
 - a. DBR/Y by 3M.
 - b. Scotch Lok 3570.
 - 2. Communication Wire: Splice is only allowed at the termination to connect to flow and soil sensor.
 - a. UR-2 butt splice kit 034005, or pre-approved equal.
- F. Utility Locate Wire: 14 gauge minimum, type AWG-UF, bearing U.S. approval, blue in color.

2.8 BACKFILL MATERIALS

- A. Pea Gravel: 3/4 x 1/2 inch washed round rock.
- B. Sand: Clean, fill sand free of clay, rocks, organic matter, or other deleterious material.
- C. Topsoil or Loam: See Section 32 91 19 - Landscape Grading.

PART 3 EXECUTION

3.1 PROTECTION

- A. Protect existing improvements and growth in areas to remain undisturbed until completion of project. Leave area in similar condition as found.
- B. Protect existing water service. Do not interrupt water service to facilities occupied by Owner or others or existing irrigation zones not impacted by construction unless permitted by Owner and only after arranging to provide temporary water service according to requirements indicated:
 - 1. Notify Owner or Owner's Representative no fewer than two days in advance of proposed interruption of water service.
 - 2. Do not proceed with interruption of water service without written approval from Owner or Owner's Representative.
- C. Protect utilities and maintain in continuous operation or in operational condition during work. Repair damage to known utilities at Contractor's expense.

- D. Use means necessary to protect materials of this Section before, during, and after installation and to protect installed Work and materials of other trades. In the event of damage immediately make repairs and replacements as directed by Owner's Representative.

3.2 EXAMINATION

- A. Verify that required utilities and sleeves are available, in proper location, and ready for use. Verify location, type, size, PSI, and GPM of existing water lines, meters, and sleeves.
- B. Verify that surfaces and structures to receive Work are accurately sized and located, sound, secure, true, complete, and otherwise properly prepared.
- C. Verify electrical service and conduit for Irrigation Controller is properly sized and located.

3.3 PREPARATION

- A. System layout is diagrammatic. Field locate existing irrigation mainline, valves, etc. to remain. Route piping to avoid plants, ground cover, and structures. If field measurements differ slightly from Drawings, modify work for accurate fit. If measurements differ substantially notify Owner's Representative prior to installation.
- B. Review layout requirements with other affected work. Coordinate locations of sleeves under paving to accommodate system and piping to minimize conflict with other work. All existing irrigation pipe located where paving is being installed shall be placed in sleeves.
- C. Coordinate connections to existing irrigation system, including system shut down, new connections, system re-start, and scheduling of new irrigation zone run times with Owner's Representative.
- D. Irrigation Head Layout Review:
 - 1. Install flags at locations of irrigation heads and components shown on Drawings. Obtain Owner's Representative's approval and make adjustments to locations as directed. Coordinate marking of pipe trenches and location of valves prior to executing Work.

3.4 CUTTING OF PAVEMENT AND REPAIR

- A. Do not cut pavement for installation of Work without Owner's Representative's approval.

3.7 TRENCHING

- A. Excavating, trenching, and backfilling are specified in Section 32 91 19 - Landscape Grading.
- B. Excavate trenches with uniform bottom and remove rocks and sharp objects to provide firm, even, clean base for pipe. Width of trench to be 1.5 times the outside diameter of the pipe.
- C. Trench Depth:
 - 1. Minimum cover over Installed Mainline Piping: 18 inches.
 - 2. Minimum cover over Installed Lateral Line Piping – Excluding Sports Field: 12 inches.
 - 3. Minimum cover over Installed Lateral Line Piping – Sports Field: 18 – 24 inches.
 - 4. Minimum cover over Installed Sleeves in Roadway: 24 inches.
 - 5. Minimum cover over Installed Sleeves at other paving: 6 inches from bottom of paving.
- D. More than one pipe is permitted in the same trench provided that:
 - 1. Two pipes may be stacked vertically if 4 inches of Sand separates them.
 - 2. Three or more pipes must be laid 4 inches apart horizontally.
- E. Where excavation is performed to excess levels backfill with specified soil material to proper levels.

- F. Keep trenches dry and frost free. Provide and operate pumping equipment to keep excavations free from standing water.
- G. All trenches and other disturbed area shall be free from heaving and/or settling by more than half inch. If necessary adjust grade, re-grade the trench and re-seed.
- H. Protect existing vegetation to remain. Cut no roots over two inches in diameter without approval of Owner's Representative. Make cuts clean, straight, at right angles to roots. Paint cuts over 1-1/2 inches diameter with approved tree paint. Repair or replace damaged plant material.

3.8 SLEEVE INSTALLATION

- A. Sleeves may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fills where there is potential for damage to pipes.
- B. Extend sleeves 12 inches beyond pavement edge or curb. Cover pipe ends and mark with stakes.
- C. Install level and perpendicular to sidewalks and pavement unless shown otherwise on drawings.
- D. Provide markers where sleeve ends are concealed.

3.9 PIPE BEDDING

- A. Mainline: Provide uniform bearing surface of Sand, 4 inches minimum depth, free of rocks and sharp objects under entire length of pipe.
- B. Lateral Line: Provide uniform bearing surface of clean topsoil, loam, or sand. If rock or other deleterious materials are encountered bed pipe with 4 inches of Sand on all sides.

3.10 PIPE INSTALLATION

- A. Irrigation lines may be jacked or pulled but cover requirements must be maintained. Jacking of PVC pipe is not permitted in rocky or bar run fill or where there is potential damage to pipes.
- B. Install pipe in accordance with manufacturer's instructions and with the following minimum clearances around pipe:
 - 1. 2 inch diameter and smaller: 2 inches
 - 2. 2-1/2 inch diameter and larger: 4 inches
 - 3. Between irrigation and other utilities: 12 inches
- C. Threaded Plastic Pipe Installation:
 - 1. Do not use solvent cement on joints.
 - 2. Wrap threaded joints with teflon tape. Minimum 4 wraps of tape.
- D. Cemented Plastic Pipe Installation:
 - 1. Cut ends square using approved pipe cutter and bevel cuts with deburring tool.
 - 2. Clean pipe of scale, sand, dirt, etc. prior to assembling.
 - 3. No excess primer shall be used on joints.
 - 4. Wipe off excess cement continuously as it appears on the surface of the pipe after making joints.
 - 5. Allow fifteen minutes of cure time on joints before moving or handling. Assemble pipe before lowering into trench.
 - 6. Snake lines to allow for contraction.

7. Transition pipe sizes at fittings and not at bell end of pipes.
8. Install thrust blocks at 90 degree corners and tees.

3.12 THRUST BLOCK INSTALLATION

- A. Install 2500psi thrust block at pipe corners, tees, ells, and stub outs as follows:
 1. Pipe 2 - 3 inches in diameter: 1 cubic foot.
 2. Pipe larger than 3 inches in diameter: 2 cubic feet.

3.13 VALVE INSTALLATION

- A. Install plumb and square, as detailed, and according to manufacturer's specifications.
- B. Manual Drain Valves:
 1. Install at mainline low points and at outlet of control valves where laterals run uphill.
 2. Record locations on as-built drawings.
- C. Install 1 valve in each valve box assembly.
- D. Valve Sump: Install a minimum of 2 cubic feet of pea gravel below each valve. Allow for 4 inches clearance between bottom of valve and valve sump.

3.14 VALVE BOX INSTALLATION

- A. Install plumb and square with adjacent construction with one valve in each valve box assembly.
- B. At Control Valve Assemblies bolt two valve boxes together as detailed.
- C. Permanently label valve type and zone number on inside of valve box lid.
- D. Set top of valve boxes flush with lawn or mulch at plant beds unless otherwise noted.
- E. Provide 12 square inches (min.) of support on each side of valve box as detailed.

3.15 CONTROL WIRE INSTALLATION

- A. Install wires below irrigation mainline with multiple wires bundled together at 5 foot maximum intervals in a continuous run. Notify Owner's Representative for approval prior if splices are required and locate in valve box.
- B. All splices will use 3M DBR/Y gel filled splices.
- C. Install (2) yellow Control Wires from controller to master valve in a single, un-spliced length.
- D. Use different colored wire for each branch of 2-Wire path.
- E. Use coded and labeled wires for each valve. Provide a numbered tag at each end of a wire at valve, and at controller. The number at each end of wire to be the same.
- F. Provide 48 inches loop in wires at each valve where controls are connected and at 100 foot maximum intervals between. Coil wire around 1/2 inch rebar dowel inside of valve box.
- G. Make electrical joints waterproof using specified connectors. Enclose joints in valve boxes.
- H. Install wire in continuous runs with no splices unless approved.
- I. Install and ground surge protection every 500 LF and at end of wire run.
- J. Show wire routes and approved splice locations on as-built drawings.
- K. Install wires in conduit when run above grade or independent of the mainline.
- L. All existing control wires that are attached to decommissioned control valves are to be pulled to a single location, rolled up and tied, and placed in a valve box.

3.18 MAINLINE PRESSURE TEST AND INSPECTION

- A. Field inspection and testing will be performed under provisions of Section 01 40 00 - Quality Requirements.
- B. Prior to backfilling and installing valves test irrigation mainline for leakage. Establish and maintain 100 PSI or 150 PSI pressure for 24 hours. Perform test a minimum of 24 hours or 2 hours after set-up of solvent weld. Notify Owner's Representative a minimum of 24 hours for review of pressure gauge at beginning and end of test period. Mainline will be accepted if pressure loss is less than 2 psi.
- C. Following the pressure test but prior to backfilling, notify Owner's Representative for review of pipe, fittings, joints, thrust blocks, bedding, control wire installation, valves, and other materials for installation and water tightness.
- D. After successful inspection of pressure test and mainline, begin backfilling and assembly of zones and system components.

3.19 BACKFILLING

- A. Remove debris, sharp rocks, and decayable matter from areas to be backfilled before proceeding.
- B. Mainlines: Provide 6 inches sand cover over piping then place Utility Locate Wire the entire length of pipes where control wires are not present. Backfill remainder of trench with topsoil or loam.
- C. Lateral Lines: Backfill trench with topsoil or loam. Protect piping from displacement.
- D. At Paved Areas: Backfill trench with sand under paved areas.
- E. Compact backfill in 6 inch lifts to match density of surrounding material. Install backfill to match adjacent elevations.

3.20 FLUSHING

- A. Mainline: Open valves and thoroughly flush piping system under full water head after piping, risers, and valves are installed. Flush for 3 minutes before replacing flush cap. Close valves and cap risers immediately after flushing.
- B. Second Flushing: Flush a second time after installation of lateral lines and sprinklers prior to nozzle installation. Flush under full water head for three minutes. Install nozzles after flushing.
- C. Drip Line Flushing: Remove flush cap and flush each zone under full water head after all connections have been made. Maintain flushing for three minutes and immediately replace flush cap.

3.21 SPRINKLER HEAD INSTALLATION

- A. Install plumb with top of Topsoil/Loam or Mulch as detailed and at locations shown on drawings. Allow a maximum of 3 inches clearance between sprinkler head and adjacent lawn or planting edge.
- B. Install 1 cubic foot pea gravel sump on all low irrigation heads where drainage occurs at zone shutdown.

3.22 IRRIGATION AUDIT

- A. Coordinate Work with an independent irrigation auditor retained by the Owner within 30 days of site work completion. The following results will be provided to the Owner's Representative and Contractor performing work of this section in a signed report by a certified Irrigation Auditor in good standing with the Irrigation Association (IA) and in accordance with the IA's Landscape

Irrigation Auditor's Handbook. Any additional audits necessary beyond the initial audit will be the responsibility of the Contractor.

1. Distribution uniformity for zones
 2. Precipitation rates for zones
 3. Catch can test of each zone with a drawing showing catch can locations
 4. Flow rates, static, and dynamic pressures at each zone
- B. Schedule irrigation audit at plant beds with Owner's Representative prior to plant material installation.
- C. Provide Irrigation Auditor and Owner's Representative with marked up drawings, drawn at the original scale of the irrigation plan, showing as-built conditions including:
1. station numbers and locations
 2. sprinkler locations and type
 3. nozzle type and size
- D. Adjust head types, spacing, nozzles, etc. at irrigation zones to achieve a minimum distribution uniformity of:
1. 60% at fixed spray zones
 2. 70% at rotary zones

3.23 SUBSTANTIAL COMPLETION REVIEW

- A. When Work of this Section is complete, notify Owner's Representative for Substantial Completion Review.
- B. Prior to notifying Owner's Representative prepare and start system in accordance with manufacturer's instructions, review zones, and make adjustments to ensure full and even coverage.
- C. Adjust system for full water coverage as directed.

3.24 SYSTEM DEMONSTRATION TO OWNER

- A. Instruct Owner's Representative in operation and maintenance of system, including adjusting of sprinkler heads. Use operation and maintenance data as basis for demonstration.

3.25 CLEANING

- A. Remove excess excavation, backfill materials, and other left over materials from the site. Clean improvements soiled by work of this Section.

3.26 FINAL COMPLETION REVIEW

- A. Notify Owner's Representative for Final Completion Review.

END OF SECTION

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. Perforated-wall pipe and fittings.
 - 2. Drainage conduits.
 - 3. Drainage panels.
 - 4. Geotextile filter fabrics.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Drainage conduits, including rated capacities.
 - 2. Drainage panels, including rated capacities.
 - 3. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated PE Pipe and Fittings:
 - 1. NPS 6 (DN 150) and Smaller: ASTM F405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
 - 2. NPS 8 (DN 200) and Larger: ASTM F667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
 - 3. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.2 DRAINAGE CONDUITS

- A. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cusped, molded-plastic drainage core wrapped in geotextile filter fabric.
 - 1. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: [30 gpm (114 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D 4716.
 - 2. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: [45 gpm (170 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 - 3. Filter Fabric: PP geotextile.
 - 4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.

- B. Multipipe Drainage Conduits: Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D1248 and wrapped in geotextile filter fabric.
1. Nominal Size: 6 inches (152 mm) high by approximately 1-1/4 inches (31 mm) thick.
 - a. Minimum In-Plane Flow: [15 gpm (57 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 2. Nominal Size: 12 inches (305 mm) high by approximately 1-1/4 inches (31 mm) thick.
 - a. Minimum In-Plane Flow: [30 gpm (114 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 3. Nominal Size: 18 inches (457 mm) high by approximately 1-1/4 inches (31 mm) thick.
 - a. Minimum In-Plane Flow: [45 gpm (170 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 4. Filter Fabric: Nonwoven, needle-punched geotextile.
 5. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
 6. Couplings: HDPE.
- C. Single-Pipe Drainage Conduits: Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
1. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: [30 gpm (114 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 2. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: [45 gpm (170 L/min.)] > at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 3. Filter Fabric: PP geotextile.
 4. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
 5. Couplings: Corrugated HDPE band.
- D. Mesh Fabric Drainage Conduits: Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Nominal Size: 6 inches (150-mm) high by approximately 0.9 inch (23 mm) thick.
 - a. Minimum In-Plane Flow: [2.4 gpm (9.1 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 2. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D4491.
- E. Ring Fabric Drainage Conduits: Drainage conduit with HDPE rings-in-grid pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
1. Nominal Size: 18 inches (0.5 m) high by 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: [82 gpm (310 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D 4716.
 2. Nominal Size: 36 inches (1 m) high by 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow: [164 gpm (621 L/min.)] at hydraulic gradient of [1.0] when tested according to ASTM D4716.
 3. Filter Fabric: Comply with requirements for flat geotextile filter fabric specified in Part 2 "Geotextile Filter Fabrics" Article.

2.3 DRAINAGE PANELS

- A. Molded-Sheet Drainage Panels: Prefabricated geocomposite, [36 to 60 inches (915 to 1525 mm)] wide with drainage core faced with geotextile filter fabric.
1. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
 - a. Minimum Compressive Strength: [10,000 lbf/sq. ft. (479 kPa)] [15,000 lbf/sq. ft. (718 kPa)] [18,000 lbf/sq. ft. (862 kPa)] [21,000 lbf/sq. ft. (1005 kPa)] when tested according to ASTM D1621.
 - b. Minimum In-Plane Flow Rate: [2.8 gpm/ft. (35 L/min. per m)] [7 gpm/ft. (87 L/min. per m)] [15 gpm/ft. (186 L/min. per m)] of unit width at hydraulic gradient of [1.0] and compressive stress of [25 psig (172 kPa)] when tested according to ASTM D4716.
 2. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
 - a. Survivability: [Class 1] [Class 2] [Class 3].
 - b. Apparent Opening Size: [No. 40 (0.425-mm)] [No. 60 (0.25-mm)] [No. 70 (0.212-mm)] sieve, maximum.
 - c. Permittivity: [0.5] [0.2] [0.1] per second, minimum.
 3. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:
 - a. Survivability: [Class 1] [Class 2] [Class 3].
 - b. Apparent Opening Size: [No. 40 (0.425-mm)] [No. 60 (0.25-mm)] [No. 70 (0.212-mm)] [No. 30 (0.6-mm)] sieve, maximum.
 - c. Permittivity: [0.5] [0.2] [0.1] [0.02] per second, minimum.
 4. Film Backing: Polymeric film bonded to drainage core surface.
- B. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Drainage Core: Open-construction, resilient, plastic-filament mesh, approximately 0.4 inches (10.2 mm) thick.
 - a. Minimum In-Plane Flow Rate: [2.4 gpm/ft. (30 L/min. per m)] of unit width at hydraulic gradient of [1.0] and normal pressure of 25 psig (172 kPa) when tested according to ASTM D4716.
 2. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D4491.
- C. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Drainage Core: Three-dimensional, PE nonwoven-strand geonet, approximately 0.25 inches (6 mm) thick.
 - a. Minimum In-Plane Flow Rate: [2.4 gpm/ft. (30 L/min. per m)] [5 gpm/ft. (62 L/min. per m)] of unit width at hydraulic gradient of [1.0] and normal pressure of 25 psig (172 kPa) when tested according to ASTM D4716.
 2. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D4491.
- D. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.

1. Drainage Core: Three-dimensional, HDPE rings-in-grid pattern, approximately 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow Rate: [40 gpm/ft. (500 L/min. per m)] of unit width at hydraulic gradient of [1.0] and normal pressure of 25 psig (172 kPa) when tested according to ASTM D4716.

2.4 SOIL MATERIALS

- A. Soil materials are specified in Section 31 20 00 "Earth Moving."

2.5 WATERPROOFING FELTS

- A. Material: Comply with [ASTM D226, Type I, asphalt] [or] [ASTM D 227, coal-tar]-saturated organic felt.

2.6 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D4491.
- B. Structure Type: Nonwoven, needle-punched continuous filament.
 1. Survivability: AASHTO [M 288 Class 2].
 2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

3.3 FOUNDATION DRAINAGE INSTALLATION

- A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [adhesive] [or] [tape].
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.
- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- I. Place layer of [flat-style geotextile filter fabric] [waterproofing felt] over top of drainage course, overlapping edges at least 4 inches (100 mm).
- J. Install drainage panels on foundation walls as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
 - 3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
 - 4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
- K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 UNDERSLAB DRAINAGE INSTALLATION

- A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [adhesive] [or] [tape].
- E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.
- F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

- G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Install horizontal drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at inside edge of footing.
 - 3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
 - 4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.5 RETAINING-WALL DRAINAGE INSTALLATION

- A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).
- C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with [adhesive] [or] [tape].
- D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- E. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- F. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
- G. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of [flat-style geotextile filter fabric] [waterproofing felt] over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Install drainage panels on wall as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
 - 3. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
 - 4. Mark horizontal chalk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.
 - 5. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
 - 6. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart.[Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails.] Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.

7. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
 8. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
 9. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
 10. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
- J. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.6 LANDSCAPING DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with [adhesive] [or] [tape].
- E. Add drainage course to top of drainage conduits.
- F. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.
- G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of [flat-style geotextile filter fabric] [waterproofing felt] over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 1. Foundation Subdrainage: Install piping level and with a minimum cover of [36 inches (915 mm)] unless otherwise indicated.
 2. Underslab Subdrainage: Install piping level.
 3. Plaza Deck Subdrainage: Install piping level.

4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of [36 inches (915 mm)] unless otherwise indicated.
 5. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of [0.5] percent and with a minimum cover of [36 inches (915 mm)] unless otherwise indicated.
 6. Lay perforated pipe with perforations down.
 7. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install thermoplastic piping according to ASTM D2321.

3.8 PIPE JOINT CONSTRUCTION

- A. Join perforated PE pipe and fittings with couplings according to ASTM D3212 with loose banded, coupled, or push-on joints.
- B. Join perforated PVC sewer pipe and fittings according to ASTM D3212 with loose bell-and-spigot, push-on joints.
- C. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 BACKWATER VALVE INSTALLATION

- A. Comply with requirements for backwater valves specified in Section 33 41 00 "Storm Utility Drainage Piping."
- B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
- C. Install horizontal backwater valves in piping[in manholes or pits] where indicated.

3.10 CLEANOUT INSTALLATION

- A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."
- B. Cleanouts for [Foundation] [Retaining-Wall] [and] [Landscaping] Subdrainage:
1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
 2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [18 by 18 by 12 inches (450 by 450 by 300 mm)] deep. Set top of cleanout flush with grade.
 3. In nonvehicular-traffic areas, use NPS 4 (DN 100) [cast-iron] [PVC] pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, [12 by 12 by 4 inches (300 by 300 by 100 mm)] deep. Set top of cleanout [1 inch (25 mm)] [2 inches (50 mm)] above grade.

4. Comply with requirements for concrete specified in [Section 03 30 00 "Cast-in-Place Concrete."] [Section 033053 "Miscellaneous Cast-in-Place Concrete."]

C. Cleanouts for Underslab Subdrainage:

1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.11 CONNECTIONS

- A. Comply with requirements for piping specified in Section 33 41 00 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to [building's] solid-wall-piping storm drainage system.
- C. Where required, connect low elevations of [foundation] [underslab] subdrainage to stormwater sump pumps. Comply with requirements for sump pumps specified in Section 221429 "Sump Pumps."

3.12 IDENTIFICATION

- A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 31 20 00 "Earth Moving."
 1. Install PE warning tape or detectable warning tape over ferrous piping.
 2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.13 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
 2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
- B. Drain piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.14 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION