

SECTION 33 46 13**FOUNDATION DRAINAGE**

SPEC WRITER NOTES:

1. Delete between // ____ // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.
2. This section covers any and all work on-site beginning from a point one foot outside the building line.

PART 1 - GENERAL**1.1 DESCRIPTION**

This section specifies materials and procedures for construction of foundation drainage systems, including installation, backfill, and cleanout extensions, to a point of connection to storm sewer.

1.2 RELATED WORK

- A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.
- B. Materials testing and inspection during construction: Section 01 45 29, TESTING LABORATORY SERVICES.
- C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.
- D. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.
- E. Cathodic Protection: Section 26 42 00, CATHODIC PROTECTION.

1.3 DEFINITIONS

SPEC WRITER NOTE: Add definitions as necessary for project clarity.

Subdrainage: Foundation drainage system that collects and removes subsurface or seepage water from building foundation from building to discharge pond.

1.4 ABBREVIATIONS

SPEC WRITER NOTE: Retain abbreviations and terms that remain after this Section has been edited.

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.6 COORDINATION

- A. Coordinate connection to storm sewer main, if approved, with the Public Agency responsible for the storm sewer system.
- B. Coordinate exterior utility lines and connections to foundation building drain.

1.7 QUALITY ASSURANCE:

- A. Products Criteria:
 - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Agency having jurisdiction over the connection to public storm sewer lines or the requirements for discharge of subsurface drainage.

1.8 APPLICABLE PUBLICATIONS

SPEC WRITER NOTE: Based on project design for local conditions, delete references not applicable for project.

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by basic designation only.

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

- A48-03 Gray Iron Castings
- C14-07 Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
- C33/C33M-11 Concrete Aggregates
- C443-10 Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
- C444-03(2009) Perforated Concrete Pipe

C578-10a	Rigid, Cellular Polystyrene Thermal Insulation
C1173-08	Flexible Transition Couplings for Underground Piping Systems
D448-08	Sizes of Aggregate for Road and Bridge Construction
D1621-10	Standard Test Method for Compressive Properties of Rigid Cellular Plastics
D2235-04(2011)	Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
D2321-11	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2751-05	Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
D3034-08	Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3350-10a	Polyethylene Plastic Pipe and Fittings Material
D4491-99a(2009)	Test Methods for Water Permeability of Geotextiles by Permittivity
D4716-08	Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D5926-09	Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
D6707-06 (2011)	Circular-Knit Geotextile for Use in Subsurface Drainage Applications
F405-05	Corrugated Polyethylene (PE) Pipe and Fittings
F477-10	Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F667-06	Larger Diameter Corrugated Polyethylene Pipe and Fittings

F2648-10 2 to 60 Inch Annular Corrugated Profile Wall
Polyethylene (PE) Pipe and Fittings for Land
Drainage Applications

1.9 WARRANTY

The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of // one year // two years // from final acceptance. Further, the Contractor will furnish all manufacturer's and supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

SPEC WRITER NOTE: Delete sections not applicable to project.

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements.
- B. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.2 COMPATIBILITY OF RELATED EQUIPMENT

Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that the result will be a complete and fully operational system that conforms to contract requirements.

2.3 UNDERSLAB HEADER

SPEC WRITER NOTE: Choose the material type based on the design requirements if an underslab header is required.

- A. PE pipe and fittings per // ASTM F2648 // ASTM F405 // ASTM F667 // or // ASTM F2678 //.
- B. PVC sewer pipe and fittings per ASTM D3034, with ASTM F477, elastomeric seal gaskets.

2.4 PERFORATED-WALL PIPES AND FITTINGS FOR VAULTS OR MANHOLES

SPEC WRITER NOTE: Pipe materials in this Article have perforated walls and are joined with tight joints.

- A. Perforated PE Pipe and Fittings:

1. Pipe shall be // ASTM D2648 // ASTM F405 // or // ASTM F667 //, Type CP; corrugated, for coupled joints.
 2. Couplings: Manufacturer's standard.
- B. Perforated PVC Sewer Pipe and Fittings shall be ASTM D3034.
- C. Perforated Concrete Pipe and Fittings: ASTM C444, Type 1, and applicable requirements in ASTM C14, Class 2, socket-and-spigot ends for gasketed joints.
1. Gaskets: ASTM C443, rubber.

2.5 SOLID-WALL PIPES AND FITTINGS

SPEC WRITER NOTE: Pipe materials in this Article have solid walls (without perforations) and are joined with tight joints. They are used for headers and piping if inlet of water is required.

- A. ABS Sewer Pipe and Fittings shall meet ASTM D2751.
1. Solvent Cement: ASTM D2235.
 2. Gaskets: ASTM F477.
- B. PE Pipe and Fittings: ASTM // D3350 // or // F405 //.
- C. PVC Sewer Pipe and Fittings: ASTM D3034.
1. Gaskets: ASTM F477.

2.6 SPECIAL PIPE COUPLINGS

- A. Comply with ASTM C1173 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.
1. Sleeve Materials:
 - a. For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
 2. Unshielded Flexible Couplings: Elastomeric sleeve with // stainless-steel shear ring and // corrosion-resistant metal tension band and tightening mechanism on each end.

2.7 CLEANOUTS

- A. Cleanouts: Cast-iron parts shall conform to ASTM A48. Lid shall be secured, scoriated, // Light // // Medium // // or // Highway // Loading class. Include cast-iron ferrule and countersunk, brass cleanout plug.
- B. Cleanout PVC Extension shall conform to ASTM D3034. PVC extensions shall have watertight joints and long sweep elbow fittings. PVC cleanout shall have threaded plug and threaded pipe hub.

2.8 DRAINAGE CONDUITS

SPEC WRITER NOTE: Verify flow of selected drainage conduits and size pipe for

accumulated flow in system. Design should not allow drainage back-up toward the foundation.

A. Molded-Sheet Drainage Conduits shall be 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.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.

SPEC WRITER NOTE: Retain "Nominal Size" Subparagraph and associated subparagraph (1) above or (2) below.

2. Nominal Size shall be 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.

a. Minimum In-Plane Flow: // 45 gpm (170 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.

SPEC WRITER NOTE: Retain two subparagraphs below with "Nominal Size" subparagraph (2) and associated subparagraph selected above.

3. Filter Fabric shall conform to ASTM D6707.

4. Fittings shall be as per manufacturer.

B. Multi-pipe Drainage Conduits shall be prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE and wrapped in geotextile filter fabric.

SPEC WRITER NOTE: Retain one "Nominal Size" Subparagraph and associated subparagraph below.

1. Nominal Size shall be 6 inches (152 mm) high by approximately 1-1/4 inches (31 mm) thick.

a. Minimum In-Plane Flow shall be // 15 gpm (57 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.

2. Nominal Size shall be 12 inches (305 mm) high by approximately 1-1/4 inches (31 mm) thick.

a. Minimum In-Plane Flow shall be // 30 gpm (114 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.

3. Nominal Size shall be 18 inches (457 mm) high by approximately 1-1/4 inches (31 mm) thick.
- a. Minimum In-Plane Flow shall be // 45 gpm (170 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.
- SPEC WRITER NOTE: Retain three subparagraphs below with "Nominal Size" Subparagraph and associated subparagraph selected above.
4. Filter Fabric shall be nonwoven geotextile.
5. Fittings shall be as per manufacturer.
6. Couplings shall be as per manufacturer.
- C. Single-Pipe Drainage Conduits shall be prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D3350 and wrapped in geotextile filter fabric.
1. Nominal Size shall be 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
- a. Minimum In-Plane Flow shall be // 30 gpm (114 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.
- SPEC WRITER NOTE: Retain "Nominal Size" Subparagraph and associated subparagraph above or below.
2. Nominal Size shall be 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
- a. Minimum In-Plane Flow shall be // 45 gpm (170 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.
- SPEC WRITER NOTE shall be Retain three subparagraphs below with "Nominal Size" Subparagraph and associated subparagraph selected above.
3. Filter Fabric shall be nonwoven geotextile.
4. Fittings shall be as per manufacturer.
- D. Mesh Fabric Drainage Conduits shall be prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include manufacturer's fittings for bends and connection to drainage piping.
1. Nominal Size shall be 6 inches (150 mm) high by approximately 0.9 inch (23 mm) thick.

- a. Minimum In-Plane Flow shall be // 2.4 gpm (9.1 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.
 - 2. Filter Fabric shall be nonwoven geotextile. 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 shall be drainage conduit with HDPE-rings-in-grid-pattern drainage core, for field-applied geotextile filter fabric. Include manufacturer's fittings for bends and connection to drainage piping.
- 1. Nominal Size shall be 20 inches (0.5 m) high by 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow shall be // 82 gpm (310 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.
- SPEC WRITER NOTE: Retain "Nominal Size" subparagraph and associated subparagraph (1) above or (2) below.
- 2. Nominal Size shall be 40 inches (1 m) high by 1 inch (25 mm) thick.
 - a. Minimum In-Plane Flow shall be // 164 gpm (621 L/min.) // Insert value // at hydraulic gradient of // 1.0 percent // Insert value // when tested according to ASTM D4716.
 - 3. Filter Fabric shall be nonwoven geotextile.
- F. Smooth PVC Drainage Conduits shall have perforated fittings and couplings complying with ASTM D3034.
- 1. Nominal size shall be 8 inches (200 mm).
 - a. Minimum flow rate equal to a NPS 4 (DN 100) pipe.
 - 2. Fittings shall be as per manufacturer.

2.9 DRAINAGE PANELS

SPEC WRITER NOTES:

- 1. Retain this Article if drainage panels are specified in this Section. Delete if drainage panels are not specified.
 - 2. Select flow rate of selected drainage panels.
- A. Molded-Sheet Drainage Panels shall be Prefabricated geocomposite, // 36 to 60 inches (915 to 1525 mm) // Insert dimension // wide with drainage core faced with geotextile filter fabric.
- 1. Drainage Core shall be Three-dimensional, nonbiodegradable, molded plastic.

- a. Minimum Compressive Strength shall be // 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) // Insert value // when tested according to ASTM D1621.
- b. Minimum In-Plane Flow Rate shall be // 2.8 gpm/ft (35 L/min. per m) // 7 gpm/ft (87 L/min. per m) // 15 gpm/ft (188 L/min. per m) // Insert value // of unit width at hydraulic gradient of // 1.0 // Insert value // and compressive stress of // 25 psi (172 kPa) // Insert value // when tested according to ASTM D4716.

SPEC WRITER NOTE: Retain nonwoven geotextile and properties in subparagraph and associated subparagraphs below for walls and, if applicable, deck or plaza applications.

- 2. Filter Fabric shall be nonwoven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to ASTM D6707.

SPEC WRITER NOTE: Survivability rates a geotextile's ability to withstand installation stresses. Class 2 is default class recommended by AASHTO M288 for subsurface drainage. Select Class 1 in subparagraph below if higher strength is required; select Class 3 if lower strength is sufficient.

- a. Survivability shall be Class // 1 // 2 // 3 //.
- b. Apparent Opening Size shall be // No. 40 (0.425 mm) // No. 60 (0.25 mm) // No. 70 (0.212 mm) // sieve, maximum.
- c. Permittivity shall be // 0.5 // 0.2 // 0.1 // per second, minimum.
- 3. Filter Fabric shall be 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 ASTM D6707.
 - a. Survivability shall be Class // 1 // 2 // 3 //.
 - b. Apparent Opening Size shall be // No. 40 (0.425 mm) // No. 60 (0.25 mm) // No. 70 (0.212 mm) // No. 30 (0.6 mm) // sieve, maximum.
 - c. Permittivity shall be // 0.5 // 0.2 // 0.1 // 0.02 // per second, minimum.
- 4. Film Backing shall be Polymeric film bonded to drainage core surface.

- B. Mesh Fabric Drainage Panels shall be prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Drainage Core shall be Open-construction, resilient, approximately 0.4 inch (10.2 mm) thick, plastic-filament mesh.
 - a. Minimum In-Plane Flow Rate shall be // 2.4 gpm/ft. (30 L/min. per m) // Insert value // of unit width at hydraulic gradient of // 1.0 percent // Insert value // and normal pressure of 25 psi (172 kPa) when tested according to ASTM D4716.
 2. Filter Fabric shall be nonwoven geotextile fabric. 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 shall be prefabricated geocomposite with drainage core faced with geotextile filter fabric.
1. Drainage Core shall be 3-dimensional, PE nonwoven-strand geonet, approximately 0.25 inch (6 mm) thick.
 - a. Minimum In-Plane Flow Rate shall be // 2.4 gpm/ft. (30 L/min. per m) // Insert value // of unit width at hydraulic gradient of // 1.0 percent // Insert value // and normal pressure of 125 psi (172 kPa) when tested according to ASTM D4716.
 2. Filter Fabric shall be nonwoven geotextile fabric. 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 shall be Drainage-core panel for field application of geotextile filter fabric.
1. Drainage Core shall be 3-dimensional, HDPE rings in grid pattern, approximately 1 inch (0.25 mm) thick.
 - a. Minimum In-Plane Flow Rate shall be // 50 gpm/ft. (625 L/min. per m) // Insert value // of unit width at hydraulic gradient of // 1.0 percent // Insert value // and normal pressure of 25 psi (172 kPa) when tested according to ASTM D4716.
- SPEC WRITER NOTE: Retain paragraph and subparagraphs below for foundation-wall applications if an insulated drainage panel is required.
- E. Fabric-Covered Insulated Drainage Panels shall be extruded PS board insulation complying with ASTM C578; fabricated with // shiplap // or // tongue-and-groove // edges and with one side having grooved drainage channels; // unfaced // faced with geotextile filter fabric//.

1. Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density and 25 psi (172-kPa) minimum compressive strength.
2. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40 psi (276-kPa) minimum compressive strength.
3. Minimum In-Plane Flow Rate shall be // 9 gpm/ft. (112 L/min. per m) // Insert value // of unit width when tested according to ASTM D4716.

SPEC WRITER NOTE: Retain subparagraph below if panels are faced with geotextile filter fabric.

4. Filter Fabric shall be nonwoven geotextile fabric. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D4491.

SPEC WRITER NOTE: Retain first paragraph and subparagraphs below for plaza deck applications if an unfaced insulation drainage panel with ribbed drainage channels is required.

F. Noncovered Insulated Drainage Panels shall be Extruded PS board insulation complying with ASTM C578; fabricated with rabbited edges and with:

SPEC WRITER NOTE: Retain one of first two subparagraphs below.

1. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40 psi (276-kPa) minimum compressive strength.
2. Type VII, 2.2-lb/cu. ft. (35-kg/cu. m) minimum density and 60 psi (414-kPa) minimum compressive strength.
3. Minimum In-Plane Flow Rate shall be // 9 gpm/ft. (112 L/min. per m) // Insert value // of unit width when tested according to ASTM D4716.

G. Expanded PS Insulated Drainage Panels shall be PS bead board insulation; panels are 4 inches (102 mm) thick by 48 inches (1220 mm) wide and faced with geotextile filter fabric.

1. Density shall be 2 lb/cu. ft. (32 kg/cu. m).
2. Compressive Strength shall be 800 lbf/sq. ft. (38 kPa).
3. Minimum In-Plane Flow Rate shall be // 3 gpm/ft. (37 L/min. per m) // Insert value // of unit width when tested according to ASTM D4716.
4. Filter Fabric shall be nonwoven geotextile fabric. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D4491.

2.10 DRAINAGE MAT

Drainage mat shall be formed three dimensional polyethylene or high-impact polymeric core or compression-resistant nylon matting of open three-dimensional construction.

2.11 SOIL MATERIALS**A. Drainage Material**

1. Bedding shall be crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.
2. Fill to 1 foot (300 mm) above pipe shall be Crushed stone, 3/4 inch (20 mm) to No. 4 per ASTM D448, at a minimum or as per geotechnical recommendations.

B. Concrete Sand shall be ASTM C33.**2.12 GEOTEXTILE FILTER FABRICS**

A. Geotextile fabric shall conform to ASTM 6707. Elongation will be greater than 50 percent and the flow rate shall range from 110 to 330 gpm/sq. ft. (4480 to 13440 L/min. per sq. m).

1. Structure Type shall be // Nonwoven, needle-punched continuous filament // or // woven, monofilament or multifilament //.
2. Style(s) shall be // Flat // and // sock //.

PART 3 - EXECUTION**3.1 EXAMINATION**

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

SPEC WRITER NOTE: Retain first paragraph below if subdrainage system is required for landscaped areas.

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PIPING APPLICATIONS

A. Underground Subdrainage Piping shall be:

SPEC WRITER NOTE: Retain one or more of three subparagraphs below that specify products suitable for Project applications. If retaining more than one type of pipe, indicate location of each on Drawings.

1. Perforated PE pipe and fittings, couplings, and coupled joints.
2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Underslab Subdrainage Piping shall be:

SPEC WRITER NOTE: Retain one or more of four subparagraphs below that specify products suitable for Project applications.

1. Perforated PE pipe and fittings, couplings, and coupled joints.
2. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.
3. Perforated concrete pipe and fittings, gaskets, and gasketed joints.

C. Header Piping shall be:

SPEC WRITER NOTE: Retain one or more of four subparagraphs below that specify products suitable for Project applications.

1. ABS pipe and fittings, // gaskets, and gasketed // and solvent-cemented // joints.
2. Cast-iron soil pipe and fittings, // Extra-Heavy // Service // class; gaskets; and gasketed joints.
3. PE drainage tubing and fittings, couplings, and coupled joints.
4. PVC sewer pipe and fittings, couplings, and coupled joints.

3.3 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:

1. At Grade in Earth shall be // Cast-iron // PVC // cleanouts.
2. At Grade in Paved Areas shall be Cast-iron cleanouts.

B. In Underslab Subdrainage Piping:

1. In Equipment Yards and Unfinished Areas shall be Cast-iron cleanouts.

3.4 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 // and install drainage piping.
- 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. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
- H. Place layer of // flat-style geotextile filter fabric // roofing felt // over top of drainage course, overlapping edges at least 4 inches (100 mm).
- I. Install vertical drainage panels as follows:
 - 1. Coordinate placement with other drainage materials.
 - 2. Lay perforated drainage pipe at base of footing. Do not install aggregate.
 - 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.

SPEC WRITER NOTE: Retain subparagraph
below if pipe is used.

- 4. Wrap bottom of panel around drainage pipe.
- 5. Attach panel to wall at horizontal mark and at beginning of pipe. Place core side of panel against wall. Use concrete nails with washers through product cylinders to attach panel to wall. 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 double-sided tape may be used instead of nails. // Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
- 6. If additional panels are required on same row, cut away 4 inches (100 mm) of installed panel core, install new panel against installed panel, and overlap new panel with installed panel fabric.
- 7. If additional rows of panels are required, overlap lower panel with 4 inches (100 mm) of fabric.
- 8. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.

9. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
- J. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
- K. Place initial 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.

3.5 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 //. Install drainage piping.
- 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 with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
- G. Install horizontal drainage panels as follows:
1. Coordinate placement with other drainage materials.
 2. Lay perforated drainage pipe at inside edge of footings.
 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.

3.6 PLAZA DECK DRAINAGE INSTALLATION

Horizontal Drainage Panel shall be installed between slab and floor cover. Place core on structural floor. Install panels to fit tightly around floor drains of building's storm drainage system. Provide stormwater access into floor drain.

3.7 RETAINING-WALL DRAINAGE INSTALLATION

SPEC WRITER NOTE: Retain one of first two paragraphs below.

- 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 //. Install drainage piping.
- D. 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.
- E. 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.
- F. 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.
- G. Place layer of // flat-style geotextile filter fabric // roofing felt // over top of drainage course, overlapping edges at least 4 inches (100 mm).
- H. Install vertical drainage panels as follows:
 1. Coordinate placement with other drainage materials.
 2. Lay perforated drainage pipe at base of footing. Do not install aggregate.

SPEC WRITER NOTE: Retain subparagraph above or first subparagraph below.

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.

SPEC WRITER NOTE: Retain first
subparagraph below if pipe is used.

6. Wrap bottom of panel around drainage pipe.
7. 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.
8. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
9. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
10. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
11. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
12. Do not use drainage panels as protection for waterproof membrane unless approved by factory-authorized service representative of waterproofing membrane manufacturer. Submit approval if so used.
- I. 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.

3.8 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 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 // roofing 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.

3.9 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.

SPEC WRITER NOTES:

- 1. Of first five subparagraphs below, retain only those applicable to Project.
 - 2. Edit first subparagraph below as required for different minimum slope and cover.
1. Foundation 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) // Insert dimension //, unless otherwise indicated.
 2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
 3. Plaza Deck Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 1.0 percent.
 4. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, 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) // Insert dimension //, unless otherwise

indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.

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) // Insert dimension //, unless otherwise indicated.
6. Lay perforated pipe with perforations down.

SPEC WRITER NOTE: Revise subparagraph below to suit Project or delete.

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 // ABS piping // PE piping // PVC piping // according to ASTM D2321.

3.10 PIPE JOINT CONSTRUCTION

- A. Cast-Iron Soil Pipe and Fittings: Hub and spigot, with rubber compression gaskets according to ASTM A74. Use gaskets that match class of pipe and fittings.
- B. Join ABS pipe and fittings according to ASTM D2751.
- C. Join // PE pipe // or // perforated PE pipe, // tubing, and fittings with couplings for soil-tight joints according to ASTM D2321.
- D. Join PVC pipe and fittings according to ASTM D2729.
- E. Join perforated PVC pipe and fittings according to ASTM D2729.
- F. Join perforated concrete pipe and fittings with gaskets according to ASTM C443.
- G. 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.

3.11 CLEANOUT INSTALLATION

- A. 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) in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
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) in depth. Set top of cleanout plug 1 inch (25 mm) above grade.

B. 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.

3.12 CONNECTIONS

- A. Connect low elevations of subdrainage system to // building's // solid-wall-piping storm drainage system.

SPEC WRITER NOTE: Retain paragraph below if gravity discharge is not possible.

- B. Where required, connect low elevations of // foundation // underslab // subdrainage to stormwater sump pumps.

3.13 IDENTIFICATION

- A. Install PE warning tape or detectable warning tape over ferrous piping.
- B. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.14 FIELD QUALITY CONTROL

SPEC WRITER NOTE: Insert specific test requirements in paragraph below to comply with authorities having jurisdiction.

Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.15 CLEANING

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.

--- E N D ---