

SECTION 057300 - DECORATIVE METAL RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel and iron decorative railings.
- B. Related Requirements:

1.2 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's product lines of decorative metal railings assembled from standard components.
 - 2. Fasteners.
 - 3. Post-installed anchors.
 - 4. Handrail brackets.
 - 5. Shop primer.
 - 6. Intermediate coats and topcoats.
 - 7. Nonshrink, nonmetallic grout.
 - 8. Metal finishes.
- B. Shop Drawings: Include plans, elevations, sections, and attachment details.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
- D. Samples for Verification: For each type of exposed finish required.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

2.3 STEEL AND IRON DECORATIVE RAILINGS

- A. Source Limitations: Obtain steel decorative railing components from single source from single manufacturer.

- B. Tubing: ASTM A500/A500M (cold formed) or ASTM A513/A513M, Type 5.
- C. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- D. Plates, Shapes, and Bars: ASTM A36/A36M.
- E. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: High-zinc-dust-content paint compatible with coating system specified.
- B. Epoxy Zinc-Rich Primer: Compatible with topcoat.
- C. Shop Primer for Galvanized Steel: Water-based galvanized metal primer.
- D. Epoxy Intermediate Coat: Compatible with primer and topcoat.
- E. Polyurethane Topcoat: Compatible with undercoat.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.5 FABRICATION

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.
 - 1. Clearly mark units for reassembly and coordinated installation.
 - 2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water.
 - 1. Provide weep holes where water may accumulate.

2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove flux immediately.
 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
- I. Form changes in direction as follows:
1. As detailed.
 2. By bending or by inserting prefabricated elbow fittings.
 3. By bending to smallest radius that will not result in distortion of railing member.
- J. Bend members in jigs to produce uniform curvature for each configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- K. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
- L. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns, unless clearance between end of rail and wall is 1/4 inch or less.
- M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry Work.
1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
 2. Coordinate anchorage devices with supporting structure.
- N. For railing posts set in concrete, provide stainless steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.
- O. Toe Boards: Where indicated on Drawings, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.6 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
 - 1. Hot-dip galvanize exterior steel and iron railings, including hardware, after fabrication.
 - 2. Hot-dip galvanize indicated steel and iron railings, including hardware, after fabrication.
 - 3. Comply with ASTM A123/A123M for hot-dip galvanized railings.
 - 4. Comply with ASTM A153/A153M for hot-dip galvanized hardware.
 - 5. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 - 6. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
- C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner
 - 1. Comply with SSPC-SP 16.
- D. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.
- E. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3.
- F. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

- G. Powder-Coat Finish for Uncoated Ferrous Metal: Prepare, treat, and coat nongalvanized ferrous metal to comply with resin manufacturer's written instructions and as follows:
1. Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3.
 2. Treat prepared metal with iron-phosphate pretreatment, rinse, and seal surfaces.
 3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than 1.5 mils.
 4. Color: Match Owner's standard campus railings.
- H. Powder-Coat Finish for Galvanized Metal: Prepare, treat, and coat galvanized metal to comply with resin manufacturer's written instructions and as follows:
1. Prepare galvanized metal by thoroughly removing grease, dirt, oil, flux, and other foreign matter.
 2. Treat prepared metal with zinc-phosphate pretreatment, rinse, and seal surfaces.
 3. Apply thermosetting polyester or acrylic urethane powder coating with cured-film thickness of not less than 1.5 mils.
 4. Color: Color: Match Owner's standard campus railings.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
1. Fit exposed connections together to form tight, hairline joints.
 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
 4. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.2 RAILING CONNECTIONS

- A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

3.3 ANCHORING POSTS

- A. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Leave anchorage joint exposed with anchoring material flush with adjacent surface.
- C. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

3.4 REPAIR

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

3.5 CLEANING

- A. Clean by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
- B. Clean by wiping with a damp cloth and then wiping dry.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

3.6 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

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09 DECEMBER 2022

- B. Restore finishes damaged during installation and construction period, so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 057300

SECTION 311000 - SITE CLEARING

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, and Archaeology Division 1, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Stripping and stockpiling topsoil.
 - 3. Removing above- and below-grade site improvements.
 - 4. Temporary erosion- and sedimentation-control measures.
- B. Related Sections:
 - 1. Division 01 Section "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
 - 2. Division 01 Section "Execution" for field engineering and surveying.
 - 3. Division 01 Section(s) "Construction Waste Management and Disposal and "Sustainable Design Requirements" for additional LEED requirements.

1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.
- D. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- E. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction.
- F. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 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.

1.5 SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs or videotape.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site.

1.7 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. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify Miss Utility for area where Project is located before site clearing. Construction Manager to hire an onsite utility locator service in addition to Miss Utility for all utilities on project site prior to any earth disturbance activities.
- E. Do not commence site operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- F. 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.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.
- J. Note: Soil stripping is severely restricted over this entire site due to the presence of archeologically valuable materials and artifacts within the upper soil zones. Absolutely no stripping of soil is to be done without permission from and coordination with the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 31 Section "Earth Moving."
1. Obtain approved borrow soil material 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. Flag each tree trunk at 54 inches above the ground.
- 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 Division 01 Section "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 Architect.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place per the site demolition plan.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- C. 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 Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions and vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain.
 - 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, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Note: This section is retained only to provide information on stripping if absolutely necessary. Soil stripping is severely restricted over this entire site due to the presence of archeologically valuable materials and artifacts within the upper soil zones. Absolutely no stripping of soil is to be done without permission from and coordination with the Owner.
- B. Remove sod and grass before stripping topsoil.
- C. Strip topsoil to depth indicated on Drawings in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- D. 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.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within protection zones.
 - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
 - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
 - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

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.

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09 DECEMBER 2022

- B. Separate recyclable materials produced during site clearing from other nonrecyclable 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 312000 - EARTH MOVING

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. Preparing subgrades for slabs-on-grade walks pavements turf and grasses and plants.
2. Excavating and backfilling for structures.
3. Subbase course for pavements.
4. Subbase course and base course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling trenches for utilities and pits for buried utility structures.

- B. Related Sections:

1. Division 01 Section "Construction Progress Documentation" for recording pre-excavation and earth moving progress.
2. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities; also for temporary site fencing if not in another Section.
3. Division 31 Section "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
4. Division 32 Section "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
5. Division 32 Section "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength 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 Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
 - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, 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.

1.4 SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
 - 1. Geotextiles.
 - 2. Warning tapes.
- B. Samples for Verification: For the following products, in sizes indicated below:
 - 1. Geotextile: 12 by 12 inches.
 - 2. Warning Tape: 12 inches long; of each color.
- C. Qualification Data: For qualified testing agency.
- D. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
 - 1. Classification according to ASTM D 2487.
 - 2. Laboratory compaction curve according to ASTM D 1557.

- E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.5 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- B. Pre-excavation Conference: Conduct conference at Project site.

1.6 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving 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. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
 - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Utility Locator Service: Notify "Miss Utility" for area where Project is located before beginning earth moving operations. Construction Manager to hire an on-site utility locator service in addition to Miss Utility for all utilities on project site prior to any earth disturbance activities.
- D. Do not commence site operations until temporary erosion- and sedimentation-control measures, specified in Division 31 Section "Site Clearing," are in place.
- E. Do not commence earth moving operations until plant-protection measures specified in Division 01 Section "Temporary Tree and Plant Protection" are in place.
- F. 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.
- G. Do not direct vehicle or equipment exhaust towards protection zones.

- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- 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 in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- 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 sieve and not more than 12 percent passing a No. 200 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 sieve and not more than 8 percent passing a No. 200 sieve.
- F. 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 sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. 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 sieve and 0 to 5 percent passing a No. 8 sieve.
- I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- J. Sand: ASTM C 33; fine aggregate.
- K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Grab Tensile Strength: 157 lbf; ASTM D 4632.
 2. Sewn Seam Strength: 142 lbf; ASTM D 4632.
 3. Tear Strength: 56 lbf; ASTM D 4533.
 4. Puncture Strength: 56 lbf; ASTM D 4833.
 5. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 6. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Grab Tensile Strength: 247 lbf; ASTM D 4632.
 2. Sewn Seam Strength: 222 lbf; ASTM D 4632.
 3. Tear Strength: 90 lbf; ASTM D 4533.
 4. Puncture Strength: 90 lbf; ASTM D 4833.
 5. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
 6. Permittivity: 0.02 per second, minimum; ASTM D 4491.
 7. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils 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 deep; colored as follows:
1. Red: Electric.
 2. Yellow: Gas, oil, steam, and dangerous materials.
 3. Orange: Telephone and other communications.
 4. Blue: Water systems.
 5. Green: Sewer systems.

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 DEWATERING

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
 - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 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.
 - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
 - a. 24 inches outside of concrete forms other than at footings.
 - b. 12 inches outside of concrete forms at footings.
 - c. 6 inches outside of minimum required dimensions of concrete cast against grade.
 - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
 - e. 6 inches beneath bottom of concrete slabs-on-grade.
 - f. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

- 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 higher than top of pipe or conduit unless otherwise indicated.
 - 1. Clearance: As indicated.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
 - 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material 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 Division 01 Section "Temporary Tree and Plant Protection."

3.6 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.7 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, may be used when approved by Architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

3.8 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.

3.9 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 2. Surveying locations of underground utilities for Record Documents.
 3. Testing and inspecting underground utilities.
 4. Removing concrete formwork.
 5. Removing trash and debris.
 6. Removing temporary shoring and bracing, and sheeting.
 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.

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 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."
- D. Trenches under Roadways: Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 24" below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."
- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches 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.
- G. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches 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.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

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 in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches 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 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under turf or unpaved areas, scarify and recompact top 6 inches 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 85 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.
 1. Provide a smooth transition between adjacent existing grades and new grades.
 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1/2 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.15 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."
- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

3.16 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. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
 - 2. Place base course material over subbase course under hot-mix asphalt pavement.
 - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 4. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
 - 5. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 - 6. 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.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Construction Manager 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 Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.

3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
- E. 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.
 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- 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 321216 - ASPHALT PAVING

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 milling of existing hot-mix asphalt pavement.
 - 2. Hot-mix asphalt patching.
 - 3. Hot-mix asphalt paving.
 - 4. Hot-mix asphalt paving overlay.
 - 5. Asphalt surface treatments.
 - 6. Pavement-marking paint.
 - 7. Traffic-calming devices.
 - 8. Imprinted asphalt.
- B. Related Sections:
 - 1. Division 02 Section "Structure Demolition" for demolition, removal, and recycling of existing asphalt pavements, and for geotextiles that are not embedded within courses of asphalt paving.
 - 2. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.
 - 3. Division 32 Sections for other paving installed as part of crosswalks in asphalt pavement areas.
 - 4. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.
 - 5. Division 32 Section "Unit Paving" for bituminous setting bed for pavers.

1.3 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 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.

- B. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- C. Samples: For each paving fabric, 12 by 12 inches minimum.
- D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:
 - 1. Each paving fabric, 12 by 12 inches minimum.
 - 2. Each type and color of preformed traffic-calming device.
 - 3. Each pattern and color of imprinted asphalt and precut marking material.
- E. Qualification Data: For qualified manufacturer and Installer.
- F. Material Certificates: For each paving material, from manufacturer.
- G. Material Test Reports: For each paving material.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the Maryland SHA.
- B. Installer Qualifications: Imprinted-asphalt manufacturer's authorized installer who is trained and approved for installation of imprinted asphalt required for this Project.
- C. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- D. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the "Standard Specifications for Construction and Materials" of the Maryland SHA for asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 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. Prime Coat: Minimum surface temperature of 60 deg F.

2. Tack Coat: Minimum surface temperature of 60 deg F.
 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F 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 for oil-based materials, 55 deg F for water-based materials, and not exceeding 95 deg F.
- C. Imprinted Asphalt Paving: Proceed with coating imprinted pavement only when air temperature is at least 50 deg F and rising and will not drop below 50 deg F within 8 hours of coating application. Proceed only if no precipitation is expected within two hours after applying the final layer of coating.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 70-22.
- B. Asphalt Cement: ASTM D 3381 for viscosity-graded material.
- C. Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70.
- D. Prime Coat: Asphalt emulsion prime coat complying with Maryland SHA requirements.
- E. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- F. Water: Potable.

2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- C. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- D. Joint Sealant: AASHTO M 324, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.
- E. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
 - 1. Color: As indicated.
- F. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
 - 1. Dowels: Galvanized steel, 3/4-inch diameter, 10-inch minimum length.

2.4 IMPRINTED ASPHALT MATERIALS

- A. Templates: Imprinted-asphalt manufacturer's standard flexible templates for imprinting pattern into hot asphalt paving.
 - 1. Pattern: Custom pattern indicated on Drawings.
- B. Coating System: Imprinted-asphalt manufacturer's standard system formulated for exterior application on asphalt paving surfaces.
 - 1. Base Coating: Portland cement and epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
 - 2. Top Coating: Epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
 - 3. Colorant: UV-stable pigment blend, added to each coating layer.
 - 4. Color: White.
- C. Precut Marking Material: Imprinted-asphalt manufacturer's standard, reflectorized, thermoplastic, 90-mil minimum thickness, formulated for exterior application on asphalt paving surfaces, and matching the imprinted pattern of templates.

2.5 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction 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: Maryland SHA HMA Superpave 25.0 mm.
 - 3. Surface Course: Maryland SHA HMA Superpave 12.5 mm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. 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.
 - 1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.
- D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

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 1-1/2 inches.
 - 2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
 - 3. Control rate of milling to prevent tearing of existing asphalt course.
 - 4. Repair or replace curbs, manholes, and other construction damaged during cold milling.
 - 5. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
 - 6. Transport milled hot-mix asphalt to asphalt recycling facility.
 - 7. Keep milled pavement surface free of loose material and dust.

3.3 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. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
 - 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.

3.4 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. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at minimum temperature of 250 deg F.
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. 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 wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

- 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.

3.5 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.
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
 - 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."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 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.

- 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: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
 - 2. 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. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 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.
 - 2. Surface Course: Plus 1/4 inch, 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 straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch.
 - 2. Surface Course: 1/8 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.8 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. 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.
 - 1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal..

3.9 WHEEL STOPS

- A. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

3.10 IMPRINTING ASPHALT

- A. General: Imprint asphalt according to manufacturer's written instructions, using manufacturer's recommended equipment.
- B. Freshly Laid Asphalt: Immediately after asphalt has been laid and compacted but still plastic, begin the surface imprinting process.
 - 1. Monitor asphalt surface temperature in compliance with manufacturer's written recommendations to ensure required temperature to perform surface imprinting.
 - 2. Reheat asphalt if surface temperature drops below that required.
- C. Reheating Asphalt: Soften asphalt pavement surface by heating to a depth of at least 1/2 inch without burning asphalt.
 - 1. Heat to a temperature of 300 to 325 deg F immediately before applying templates.
 - 2. Regularly monitor the pavement temperature to prevent overheating.
 - 3. Direct flame heaters are not permitted.
 - 4. If pavement is overheated and begins to emit black smoke, remove damaged pavement by milling down 1 inch and replace removed pavement with new, compacted surface course prior to resuming imprinting work.
- D. Surface Imprinting: Apply and imprint templates to a minimum depth as required to embed precut marking material flush or barely beneath pavement surface.
- E. Coating Application: After imprinted surface has cooled, apply two layers of base coating followed by two layers of top coating. Do not allow traffic until coating has completely dried and cured.

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 - 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.12 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.
 - 1. Do not allow milled materials to accumulate on-site.

END OF SECTION

SECTION 321313 - CONCRETE PAVING

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. Driveways.
- 2. Roadways.
- 3. Parking lots.
- 4. Curbs and gutters.
- 5. Walks.

- B. Related Sections:

- 1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
- 2. Division 32 Section "Decorative Concrete Paving" for stamped concrete other than detectable warnings.
- 3. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.4 SUBMITTALS

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

- B. LEED Submittals:

- 1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.

2. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
- C. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
- D. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- E. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
 1. Exposed Aggregate: 10-lb Sample of each mix.
 2. Wheel Stops: 6 inches long showing cross section; with fasteners.
- F. 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.
- G. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.
- H. Material Certificates: For the following, from manufacturer:
 1. Cementitious materials.
 2. Steel reinforcement and reinforcement accessories.
 3. Fiber reinforcement.
 4. Admixtures.
 5. Curing compounds.
 6. Applied finish materials.
 7. Bonding agent or epoxy adhesive.
 8. Joint fillers.
- I. Material Test Reports: For each of the following:
 1. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- J. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

- B. 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.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- E. ACI Publications: Comply with ACI 301 unless otherwise indicated.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- 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 for oil-based materials 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
 - 1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. [**Do not use notched and bent forms.**]
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

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09 DECEMBER 2022

- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- D. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- E. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- F. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 deformed bars.
- G. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 deformed bars.
- H. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.
- I. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- J. Deformed-Steel Wire: ASTM A 496/A 496M.
- K. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain.
- L. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- M. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.
- N. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- O. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- P. 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, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- Q. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- R. Zinc Repair Material: ASTM A 780.

2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
1. Portland Cement: ASTM C 150, portland cement Type I/II.
- B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.
1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
1. Aggregate Sizes: 3/4 to 1 inch nominal.
- D. Water: Potable and complying with ASTM C 94/C 94M.
- E. Air-Entraining Admixture: ASTM C 260.
- F. 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.
1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- G. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
1. Manufacturers: Subject to compliance with requirements,:
 - a. ChemMasters.
 - b. Davis Colors.
 - c. Dayton Superior Corporation.
 - d. Elementis Pigments.
 - e. Hoover Color Corporation.
 - f. Lambert Corporation.
 - g. LANXESS Corporation.
 - h. QC Construction Products.
 - i. Scofield, L. M. Company.
 - j. Solomon Colors, Inc.

- k. Stampcrete International, Ltd.
 - l. SureCrete Design Products.
2. Color: As selected by Architect from manufacturer's full range.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.

2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. 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.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
 1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

2.6 DETECTABLE WARNING MATERIALS

- A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
 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:

- a. Advanced Surfaces Inc.
 - b. Matcrete Precision Stamped Concrete Tools.
 - c. Southern Color N.A., Inc.
 - d. Stampcrete International Ltd.
 - e. Superior Decorative by Dayton Superior.
- B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.
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. Advanced Surfaces Inc.; Liquid Release.
 - b. Matcrete Precision Stamped Concrete Tools; Liquid Release Agent.
 - c. Southern Color N.A., Inc.; SCC Clear Liquid Release.
 - d. Stampcrete International Ltd.; Stampcrete Liquid Release.
 - e. Superior Decorative by Dayton Superior; Pro Liquid Release.

2.7 PAVEMENT MARKINGS

- A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952.
1. Color: As indicated.
- B. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
1. Color: As indicated.
- C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
1. Color: As indicated.
- D. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
1. Color: As indicated.

2.8 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
1. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.

2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
 - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.
- B. Proportion mixtures to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28 Days): 3500 psi.
 - 2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
 - 3. Slump Limit: 4 inches, plus or minus 1 inch.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
 - 1. Air Content: 5-1/2 percent plus or minus 1.5 percent for 1-1/2-inch nominal maximum aggregate size.
 - 2. Air Content: 6 percent plus or minus 1.5 percent for 1-inch nominal maximum aggregate size.
 - 3. Air Content: 6 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
 - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
- G. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.10 CONCRETE MIXING

- A. 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.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. 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.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or 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 to reinforcement.
- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
- F. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.5 JOINTS

- A. 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.
1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. 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.
1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
 2. Provide tie bars at sides of paving strips where indicated.
 3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
 2. Extend joint fillers full width and depth of joint.
 3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
 4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
 5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- D. 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, as follows, to match jointing of existing adjacent concrete paving:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes.
 - a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. 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.
- G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. 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.
- J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

- L. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

- M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.

- B. 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. 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.

3.8 DETECTABLE WARNINGS

- A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Division 32 Section "Unit Paving".
 - 1. Tolerance for Opening Size: Plus 1/4 inch, no minus.

- B. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
 - 1. Before using stamp mats, verify that the vent holes are unobstructed.
 - 2. Apply liquid release agent to the concrete surface and the stamp mat.

3. Stamping: While initially finished concrete is plastic, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
4. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.
5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

3.9 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. 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 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.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.10 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 - 1. Elevation: 3/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface: Gap below 10-foot-long, unlevelled straightedge not to exceed 1/2 inch.
 - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
 - 5. Lateral Alignment and Spacing of Dowels: 1 inch.
 - 6. Vertical Alignment of Dowels: 1/4 inch.
 - 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
 - 8. Joint Spacing: 3 inches.
 - 9. Contraction Joint Depth: Plus 1/4 inch, no minus.
 - 10. Joint Width: Plus 1/8 inch, no minus.

3.11 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.
 - 1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.

3.12 WHEEL STOPS

- A. Securely attach wheel stops to paving with not less than two steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

3.14 REPAIRS AND PROTECTION

- A. 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 Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. 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.
- D. 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.

END OF SECTION

SECTION 321443 - POROUS UNIT PAVING

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. Concrete grid pavers with aggregate fill.
 - 2. Solid concrete pavers with openings between pavers filled with aggregate.
 - 3. Aggregate setting bed for pavers.
- B. Related Requirements:
 - 1. Division 31 Section "Earth Moving" for excavation and compacted subgrade.
 - 2. Division 32 Section "Concrete Paving" for cast-in-place concrete curbs that serve as edge restraints for porous paving.
 - 3. Division 32 Section "Unit Paving" for nonporous unit paving, edge restraints.
 - 4. Division 32 Section "Plants" for ground cover planted in porous paving.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For all materials other than aggregates.
- B. LEED Submittals:
 - 1. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
- C. Sieve Analyses: For aggregate materials, according to ASTM C 136.
- D. Samples:
 - 1. Full-size units of each type of unit paver indicated.
 - 2. Exposed edge restraints.
 - 3. Precast concrete curbs.
 - 4. Aggregate fill.

5. Aggregate setting bed materials.

1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

1.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

PART 2 - PRODUCTS

2.1 CONCRETE UNIT PAVERS

- A. Regional Materials: Pavers shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Source Limitations: Obtain each type of paver from single source that has resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Concrete Grid Pavers: Grid paving units complying with ASTM C 1319, made from normal-weight aggregates.
 1. Thickness: 3-1/2 inches.
 2. Face Size and Shape: As indicated.
 3. Color: Match Architect's sample.
- D. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67, and made from normal-weight aggregates.

1. Thickness: 3-1/2 inches.
2. Face Size and Shape: As indicated.
3. Color: Match Architect's sample.

2.2 CRUSHED STONE-URETHANE POROUS PAVING

- A. Source Limitations: Obtain all components from single source that has resources to provide materials and products of consistent quality in appearance and physical properties. All materials and compounds shall be 100% sourced and manufactured in the USA.
- B. Urethane-bound porous paving shall be supplied by a manufacturer and installed by a contractor with at least 5 years experience that can supply references for similar applications and installations.
- C. Basis of Design: Subject to all performance criteria, crushed stone urethane-bound porous paving shall be KBI Perma-Drive (with Armorcoat high-strength surface coat) by Atlantic Power and Infrastructure or an approved alternate installed per all product manufacturer's requirements.

2.3 ACCESSORIES

- A. Plastic Edge Restraints: Triangular PVC extrusions, 3-1/8 inches high by 9-1/2 inches wide, designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch-diameter by 12-inch-long steel spikes.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrickStop Corporation.
 - b. Cambridge Pavers, Inc.
 - c. Dimex Corporation.
 - d. Oly-Ola Edgings, Inc.
 - e. Pave Tech Inc.
- B. Steel Edge Restraints: Painted steel edging, 1/4 inch thick by 5 inches high, with loops pressed from or welded to face to receive stakes at 36 inches o.c., and with steel stakes 15 inches long for each loop.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Border Concepts, Inc.
 - b. Collier Metal Specialties, Inc.
 - c. Russell, J. D., Company (The).
 - d. Sure-loc Edging Corporation.
 2. Color: Match Architect's sample.
- C. Aluminum Edge Restraints: Straight, 3/16 inch thick by 4 inches high extruded-aluminum edging, with loops pressed from face to receive stakes at 12 inches o.c., and with aluminum stakes 12 inches long for each loop.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. BrickStop Corporation.
 - b. Curv-Rite, Inc.
 - c. Permaloc Corporation.
 - d. Sure-loc Edging Corporation.

- D. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi and water absorption not more than 5 percent, in shapes and sizes indicated.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Hanover Architectural Products, Inc.
 2. Regional Materials: Precast concrete curbs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
 3. Color and Texture: Match Architect's sample .

2.4 AGGREGATE SETTING-BED MATERIALS

- A. Regional Materials: Aggregate and soil shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 5.
- C. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57.
- D. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
- E. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:
 1. Survivability: Class 2; AASHTO M 288.
 2. Apparent Opening Size: No. 40 sieve, maximum; ASTM D 4751.
 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.5 FILL MATERIALS

- A. Graded Aggregate for Porous Paving Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8.
 1. Color: As indicated.

- B. Grass Seed: Comply with requirements in Division 32 Section "Turf and Grasses."

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for porous paving.

3.2 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Tolerances:
 - 1. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch unit-to-unit offset from flush.
 - 2. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches and 1/4 inch in 10 feet or a maximum of 1/2 inch.
- E. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after porous paver installation.
- F. Provide curbs as indicated. Install curbs before placing unit pavers.
 - 1. Install curbs on a bedding of compacted base-course material over compacted subgrade. Install curbs before placing base course for pavers. Set curbs at elevations indicated, accurately aligned, and place and compact base-course material behind curbs as indicated.

3.3 SETTING-BED INSTALLATION

- A. Compact subgrade uniformly to at least 95 percent of ASTM D698 laboratory density.

- B. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- C. Place drainage geotextile over prepared subgrade, overlapping ends and edges at least 12 inches.
- D. Place aggregate subbase and base, compact by rolling or tamping with plate vibrator, and screed to depth indicated.
- A. Place base course, compact by rolling or tamping with plate vibrator, and screed to depth indicated.

3.4 PAVER INSTALLATION

- A. Set unit pavers on base course, being careful not to disturb base. Place pavers hand tight against lugs or spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch with pieces cut to fit from full-size pavers.
 - 1. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
- B. Compact pavers into base course by static rolling to ensure a consistent top elevation.
 - 1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches of uncompacted pavers adjacent to temporary edges.
 - 2. Before ending each day's work, compact installed concrete pavers except for 36-inch width of uncompacted pavers adjacent to temporary edges (laying faces).
 - 3. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches of laying face.
 - 4. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- C. As work progresses, remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- D. Within 60 days of completion of the installation, the surface infiltration rate of the pavement shall be field verified to confirm the required infiltration rate of the pavement. If the system fails to perform as required, it shall be removed and replaced at no cost to the Owner.

END OF SECTION

SECTION 329100 - PLANTING SOILS

PART 1 – GENERAL

1.1 SUMMARY

- A. This section includes planting soil materials, mixes and installation procedures.
 - 1. Related sections:
 - a. Section 311000 – Site Clearing for stripping and stockpiling topsoil.
 - b. Section 329100 – Turf and Grasses
 - c. Section 329300 – Exterior Plants

1.2 REFERENCES

- A. The following references and standards are used herein and shall mean:
 - 1. ASTM: American Society of Testing Materials.
 - 2. USDA: United States Department of Agriculture.
 - 3. U.S. Department of Agriculture, natural resources conservation service, 2003. National soil survey handbook, title 430-vi. Available online: <http://soils.usda.gov/technical/handbook/>.

1.3 SUBMITTALS

- A. Planting soils for trees, shrubs and groundcovers will be installed by Landscape Contractor. Submit soil installer's qualifications for approval.
- B. Product data: submit manufacturer product data and literature describing all products required by this section to the architect for approval. Provide initial submittal twelve weeks before the installation of planting mixes.
- C. Material certificates: Submit material certificates for all natural and bulk material indicating that the material meets the requirements of the specification to the architect for approval. Provide initial submittal twelve weeks before the installation of planting mixes.
- D. Samples: Submit samples of each product and material where required by the specification to the Landscape Architect for approval. Label samples to indicate product, specification number, characteristics, and locations in the work. Delivered materials shall closely match the samples.
 - 1. Submit two one- gallon samples of all topsoil (salvaged and imported), coarse sand, organics and one-gallon samples of planting mixes if required, and other soil amendment products in this section. The number of samples shall be as required for each material as indicated below.
 - a. Samples should be labeled to include the location of the source of the material.

- b. Samples of all products and planting mix components shall be submitted twelve weeks before the installation of planting mixes.
 - c. Planting mixes shall be submitted within two weeks following approval of the mix component.
2. Submit soil test analysis reports from the following approved soil-testing laboratory, or approved equal.

Turf Diagnostics and Design - KS
 613 E. 1st Street
 Linwood, KS 66052
 or
 Turf & Soil Diagnostics - NY
 35 King Street
 Trumansburg, NY 14886

Or approved equal prior to submitting soil for testing.

Contractors that may wish to use an alternative soil testing laboratory shall submit their qualifications for approval by the architect prior to submitting soils for testing. Note testing labs shall have a minimum of 5 years experience with the test protocols of the United States Golf Association - green section.

- E. Product Analysis: Existing and Imported Topsoil Testing. Include recommendations from soil testing lab to produce a fertile horticultural soil.
1. Soil Testing Procedures: Provide the following 3 soil tests (A through C) from 2 selected locations on site for a total of 6 tests.
- a. Textural Analysis (SOIL TEST A): Provide a particle size analysis of the existing site soils including the following gradient of the soils particle sizes to determine the soils textural content: tests which do not provide a detail breakdown of the sieve particle sizes of the sands and gravels from (0.05 to +2mm) will not be accepted and will require retesting.

<u>USDA Designation</u>	<u>Size in mm.</u>
Gravel	+2mm
Very coarse sand	1-2 mm
Coarse sand	0.5 -1 mm
Medium sand	0.25-0.5 mm
Fine sand	0.1-0.25 mm
Very fine sand	0.05-0.1 mm
Silt	0.002-0.05 mm
Clay	minus 0.002 mm

- b. Nutritional Analysis (SOIL TEST B): Provide a chemical analysis of the topsoil including the following:
 - 1) pH and buffer pH.

- 2) Percent organic content by oven dried weight, Ashburn method.
 - 3) Nutrient levels by parts per million including nitrogen, phosphorus, potassium magnesium, manganese, iron, zinc, and calcium. Nutrient test shall include the testing laboratory recommendations for supplemental additions to the planting mix for the plant material specified.
 - 4) Soluble salt by electrical conductivity of a 1:2 soil water sample measured in milliohm per cm.
 - 5) Cation exchange capacity (CEC).
- c. Water permeability (SOIL TEST C): Provide water permeability testing of the existing and imported-soils. Provide an evaluation of the soils ability to properly drain after being de-compacted.
- 1) Water permeability with the sample compacted between 80% and 85% maximum proctor density utilizing proctor test (ASTM f-1815 F97).
 - 2) Soil Bulk density with sample compacted between 80% and 85% maximum proctor density utilizing proctor test (ASTM-F1815 F97).
 - 3) Water permeability and bulk density testing shall be performed by:

Turf & Soil Diagnostics - NY
35 King Street
Trumansburg, NY 14886

F. Product Analysis: Soil Amendments.

1. Organic Matter: Soil Amendments (SOIL TEST D): organic composition: submit the manufacturer's particle size analysis, pH, soluble salts, organic matter content, carbon/nitrogen ratio, source of compost stock, certificate of length of composting period, and certificate that the compost meets the requirements of the us composting council for all organic matter the Landscape Architect for review and approval.
2. Sand Amendments (SOIL TEST E): Submit the manufacturer's particle size analysis for all coarse sands, for the sands overall textural analysis. Submit for Landscape Architects review. Provide the manufacturer's fines modulus index for each coarse sand source.
3. All testing will be at the expense of the contractor. The architect may request additional planting mix tests on different mix component ratios in order to attain results that more closely meet the mix requirements.

1.4 EXISTING SOIL QUALITY & COMPACTION EVALUATION

- A. Prior to the installation of planting mixes, select a planting bed to mock-up using the means and methods and equipment proposed by the contractor to complete the soils installation work.
- B. The contractor shall monitor his placement operations so that the soils will not be compacted above 85% standard proctor.

1.5 SEQUENCING AND SCHEDULING

- A. General: prior to the start of work, prepare a detailed schedule of the work for coordination with other trades. Schedule shall include sampling and laboratory turnaround time, including time for re-submittals if required to satisfy requirements of the specifications
- B. Schedule the installation of planting mixes after the area is no longer required for use by other trades and work.
- C. Schedule all utility installations prior to beginning work in this section.

1.6 QUALITY ASSURANCE

- A. The soil installer shall be a firm having at least 5 years of successful experience of a scope similar to that required for the work, including the preparation, mixing and installation of custom planting mixes in urban locations and over building structures.
- B. Comply with applicable local requirements of the laws, codes, ordinances, and regulations of federal, state, and municipal authorities having jurisdiction. Obtain necessary approvals from all such authorities.
- C. Comply with all requirements for control of silt and sediment during soil installation work as indicated in the contract documents.
- D. Soil tests and soil amendments are to be completed by a qualified landscape Installer meeting the following criteria
 - 1. Professional Membership: Landscape installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Weather: Do not mix, deliver, or place soils in frozen, wet, or muddy conditions.
- B. Protect soil and planting mix stockpiles from rain and washing that can separate fines and coarse material. Cover stockpiles with filter cloth at the end of each workday.
- C. Protect planting mix stockpiles from contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage

1.8 SITE CONDITIONS

- A. It is the responsibility of the contractor to be aware of all surface and sub-surface conditions, and to report any circumstances that will negatively impact soil drainage. Do not proceed with work until unsatisfactory conditions have been corrected.

1.9 PROTECTION OF EXISTING UTILITIES

- A. Prior to any work being performed the contractor shall insure that all existing utilities within and surrounding the project site have been clearly marked in accordance with the Miss Utility.
- B. Carefully examine the civil, record, and survey drawings to become familiar with the existing underground conditions before digging.

PART 2 – PRODUCTS

2.1 EXISTING AND IMPORTED TOPSOIL

- A. Provide imported topsoil if there is inadequate quantities of existing topsoil.
- B. Topsoil shall contain not less than 2.0% or more than 5% percent by weight of organic matter. The soils shall be obtained from a site where the soil quality has proven ability to grow crops or harvested from a development site.
- C. The pH value shall be between 6.0 and 7.5.
- D. Topsoil shall not contain materials and contaminants at levels that would be harmful to plant growth; or impair drainage, installation or maintenance of the resulting planting soil; or adversely impact its intended use including the following:
 - 1. Refuse; construction debris; roots; wood; sticks; brush; clumps of root mats of plants larger than 4 inch in any dimension. The aggregate of all the above materials shall not exceed 5% of the total soil volume as assessed by visual inspection.
 - 2. Deleterious substances or toxic materials at levels that is harmful to humans or plants as determined by EPA regulations.
 - 3. Plant or soil pests; undesirable grasses, noxious weeds or weed seeds. The contractor shall be responsible for removal of all weeds and controlling any soil born plant pest or diseases.
- E. Soil texture: recommended soil texture is loam, clay loam, or sandy clay loam with a minimum sand content not less than 50% and combined clay and silt content not greater than 45%. Soils can surpass these levels but the final topsoil may require the addition of coarse sand to bring the final soil texture to within these acceptable ranges.
- F. Soil shall not be screened or shredded. The amount of rock, roots and debris in the soil shall be controlled by source selection not screening.

2.2 COARSE SAND

- A. Coarse concrete sand, ASTM C-33 fine aggregate, with a fines modulus index of 2.8 and 3.2.
 - 1. Coarse sands shall be clean, sharp, natural sands free of limestone, shale and slate particles. Coarse sand pH shall be lower than 7.0.
 - 2. Provide the following particle size distribution:

Sieve	percent passing
3/8 inch (9.5mm)	100
No 4 (4.75mm)	95-100
No 8 (2.36mm)	80-100
No 16(1.18mm)	50-85
No30 (.60mm)	25-60
No50 (.30mm)	10-30
No100 (.15mm)	2-10

- B. Provide two 1-gallon samples with manufacturer’s literature and material certification that the product meets the requirements.
- C. Provide soil submittal tests E for the sand component of the mix.

2.3 PINE FINES

- A. Horticultural grade milled loblolly pine bark, size 0.1 mm - 15.0 mm. Pine bark shall be aged at least nine months and shall be screened. pH shall range between 4 and 5.
- B. Pine bark fines shall contain less than 10% wood fiber and sawdust.
- C. Provide two one-gallon sample with manufacturer’s literature and material certification that the product meets the requirements.
- D. Provide soil submittal tests for the organic pine fines component:
 - 1. Organic composition: submit the manufacturer’s particle size analysis, pH, soluble salts, organic matter content, carbon/nitrogen ratio, source of compost stock, certificate of length of composting period,
 - 2. Provide certificate that the organics meets the requirements of the us composting council for all pine bark and organic matter the landscape architect for review and approval.

2.4 INORGANIC SOIL AMENDMENTS

- A. Provide the following soil amendments should the results of the soil tests require:
- B. Lime: ASTM C 602, agricultural limestone containing a minimum 80% calcium carbonate equivalent and as follows:
 - 1. Class: class t, with a minimum 99 percent passing through no. 8 (2.36-mm) sieve and a minimum of 75% passing through no. 60 (0.25-mm) sieve.
 - 2. Class: class o, with a minimum 95 percent passing through no. 8 (2.36-mm) sieve and a minimum of 55% passing through no. 60 (0.25-mm) sieve.
 - 3. Provide lime in the form of dolomitic limestone.
- C. Sulfur: granular, biodegradable, containing a minimum of 90% sulfur with a minimum 99% passing through no. 6 (3.35-mm) sieve and a minimum of 10% passing through no. 40 (0.425-mm) sieve.

- D. Iron sulfate: granulated ferrous sulfate containing a minimum of 20% iron and 10% sulfur.
- E. Aluminum sulfate: commercial grade, unadulterated.

2.5 AMENDED LAWN & PLANTING SOIL

- A. Mix of existing soil, approved soil amendment and organics in the mixing ratios described in Section 3.7
- B. Additional amendments incorporated per recommendations of soil testing lab.

2.6 IMPORTED SOILS MIX

- A. If existing soils cannot be modified in place then a mixture of imported topsoil, coarse sand and pine bark mixed in the following proportions

<u>Material</u>	<u>% by volume</u>
Imported Topsoil	40-50%
Pine Fine (Organics)	10%
Coarse Sand	40-50%

- B. Adjust the ratio of the components to achieve an average water permeability between 3 inch to 5 inches per hour when compacted to 85% of maximum dry density.

2.7 ORGANIC MATTER

- A. Organic blended material composted sufficiently to break down all woody fibers, weed seeds, and leaf structures, free of toxic and non-organic matter. Source material shall be limited to the following:
 - 1. Aerobically composted leaves, and or yard debris. Note compost made from primarily green yard waste will not be acceptable.
 - 2. Hardwood Bark fines and organic material designed to produce compost high in fungal material.
 - 3. Bio-solids based compost, shall not be used.
 - 4. Organic matter shall be commercially prepared compost and meet US Compost Council, Seal of Testing Assurance (STA/TMECC) criteria for stable, mature product.
 - 5. Submit two one-gallon samples and supplier's literature certifying (STA) compliance for approval.
- B. Compost shall be a homogeneous material free of soil clods, lumps, roots, stones, and foreign material. The compost shall be screened such that a minimum of 90% passes us standard 0.25" sieve and no more than 20% passes a US std. No. 10 sieve.
- C. Provide a one-gallon samples with manufacturer's literature and material certification that the product meets the requirements. Must be supplied by a professional compost commercial operation.

- D. pH of 6.0 to 7.8
- E. Soluble salts: EC levels less than 4.0 milliohms per cm when determined on saturation extract.
- F. Organic matter content: 50% or greater, as determined by weight by ASTM D2974-87 Method
- G. Carbon/Nitrogen Ratio: Less than 1:20
- H. All compost testing shall be done in conformance with the US. Compost Council's publication test methods for the examination of composting and compost unless specified otherwise.

2.8 CHEMICAL ADDITIVES & HERBICIDES

- A. Chemical materials designed to increase soil fertility. All material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the season in which the products are to be used.
 - 1. Fertilizer for planting shall be organic fertilizer, derived from organic sources. Fertilizer selections shall be based on the recommendations of the soil tests. Submit manufacturers' product literature for approval.
 - 2. Selective herbicides: EPA registered and approved, of type recommended by manufacturer for application.

PART 3 – EXECUTION

3.1 SITE EXAMINATION

- A. Examine the grades and soil conditions for any circumstances that might be detrimental to soil drainage, including but not limited to: uneven subgrades and soil liners or waterproofing, that may hold or pond water; deposits of construction-related sediment, waste or soil contamination; storage of material or equipment; soil compaction or poor drainage.
- B. Confirm that all utility work (and installation of planter irrigation mainlines, if applicable) has been completed and tested.
- C. Examine the grading verifying all elevations. Soils shall be considered severely disturbed, if the grade was lowered more than 14 inches, or the soil was compacted in lifts regardless of the final grade.
- D. Confirm that all other work within the area of soil profile remediation is completed. Confirm that subgrade conditions present positive flow to outfall or building edge conditions such that all planting areas will have positive subsurface drainage.
- E. Notify the landscape architect in writing of any unsatisfactory conditions.

3.2 COORDINATION WITH PROJECT WORK

- A. The contractor shall coordinate with all other work that may impact the completion of the work of this section. Do not place soil mixes or soil profile remediation, in any locations if they will be adversely compacted or disturbed from other trades work. Coordinate with the General Contractor to protect remediated soils or planting mixes from compaction by other trades.
- B. Assure that all sediment control required by the project manual and as shown on the drawings is in place during the installation of planting mixes. Provide additional sediment control to retain planting mixes within the project limits as needed.

3.3 GRADE AND ELEVATION CONTROL

- A. Provide grade and elevation control during soil profile remediation or soil improvement. Utilize grade stakes, surveying equipment and other means and methods to assure that grades and contours conform to the grades indicated on the drawings.
- B. Maintain grade stakes until architect has viewed and approved the grades.

3.4 PREPARATION OF SUBGRADE

- A. Contact all required utility companies and county agencies such as miss utility for location and approval for all excavations.
- B. In conjunction with the preparation of the subgrade contractor should install the under drainage as indicated on the drawings.
- C. Excavate all planting areas with extreme care to minimize disturbance and damage to subsurface utilities.
- D. Prior to commencing any soil placement and finish grading operations contractor shall notify the Landscape Architect allowing enough time for a thorough inspection of the subgrade. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the architect.
- E. Do not proceed with the soil profile remediation or installation of planting mix, until all utility work in the area has been installed. Do not begin planting mix installation until all subsurface drainage, (irrigation main lines, and lateral lines, if applicable) shown on the drawings are installed and approved by architect.
- F. Prior to grading, apply round-up or other approved herbicide as per the manufacturer's directions if required to eliminate any existing weeds. Allow sufficient time for the herbicide to take effect.
- G. The subgrade shall first be loosened and roughened by rototilling or scarifying with the teeth of a backhoe at least 6-8 inches deep.
- H. Remove all stones and debris over 1-1/2 inches. Remove any subsoil contaminated to a degree that will negatively impact plant growth. Contamination shall include concrete wash out, fuels,

and oils, cleaning fluids organic debris, or any items deemed not contusive to good and normal tree and plant growth. Haul off-site and satisfactorily dispose of all unsuitable material.

- I. Remove all stones over 1-1/2 inches, as well as asphalt, concrete, aggregates, contaminated soils, brickbats, grade stakes, rubbish, and general or organic debris, or any items deemed not contusive to good and normal tree and plant growth. Haul off-site and satisfactorily dispose of all unsuitable material.
- J. Protect adjacent walls, walks, and utilities from damage or staining by the soil or placement operations.
 - 1. Use 1/2-inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items, and as directed by the Landscape Architect during the progress of the work.
 - 2. Clean up any soil or dirt spilled on any paved surface, including at the end of each working day.
 - 3. The contractor shall repair damages to the paving or architectural finishes to the satisfaction of the architect.
- K. Protect the prepared subgrade areas from traffic until the planting mix is installed. Do not allow the subgrade to become compacted. In the event that the roughened prepared areas become compacted, loosen the area again prior to installing soils or planting mixes.

3.5 GENERAL SOILS INSTALLATION PROCEDURES

- A. It is imperative that the contractor only works with soil during optimal moisture levels. Working the soil when wet will adversely affect the soils structure and ultimate ability to drain. Soil moisture level must be below 20%. Contractor shall verify and monitor this level prior and during soil placement activities.
- B. Schedule soil placement operations during extended periods of dry weather. No soil shall be handled in a wet or frozen condition. Contractor shall use the following general field verification techniques for proper soil moisture content working:
 - 1. The soil is too wet if it clumps or has surfaces with a polished appearance when tillage equipment is used.
 - 2. The soil is too dry, if large (peds) clods of soil cannot be broken by the force of a hand.

3.6 SUBSOILS: REMEDIATION (DECOMPACTION) PROCEDURES

- A. Follow the requirements of the proceeding Section General Soils Installation Procedures.
- B. Adjust the grade of the existing soil by reducing the elevation to insure the grade will allow the placement of organics and the de-compaction sub-soiling, as well as some settlement.
- C. For amended planting beds for trees, shrubs and groundcovers (exclusive bioretention areas):

1. Begin the soil remediation procedure by placing a 4-inch minimum layer of approved Organic Matter (Compost) over the entire area or bed to be de-compacted and amended through the sub-soiling technique.
 2. Loosen the subsoil with organics in place to a minimum depth of 24 inches for amended planting soil, with a backhoe or similar piece of equipment to break-up the soil. Drop the soil from the backhoe a minimum of 4 - 6 feet distance from the bucket to break up the clods into soil chunks of about 6 - 10 inches in size. Use the tines of the fork to break up any of the larger chunks into these dimensioned peds. 50% of the soil peds should be 6 inches or less in size.
 3. The organic matter will be mixing with the broken-up soil peds as well as distributing down into the bottom of the excavation. The organic matter will provide channels (veins) for the roots of plant material to penetrate, as well as de-compact the soil. Compost veins must reach down the full 24 inches to be effective.
 4. Once completed, place an additional 4 inch approved topsoil. Rake smooth to slope and grade.
- D. For amended lawn soil:
1. Scarify and till soil to the top 6-8 inches of subsoil.
 2. Place a 4 inch uniform layer of approved existing or imported topsoil over the entire turf areas.
 3. Till 3-4 inches of approved organics
- E. Use the backhoe to smooth out the rough surface. Work the soil, as you go making sure the entire area is uniformly excavated and mixed.
- F. Depending on the soils textural make-up, the final bulk density of the soil shall be as recommend by the water permeability test (SOIL TEST C).
- G. Contractor shall immediately protect all planting beds or turf areas with posts, string line, and flagging. Do not allow the soil to become re-compacted. If this condition occurs, it may require these remediation procedures to be reinstated.

3.7 IMPORTED SOIL PLACEMENT PROCEDURES

- A. Follow the requirements of the proceeding Section 3.7.
- B. Remove and transport soils with minimal handling and working to help maintain its textural integrity. Do not sift or screen. Maintain soil peds in the 1-2 inch (3-6cm) or larger.
- C. Begin installing soil by backfilling the beds and planting areas with the first lift by blending with existing loosened subgrade to a depth of 2 to 3 inches (5-8cm).

- D. All equipment utilized to install planting mix shall be a wide track machine rated with a ground pressure of 4-psi or less. All grading and soil delivery equipment shall have buckets equipped with teeth to scarify any soil that becomes compacted
- E. Soil shall be spread with approved equipment that minimizes compaction to depths indicated. Place soil so that it will allow a 2-3 inch level of settlement. Slope all soils away from the base of the building.
- F. Contractor shall monitor soil pH to insure that pH levels to not exceed 7.0-7.1 range. Contractor shall add the appropriate amount of aluminum sulfate or sulfur to reduce pH to within acceptable levels.
- G. Once the soils have been placed, the contractor shall immediately protect all planting bed areas with posts, string line, and flagging. Do not allow the soil to become compacted by pedestrian traffic, or other construction activities.
- H. Allow the beds to settle a minimum of one week. Fill in all low areas, and smooth any surface irregularities and corrected and prevent the formation of low spots and pockets that would retain water.
 - 1. Note: the settlement time will be based on rainfall for that period. If no rain, and no settlement. A longer period than one week may not be enough unless contractor irrigates the area to promote settlement.
- I. Install plant materials as per section 32 9300.
- J. Contractor shall plant as soon as possible to get roots established within the placed soil. Waiting too long may reduce the soil inoculation effectiveness and establishment organisms into the compost getting live roots into the planting soil will help maintain the soil biology and encourage soil drainage.

3.8 MAXIMUM AMENDED SOIL COMPACTION

- A. Compact the planting mix to the compaction rates indicated and using the methods approved for the soil mock up.
 - 1. Achieve a soil density of between 80 and 85% of maximum dry density standard proctor.
 - 2. Maintain moisture conditions within the planting mixes during installation to allow for satisfactory compaction. Suspend installation operations if the planting mix becomes wet.
 - 3. Apply water if the soil is overly dry.
 - 4. Provide adequate equipment to achieve consistent and uniform compaction of the planting mixes. Use the smallest equipment that can reasonably perform the task of spreading and compaction.

- B. Planting mix compaction shall be tested at each lift using a cone penetrometer calibrated to the mock up soil and its moisture level. The same penetrometer and moisture meter used for the testing of the mock up shall be used to test installed soil throughout the work. The final soil profile shall have penetrometer readings similar to the profile in the soil mock up when the soils are at similar moisture levels
 - 1. Check the soil resistance with the penetrometer every 1000 square feet and wherever requested by the architect.

3.9 COMPACTION REDUCTION

- A. Any soil that becomes compacted to a density greater than the specified density or the density in the approved mockup shall be dug up and reinstalled.
- B. Within the trees, shrubs and groundcovers beds surface roto-tilling shall not be considered adequate to reduce over compaction at levels 6" or greater below finished grade. This requirement includes compaction caused by other subcontractors after the planting mix is installed and approved

3.10 FINE GRADING

- A. For any soil grade indicated the finish surface of all planted areas shall meet the grades as indicated on the drawings, after the twelve-month settling period. Allow the finished grades to remain higher than the grades on the grading plan, as defined in paragraph planting mix installation, to anticipate settlement over the first year.
- B. Utilize equipment with rakes or buckets with teeth for fine grading to keep surface rough. Do not use the bottom of a loader bucket such that the finished grade is smooth and slightly compressed.
- C. Adjust the finish grades to meet field conditions as directed.
- D. Provide for positive drainage from all areas toward inlets, drainage structures, and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall, and inlet elevations.
- E. Fill all dips and remove any bumps in the overall plane of the slope.
 - 1. The tolerance for dips and bumps in shrub and ground cover planting areas shall be a 1" deviation from the plane in 10'.

3.11 APPLICATION OF ORGANICS AND CHEMICAL ADDITIVES

- A. Do not use fertilizers unless recommended by soils tests and at rates appropriate to the planting mix and specific plants to be installed.
- B. Types, rates, and application methods, shall be approved by the Landscape Architect prior to any applications.

3.12 PROTECTION

- A. Protect planting mix from compaction and contamination by dust, debris, and any toxic material harmful to plants or humans after placement. Any area, which becomes compacted, shall be de-compacted as per the procedures described in Section 3.8. Any uneven or settled areas shall be filled and re graded.
- B. Phase the installation of the planting mix such that equipment does not have to travel over already installed planting mix.

3.13 CLEAN-UP

- A. During installation, keep pavements clean and work area in an orderly condition.
- B. Keep the site free of trash and debris at all times. Immediately dispose of wrappings or waste materials associated with products necessary for the completion of the work.
- C. All trash shall be kept in a central collection container. Do not bury trash or debris in back-fill.
- D. Once installation is complete, remove any excess soil from pavements, walls, or other surfaces.

3.14 REPAIR OF SETTLED PLANTING MIX

- A. At the end twelve months after the date of substantial completion of the planting mix installation work, inspect the site and restore any areas where the grades have settled beyond the elevations shown on the drawings by an amount greater than 5% of the soil depth.
 - 1. In shrub planting areas where the settlement is 3" or less, remove the mulch, top dress the area with the specified planting mix and re-mulch.
 - 2. In all ground cover areas and shrub planting areas where the settlement is greater than 3" remove the mulch and plants, add the specified planting mix, re-plant and re-mulch.

3.15 PROTECTION DURING CONSTRUCTION

- 1. The contractor shall protect soil work and materials from damage due to landscape operations, operations by other contractors or trespassers. Install 1/2-inch plywood mats over the soil wherever vehicles, equipment, or foot traffic must enter the area maintain protection during installation until acceptance. Treat, repair, or replace damaged planting mix installation work immediately.
- 2. Till compacted planting mix and replace planting mix that has become contaminated as determined by the landscape architect. Planting mix shall be tilled or replaced by the contractor at no expense to the owner.

END OF SECTION 329100

SECTION 329200 – TURF AND GRASSES

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.
- B. Contractors shall note that the entire project site is on archeology preservation zone and any excavation or disturbance of existing undisturbed grade must be executed exactly per specifications or instructions of Architect or Owner.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sodding for Mown Turf
 - 2. Erosion-control material(s)
- B. Related Sections:
 - 1. Retain Sections in subparagraphs below that contain requirements Contractor might expect to find in this Section but are specified in other Sections.
 - 2. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
 - 3. Section 312000 "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 4. Section 329300 "Exterior Plants"
 - 5. Section 321443 "Porous Paving"
 - 6. Section 329100 "Planting Soils"

1.3 DEFINITIONS

- A. Initial Acceptance: Is defined as the event when the work is substantially completed and approved in writing by the Landscape Architect, and establishes the date for the Warranty and Maintenance periods to commence.
- B. Partial Acceptance: Is defined as the event when work is substantially completed on a portion of the Project and the Contractor will be delayed one planting season from completing the remainder of the work. The Landscape Architect may grant a partial acceptance for the approved portion of the work that qualifies, and will establish the date for the warranty and maintenance period to commence only on the completed portion. Granting of partial acceptance shall also extend the Warranty period correspondingly.
- C. Maintenance Turnover: Is the date of maintenance transition for all plant material installed as part of this contract, turned over to the Owner with their knowledge and agreement. From that date the Owner will assume responsibility for the maintenance of all plant material.
- D. Final Acceptance: Is defined as the event when the Warranty and Maintenance periods are over, and the Contractor has complied with all provisions of the contract documents, and the Landscape Architect grants the Contractor release from further contractual obligations as they pertain to the provisions specified only in this Section.
- E. Retain definition(s) remaining after this Section has been edited.
- F. Finish Grade: Elevation of finished surface of planting soil.

- G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Insert other definitions if required to support planting requirements shown on Drawings.

1.4 ACTION SUBMITTALS

- A. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
1. Certification of each seed mixture for turfgrass sod. Include identification of source and name and telephone number of supplier.
- B. Product Data: For each type of product indicated.
1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified landscape Installer.
- B. Product Certificates: For soil amendments and fertilizers, See Section 329100.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
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' experience in turf 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.
 4. Certification program in first subparagraph below is administered by the Professional Landcare Network. See Evaluations.
 5. Personnel Certifications: Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation, maintenance and irrigation specialty area(s), designated CLT-Exterior.
 - b. Certified Turfgrass Professional, designated CTP.
 - c. Certified Turfgrass Professional of Warm Season Lawns, designated CTP-CSL.
 6. Maintenance Proximity: Not more than two hours normal travel time from Installer's place of business to Project site.
 7. Pesticide Applicator: State licensed, commercial.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.8 PROJECT CONDITIONS

- A. Planting Restrictions: Sodding or Seeding of Warm Season Grasses (WSG) is best done from March 15 to June 1.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.
 - 1. No seeding shall be done on frozen ground, when the temperature is 32 degrees F (or lower) or 90 degrees F or higher unless authorized in writing by the Landscape Architect.
 - 2. Native Warm Season Grasses (WSG) should be planted when soils reach 60 degrees F, and are rising. The later planting date allows for early season weed control with herbicides or repeated tillage and a clean seedbed prior to planting. Measure the soil temperature in spring with a thermometer; when the temperature at a depth of 2 inches is 55-60 degrees F, WSGs will germinate.

1.9 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:
 - 1. Sodded Turf: 30 days from date of planting completion.

PART 2 -PRODUCTS

2.1 TURFGRASS SOD

- A. Turfgrass Sod: Certified, complying with "Specifications for Turfgrass Sod Materials" in TPI's "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.
 - 1. Turfgrass Species: three-way blend (34%, 33%, and 33%) of Turf-type Tall Fescue 'Proven' cultivars listed in the "Recommended Turfgrass Cultivars for Certified Sod Production and Seed Mixtures in Maryland" (Turfgrass Technical Update TT-77), latest edition, published by the University of Maryland, Department of Natural Resource Science and Landscape Architecture.

2.2 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5. (Only use if Hydroseeding)
- C. Fiber mulch in paragraph above and nonasphaltic tackifier in first paragraph below are primarily used to protect hydroseeded areas from wind and water erosion during establishment.
- D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors. (Only use if Hydroseeding)

2.3 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 and aid establishment of native warm season grass.
 - 1. Round Up
 - 2. Plateau

2.4 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a p mesh. Include manufacturer's recommended staples or biodegradable stakes, 6 inches long.
 - 1. Products: Subject to compliance with requirements, provide the following or approved equal
 - a. North American Green – BioNet SC150BN Double Net Straw-Coconut Blanket.

PART 3 -EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations. Restore damage resulting from lack of protection, or improper installation of protection, as approved by the Landscape Architect.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Contractor may move temporary tree protection, silt fencing, and other erosion control measures where required to complete the installation of this work. Reinstall all fencing after installation in Tree Protection area is complete.

3.3 TURF AREA PREPARATION

- A. Prior to seeding, apply approved herbicide as per the manufacturer's directions to eliminate any existing weeds and other broadleaf turf grasses. Allow sufficient time for the herbicide to take effect.
- B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. Retain first two paragraphs below for erosion-control matting.
- C. Retain first paragraph below for erosion-control blanket or mesh.
- D. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.5 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application. Consult FGM manufacturer for most effective seeding application for various conditions, and confirm with Landscape Architect. Broadcast seeding followed by hydraulic application of FGM may be recommended/required.

3.6 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade,

eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

1. Lay sod across angle of slopes exceeding 1:3.
 2. Retain subparagraph below if required. Steel staple anchors are commonly used.
 3. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.7 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 2. Retain first subparagraph below if mulching is required.
 3. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 4. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Use permanent irrigation system with Owner approval to keep turf uniformly moist to a depth of 4 inches.
1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Revise rate of watering in subparagraph below to suit Project.
 3. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height 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. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow to a height of 1 to 2 inches
- D. Turf Postfertilization: Apply fertilizer only as recommended by sod provider.

3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
 2. 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.

- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.9 WARRANTY PERIOD

- A. Grass Areas: Contractor shall warrant that all seed planted under this Contract will be healthy and in flourishing condition of active growth for a Warranty Period of 12 months from date of Initial Acceptance. For fall plantings, Warranty Period shall be extended to include at least 4 months of active growing season.

3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove nondegradable erosion-control measures after grass establishment period.

END OF SECTION

SECTION 329300 -EXTERIOR PLANTINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of work: Work of this section includes, but is not limited to the following:
 - 1. Layout, bed establishment, excavation for planting trees, shrubs, groundcovers, and herbaceous plants in at grade installations.
 - 2. Layout and planting of trees, shrubs, groundcovers, and herbaceous plants in over structure installations.
 - 3. Plant Warranty and Maintenance.
- B. Contractors shall note that the entire project site is on archeology preservation zone and any excavation or disturbance of existing undisturbed grade must be executed exactly per specifications or instructions of Architect or Owner.

1.2 RELATED WORK

- A. Section 329200 - Turf and Grasses
- B. Section 329100 - Planting Soils
- C. Section 321443 - Porous Unit Paving

1.3 REFERENCES

- A. Standards: Comply with applicable recommendations of the following:
 - 1. "Standardized Plant Names", American Joint Committee on Horticultural Nomenclature.
 - 2. "American Standard for Nursery Stock", American Association of Nurserymen (ANSI Z60.1), latest edition.

1.4 DEFINITIONS

- A. Initial Acceptance: Is defined as the event when the work is substantially completed and approved in writing by the Landscape Architect, and establishes the date for the Warranty to commence.
- B. Partial Acceptance: Is defined as the event when the work on a portion of the work is substantially completed and the Contractor will be delayed one planting season from completing the remainder of the work. The Landscape Architect may grant a Partial Acceptance for the approved portion of the work that qualifies, and will establish the date for the Warranty to commence only on the completed portion. Granting of Partial Acceptance shall also extend the Warranty period correspondingly.

- C. Maintenance Turnover: Is defined as the date of maintenance transition for all plant material installed as part of this contract, over to The Client with their knowledge and agreement. From that date The Client will assume responsibility for the maintenance of all plant material.
- D. Final Acceptance: Is defined as the event when the Warranty Period is over, and the Contractor has complied with all provisions of the contract documents, and the Landscape Architect grants the Contractor release from further contractual obligations as they pertain to the provisions specified only in this Section.
- E. 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.

1.5 SUBMITTALS

- A. Contractor's Qualifications: If the sub-contractor has not been pre-qualified and accepted by the Client, submit the following information.
 - 1. Installer qualifications, verifying years of experience.
 - 2. List of completed projects having similar Scope of Work identified by date, name, and location, including planting of large caliper trees and planting over structure.
 - 3. A minimum of three current references with names and phone numbers to be contacted.
- B. Plant Information: Plant material quantities shall be as shown on the Landscape Drawings. Submit the following items.
 - 1. The specific variety, quantity, and size of plant to be provided,
 - 2. Nurseries where plant material has been located, it is the intention to source as much plant material as possible that has been grown within a 500-mile radius of the project site.
 - 3. All plant material shall be nursery propagated and grown. No wild-collected plant material shall be used on this job.
 - 4. Provide a tentative schedule for tree planting, selection/tagging, approvals and installation within 2 weeks of contract signing.
- C. Product Data: Submit the following manufacturer's information and source data for items that apply.
 - 1. Commercial fertilizers and herbicides.
 - 2. Chemical additives.
 - 3. Organic amendments.
 - 4. Lime.
 - 5. Iron Sulfate.
 - 6. Filter Cloth/Soil Separator.
 - 7. Erosion Control Mat.
 - 8. Drainage Boards.
 - 9. Staking and guying materials.
 - 10. Temporary watering accessories.
 - 11. Aquatic Planting Containers
- D. Material Samples: Submit one pound samples, packaged in plastic bags, to the Landscape Architect for examination and approval prior to any landscape operations.

1. Mulch
- E. Warranty and Maintenance:
 1. Submit written warranty and maintenance agreement for all workmanship and materials specified, if accepted as an add alternate to the contract.

1.6 QUALITY ASSURANCE

- A. Installer Qualification: Not less than 5 years documented successful experience in installation of work similar to Work of this Project.
- B. Plant Substitutions- Pre-Bid:
 1. It is the Landscape Contractor's responsibility to make every reasonable effort to find the plant material specified by the Landscape Architect.
 2. Contractor is also responsible for qualifying their bid, to document any plant suitability or availability problems they foresee.
 3. Contractor may offer substitutions to the Landscape Architect for consideration if there are legitimate availability problems.
 4. Contractor may also offer substitutions if there are known disease or insect resistant species that can be substituted for a pest prone plant, if specified.
 5. Contractor shall submit a Base Bid as per plans and specifications, plus any price changes or clarifications for all recommended plant substitutions.
- C. Plant Substitutions- Post-Bid, Pre Installation:
 1. It is the intent to reduce or eliminate post -bid pre-installation substitutions by the Contractor.
 2. Substitutions of plant materials will not be permitted unless authorized in writing by Landscape Architect.
 3. If proof is submitted that any plant accepted during the bidding process is not attainable, a proposal will be considered for use of nearest equivalent size or variety, with corresponding adjustment of Contract price if necessary.
 4. These provisions do not relieve Contractor of responsibility for obtaining required materials in advance if special growing conditions or other arrangements that must be made in order to provide the required materials.
- D. Preliminary Plant Acceptance:
 1. Landscape Architect or his representative may view plants at their place of growth or upon delivery. Landscape Architect reserves the right to tag plants at their place of growth. Representative photographs may be requested prior to review in person.
 2. The Client has the right to make changes in plant types, provided they are of equal value and quantity prior to Landscape Architect approvals and purchasing by the Landscape Contractor.

3. At the Landscape Architect's choosing, for distant material, photographs may be submitted in lieu of on site inspections for preliminary reviews prior to on site inspection. Photographs shall be representative of actual material available.
4. Send Landscape Architect written request for plant inspection at their place of growth at least ten calendar days prior to purchase or digging.
5. Identify place of growth and quantity of plants to be inspected, as well as total number of specified size and type material from which selections may be made.

E. Final Plant Acceptance for Installations.

1. No trees or large shrubs established or grown in containers at any time during their life will be accepted. This includes plant material produced via Pot-In-Pot production.
2. Trees must have been planted bare root and grown in the nursery until dug, balled and burlapped. This is to reduce incidences of girdling roots.
3. In addition, trees must be grown and harvested appropriately with respect to the tree root flare and grafts. Trees grown too deep or with excess soil over their root system against the trunk will not be accepted.
4. Roots shall not be deeper than 3" below the soil level 4" from the trunk.

1.7 DELIVERY, STORAGE AND HANDLING

A. Handling:

1. Do not bind plants with wire or rope.
2. Lift and handle plants from bottom of ball only. Use extreme care in handling all plant material.
3. Plants damaged in transit, storage or handling may be rejected at the sole discretion of the Landscape Architect. Contractor shall note that consideration for plant material damage may not be life threatening, but rather cosmetic such as broken branches or scratched trunks, to qualify plant for rejection.
4. Plant Labels: Securely attach legible labels to at least 25% of each species and variety of separate plants in each shipment. Remove labels only after planting has been installed and approved.

B. Storage:

1. Coordinate the temporary storage of plant material with the General Contractor or other trades as required to keep plants away from on-going construction activities.
2. Protect plants from sun or drying winds.
3. If plants cannot be planted immediately on delivery, keep in shade, well protected with soil, damp mulch, or other acceptable material and keep well watered.
4. Do not store plants on-site for longer than three days after delivery.

1.8 SITE CONDITIONS

A. Utilities and Underground Features:

1. The Contractor shall notify utility companies and/or the General Contractor in advance of construction activities to locate utilities.
2. Site lighting, irrigation and other private utilities, including cable TV, communication and data lines, security wiring, irrigation lines, drain systems etc., shall be located and marked by the General Contractor.
3. If there is a conflict between utilities or other underground obstructions and plant material, coordinate with the Landscape Architect for relocating plants prior to installation.

B. Concealed Contingencies:

1. The correction of undisclosed or discovered subsurface conditions such as rock, roots, stumps, water, clay pan, soils contaminated with toxic substances or other site obstacles encountered in the excavation work, shall be brought to the attention of the Landscape Architect.
2. After determination that the discovered or undisclosed conditions are not the Contractor's responsibility, obtain written direction for changes to the design, or to proceed with pricing in order to obtain approvals to implement corrective measures.

C. Drainage:

1. Every effort has been made to select plants suitable for the site conditions they will encounter, however, if plants are to be in areas that show any signs of poor drainage Contractor shall perform drainage tests as per Section 3.2.
2. Poor Drainage areas encountered in the plant pit excavation work shall be brought to the Landscape Architect's attention prior to placing soils or planting.
3. Contractor shall make himself aware of subsurface underdrains and building foundation drains which may be available for use in providing plant bed underdrainage. Verify with the Landscape Architect drains which may be used.

D. Site Preparation:

1. Coordinate plant material installations with site utilities and grading operations.
2. Do not commence work until temporary trailers, aggregates used for walkways, geotextile fabrics, tree protection devices, and construction materials and debris not conducive to the establishment of plant materials, have been removed from the immediate area.
3. Do not commence this work until grades have been set and planters and drains are completed.

1.9 PLANTING SEASONS

A. B&B, deciduous trees and shrub material:

1. Lowest Risk: March 1 to May 30 and September 15 to December 1.

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09 DECEMBER 2022

- a. Deciduous plants dug and planted while dormant in spring or fall except for those listed below.
 - b. Deciduous plants dug during dormancy and planted after producing leaves providing they have been properly stored.
 - c. Deciduous plants dug after leaves have fully expanded and hardened off.
2. Highest Risk – Unacceptable Timing:
 - a. Deciduous plants dug in the spring during newly expanding leaf production.
- B. Evergreen B&B material:
1. Freshly dug evergreen material should not be moved without proper conditioning during active growth.
- C. Summer dug B&B material shall be handled in one of the following methods in order to harden off:
1. Properly hardened-off in the field 7-10 days prior to digging by a gradual process of trenching and soaking, leaving the bottom surface of the ball attached to soil until shipping. Use of biostimulants per nurserymen's recommendation.
 2. Condition under irrigation in partial shade for at least 4 days prior to shipping.
- D. Hardened-off B&B evergreen or deciduous material can be planted year round provided soil conditions permit.
- E. Perennials:
1. May be installed as soon as the ground is workable in the Spring after March 1 until November 15.
- F. Excluded Material:
1. The following trees may only be installed between February 15 and June 15.
 - a. White Oak (*Quercus alba*), Scarlet Oak (*Quercus coccinea*), Red Oak (*Quercus rubra*), Willow Oak (*Quercus phellos*), Flowering Dogwood Varieties, (*Cornus florida*), Sweet Gum (*Liquidambar styraciflua*) Tulip Poplar (*Liriodendron tulipifera*) and all conifers with the exception of White Pines (*Pinus strobus*). All other species designated as Fall Dig Hazards by the supplying nursery.
- G. Out of season plant installations:
1. A professional horticulturist, nurseryman or arborist shall be consulted to determine the proper time, based on plant species and weather conditions, to move and install particular

plant material to minimize plant stress if it required to move material outside of the preceding guidelines.

2. Should plant material be required to be installed for the Contractor's convenience, it shall be at the Contractor's full risk and responsibility.
3. Landscape Architect will only allow variance in planting season upon written request.
4. Any additional costs related to possible out-of-season digging of trees must be listed in the bid.

1.10 WARRANTY PERIOD

- A. Contractor shall warrant that all trees, shrubs, vines, groundcovers, perennials, and bulbs planted under this contract shall be warranted from the date of Initial Acceptance for the following periods.
 1. At-grade Installations, except for trees over 6 inch caliper: 1 Year.
 2. Trees over 6" caliper: 2 Years.
 3. Over-structure installations: 2 Years.
- B. Plants shall be in healthy and in flourishing condition of active growth for the entire Warranty Period. Completion of Warranty Period shall be assessed during active growing season, only.
- C. Any delay in completion of planting operations, which extends the planting into more than one planting season shall extend the Warranty period correspondingly.
- D. Contractor shall provide written Warranty certificates to the Landscape Architect.
- E. Warranty Provisions:
 1. Remove plants that are in the opinion of the Landscape Architect or the Owner, at least 25% dead, unsightly, or not in healthy condition.
 2. Replace removed plants, and plants missing due to Contractor's negligence. Replace when weather conditions permit and within specified planting period, or as directed by Landscape Architect.
 3. Provide replacement plants closely matching adjacent specimens of same species.
 4. Warrant replacement plants for additional period of one year from date of their acceptance after replacement. Note that failure to replace plants in a timely and responsive manner may result in reduction and/or forfeiture of final payments.
 5. It is the Contractor's responsibility to notify the Owner in writing of any apparent negligence or conditions following Maintenance Turnover which might compromise provisions of the Warranty.

1.11 MAINTENANCE

- A. Begin maintenance immediately after plants are installed and continue until Initial Acceptance.
- B. Maintenance Requirements:
 1. Protect plants and planting areas from damage.
 2. Keep plants healthy, vigorous, trim, and neat.
 3. Prune to maintain plants in normal natural growth pattern.

4. Spray to control disease and insects.
5. Maintain mulch bed to 2-inch depth. Note: complete re-mulching of plant materials is not required as part of the contract).
6. Keep beds free of weeds.
7. Provide manpower in order to water or operate the temporary watering measures, all plant materials as required to maintain adequate moisture, and when directed by Landscape Architect or Owner.
8. Maintain stakes and guys in taut and rigid state with wires in place and safety flags clearly visible. Remove stakes and guys when no longer necessary for plant establishment.
9. Reset plants to proper grade and upright condition if required and add topsoil and mulch to areas of settlement.
10. Provide additional stakes as required to support trees particularly evergreens in areas prone to high winds or settlement.
11. Maintain all plants until Initial Acceptance by the Landscape Architect and Maintenance Turnover.

1.12 ACCEPTANCE

A. Initial Acceptance:

1. Notify Landscape Architect ten calendar days prior to date Contractor wishes the Landscape Architect to view the progress of the work and to prepare final landscape punch lists on completion of the planting.
2. Landscape Architect will view Work for conformance with Contract Documents. Work will be accepted provided that all requirements have been complied with, punch list items have been completed, and receipt of plant material Warranty certification.
3. When all items have been satisfied the Landscape Architect will issue a Notice of Initial Acceptance and a Date for commencement of Warranty timetable and Maintenance Turnover.

B. Partial Acceptance:

1. Acceptance may be made on partially completed Work, if approved by Landscape Architect.
2. If Work has stopped for reasons beyond Contractor's control Acceptance will be made on partially completed Work.
3. Landscape Architect will view Work for conformance with Contract Documents. Work will be partially accepted provided that all requirements, including punch list items for those particular items have been completed, and that plants are alive and in healthy, vigorous condition.
4. When all items have been satisfied the Landscape Architect will issue a Notice of Partial Initial Acceptance and a Date for commencement of Warranty timetable and partial Maintenance Turnover.

C. Maintenance Turnover:

1. Prior to Initial Acceptance an agreed date of Maintenance Turnover shall be confirmed by the Landscape Architect in writing and shall be signed off by the Client and the Contractor prior to an end of on going plant maintenance activities and responsibilities.

2. Contractor shall meet with Landscape Architect and the Client's representative to review and advise of general maintenance procedures prior to Maintenance Turnover.
- D. Final Acceptance:
1. Notify Landscape Architect one month prior to expiration of Warranty period that Final Acceptance is required.
 2. Landscape Architect will review landscape Work for conformance with Contract Documents, and note any plants requiring adjustments or replacement. Landscape Architect will issue a letter of outstanding items.
 3. The Landscape Architect will issue Final Acceptance letter, when all requirements are satisfied and Contractor is released from further contractual obligations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Manufacturers offering products that comply with the requirements of this Section are listed below. Those manufacturers not listed who offer products that comply with the requirements of this Section will be considered as substitute manufacturers, requiring the Landscape Architects approval.

2.2 PLANT MATERIALS

- A. Type:
1. Refer to Plant Schedule on Drawings for genus, species and variety or cultivar. Note: plant quantities shown on the plans govern. Plant list is for Contractor's convenience only.
 2. Comply with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock".
- B. Appearance:
1. Provide sound, healthy, vigorous plants, well branched and densely foliated when in leaf, free of disease, insect pests, eggs or larvae, with healthy well-developed root systems as accepted by the Landscape Architect.
 2. Plants shall be typical of their species or variety and shall have a normal habit of growth.
 3. Provide plants of "specimen quality", exceptionally heavy, symmetrical, and tightly knit.
 4. No excessive tip pruning or shearing of evergreens permitted. Plants should exhibit a natural quality.
- C. Size:
1. Comply with measurements on Plant Schedule except plants larger than specified may be used if acceptable to Landscape Architect, and at no change to Contract sum.
 2. If larger plants are accepted, increase ball of earth in proportion to size of plant.
 3. Rootball depths for tree plantings over structure shall be limited as indicated on the planting schedule. Trees harvested with a ball deeper than specified shall be rejected.

4. Trees: Measure caliper at point on trunks 6 inches above natural ground line for trees up to 4 inches in diameter, and 12 inches above natural ground line for trees over 4 inches in diameter.
5. Shrubs:
 - a. Measure plants when branches are in normal position, after pruning.
 - b. Height and spread dimensions specified refer to main body of plant and not from branch tip to branch tip.
6. If size range is given, comply with minimum sizes and provide 50 percent of plants of maximum size.

D. Nursery Cultivation:

1. Provisions stated in preceding Quality Assurance Section shall also govern (No container grown trees or large shrubs accepted, this includes materials produced by “Pot-in-Pot” production techniques).
2. Provide plants that are nursery grown in accordance with the latest horticultural practices with the exceptions noted and grown under climatic conditions similar to those in locality of the Project. Provide plants that have been root pruned within last two years.
3. Dig plants fresh for delivery to the project during season for planting. Should time table for plant installation be out of phase with recommended planting times, notify Landscape Architect so that an alternative plant digging schedule can be approved.
4. Oaks for example typically require a dormant season harvesting prior to leafing out. No B&B heeled-in plants, out of season dug, or plants from cold storage will be accepted, without prior knowledge and written acceptance from the Landscape Architect.
5. Container grown stock:
 - a. Only small shrubs and herbaceous groundcovers will be accepted.
6. Do not prune trees before delivery. Prune per instruction of Landscape Architect following installation.

2.3 SOILS

- A. See Section 329100 for specifications regarding soils, soil planting mixes and soil amendments.

2.4 PLANTING ACCESSORIES

- A. Filter Cloth / Soil Separator:
 1. Water permeable woven filtration fabric of fiberglass or polypropylene fabric.
 2. Acceptable products and manufacturers:
 - a. Mirafi by Mirafi Inc.
 - b. Stablenka Type T-80 by American Enka Co., or approved equals.
- B. Erosion-Control Mat for slopes greater than 3:1, or flow velocities greater than 12fps, or as directed by the Landscape Architect.: Biodegradable wood excelsior, straw, and/or coconut-fiber mat enclosed in a natural fiber mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
 1. Available Manufacturers: Basis for design shall be: North American Green – BioNet SC150BN Double Net Straw-Coconut Blanket, or approved equal.

- C. Stakes, Guys and Deadmen:
 - 1. Wood stakes: 2-inch x 2-inch hardwood, reasonably free of knots.
 - 2. Wire: 9 gauge galvanized or zinc-coated, 2-strand, twisted wire
 - 3. Turnbuckles: Galvanized or zinc-coated, of size to hold wire or cable used.
 - 4. Deadmen: Oak, 6-inch diameter x 36 inches long, or as indicated on the drawings.
 - 5. Straps: 3/4 inch wide polypropylene webbing; 900lb tensile strength; brown, black or olive green.

- D. Watering and Temporary Irrigation Accessories:
 - 1. Watering Hose: 150 Ft. Lengths in quantity to reach all trees and soaker hose connections from hosebib or quick coupler locations.
 - 2. Soaker Hose: Black, provide adequate length to coil one full revolution around each shrub in areas that do not have automatic irrigation, and connect to hose bib or quick coupler location, not required for all reforestation whips.
 - 3. Drip Irrigation Bags: TreeGator, 20 gallon bag, or equal, provide one per tree in areas that do not have automatic irrigation.

- E. MULCH & TOP DRESSINGS
 - E. Provide well-composted pine bark, mulching grade, uniform in size, and free from foreign matter, natural color, or approved equal.
 - 1. Horticultural grade milled loblolly pine bark size 0.1 mm - 15.0 mm. Pine bark shall be aged at least nine months and shall be screened. pH shall range between 4 and 4.3.
 - F. Provide Rotary Kilned Aggregate mulch (or approved equal) 1” thickness for use on the Greenroof Planting.

2.6 PRE-EMERGENT HERBICIDE

- A. Pre-emergent herbicide shall be a product specifically designed to prevent the germination of seeds in lawn and planting bed areas.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITE CONDITIONS:

- A. Contractor shall be responsible for making himself familiar with all underground utilities, pipes and structures, by contacting a local Utility locating service 72 hours prior to digging. Contractor shall take sole responsibility for any cost incurred due to damage to these utilities.
- B. Examine conditions in which Work is to be installed. Do not proceed with Work until unsatisfactory conditions are corrected. Do not install soils or plants prematurely when the site and planters are not ready for plants or when construction conditions may damage installed material.
- C. Do not willfully proceed with planting as designed when it is obvious that conditions and/or obstructions exist due to changes in building or site conditions. Such conditions shall be

brought to the immediate attention of the Landscape Architect. The Contractor may be held responsible for all necessary replanting due to failure to give notifications so that material can be relocated or conditions corrected prior to plant installations.

- D. Remove any existing plant material necessary for the installation and the completion of the planting designed and contracted as part of this project.
- E. Plant layout staking:
 - 1. Stakeout ground locations in the field for trees and outlines of plant beds.
 - 2. Review staked layout in field with Landscape Architect or field representative prior to planting.

3.2 SOIL DRAINAGE TESTS:

- A. Before planting, determine that areas to receive plant material have adequate sub-soil drainage, and that the Drainage installed as noted above is functioning. Contractor is responsible for correcting all drainage conditions which may adversely impact the establishment of specified plantings.
 - 1. Perform water percolation tests as indicated on the Soils Plan.
 - 2. Test by digging tree and shrub pits to the full depth and dimensions indicated on drawings.
 - 3. Fill excavations to 1/3 depth with water and time percolation rate. A rate of one inch per hour is the allowable minimum percolation rate. Allow all water to percolate out before planting.
 - 4. If, after 24 hours, water remains in excavation, perform a more detailed percolation test as described below and notify Landscape Architect in writing
 - 5. At bottom of planting pit, excavate rectangular pit 12 inches by 12 inches by 18 inches deep. Pour water into this small pit to a depth of 6 inches (approximately 3 - 3 3/4 gallon). Note time required for water to be completely absorbed. Divide time noted by 6, to achieve average rate of absorption for 2 inches of water.

3.3 PLANT MATERIAL PREPARATION:

- A. Digging Plants at Nursery:
 - 1. Dig balled and burlapped (B&B) plants with firm, natural balls of earth of diameter not less than that recommended by American Standard of Nursery Stock; of sufficient depth to include fibrous and feeding roots.
 - 2. Plants grown too deep or with excess soil over their roots will not be accepted.
 - 3. Plants with cracked or broken balls are not acceptable.
 - 4. Remove dirt thrown onto ball top by cultivation and other nursery practices prior to digging.
- B. Mark north-facing side of all trees greater than 4-1/2" caliper at place of growth, and position trees in similar exposure at installation. Final positioning is to be directed by Landscape Architect.

3.4 GENERAL AT-GRADE PLANTING INSTALLATIONS

- A. Excavation:
1. Excavate to dimensions as indicated on the planting plan and details.
 2. Loosen any hard or unsuitable subsoil encountered in the excavation of the bottom of the pit to an additional depth of 6 inches.
 3. Remove all trash, brickbats, debris or other material not conducive to plant material growth.
 4. Notify Landscape Architect for corrective measures, if rock, tree roots, or other underground obstructions are encountered that would be detrimental to growth of plant material or require the tree to be shifted.
 5. Excavation in areas where there are existing trees, do not excavate closer than 6" for each caliper inch DBH, or as directed by the Landscape Architect. (For example, an 18" caliper tree you would not excavate closer than 9')
 6. Notify the Landscape Architect to determine if they wish to view the preparation of a typical tree pit for compliance with the contract documents.
- B. Tree Installations:
1. Set balled and burlapped (B&B) tree stock plumb and in center of so that the top of ball is slightly above (2-3") the elevation of the planter edge to allow for settlement.
 2. Set plants plumb and brace rigidly in position until planting soil is tamped solidly around ball and roots.
 3. Cut away and remove burlap, rope, wire basket etc. from the top 1/2 and sides of root balls, retain on bottoms. Thoroughly cut and remove wire basket top and bend down into tree pit.
 4. Place approved soil backfill around base and sides of ball in layers, up to 4-6" of the top of the planting area.
 5. Settle backfill and eliminate voids and air pockets.
 6. When backfill is complete water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed.
 7. Place a 2" layer of approved shredded hardwood mulch.
 8. Stake all trees as noted below.
- C. Installation of Shrubs and Groundcovers in Planting Beds:
1. Plant shrubs in same manner as specified above.
 2. Set shrubs and groundcovers in locations as indicated on the Planting Plan.
 3. For large shrubs over 6' in height (Hollies for example), place the root flare slightly above (2-3") surrounding soil level or (2-3") above the top elevation of the planter coping, to allow for soil compaction and settlement. Otherwise, set shrubs so that top of ball is level with surrounding soil.
 4. When installing container-grown plants remove soil from outer root area to pull and spread out roots prior to planting.
 5. Plants that are pot bound shall be split apart to open root systems that maybe spiraled within containers to reduce girdling roots and improve soil root contact. Spread out roots and tamp soil around root zone.
- D. Groundcovers and Perennials (includes plugs):

1. Layout plants for each bed by spacing them in staggered rows aligned with the outer edge of the planting beds or in naturalistic drifts as indicated on the drawings or as directed by the Landscape Architect.
 2. Set plants at equal distance apart as indicated on the plant schedule.
 3. Dig planting holes with hand trowel, large enough to allow for spreading roots.
 4. Before planting, crush biodegradable pots and remove non-biodegradable pots. Split or open root systems of potted plants to improve soil root contact, and spread out roots of pot bound plants.
 5. Set plants in planting hole and backfill soil by hand setting plants plumb, and straight.
 6. Install plant so that level of root crown after settlement is same elevation at which it grew in nursery.
 7. Plant so that each root ball has good soil to root contact. Do not plant in mulch, but below mulch level.
 8. Cover bare root plants up to crown of plant soil level.
 9. Water again after placing final layer of backfill.
- E. Topsoil Layers and Mulch:
1. Smooth beds to conform to grades and adjust for settlement.
 2. Mulch:
 - a. Place a minimum of 2" and not more than 3" layer of approved mulch in shrub areas, and in areas to receive groundcovers, or as indicated on drawings.
 - b. Tree saucers are not required in planters.

3.5 STAKING AND PRUNING

- A. Stake and guy trees only under one or more of the following conditions:
1. Large tree size (over 4.5" inch diameter);
 2. Tree is planted in a location with high wind;
 3. Tree is planted adjacent to a primary pedestrian path (consult owner or Architect with questions);
 4. Tree is a fall-planted evergreen;
 5. Tree is planted on slopes 3:1 or steeper.

Maintain stakes and guy wires until acceptance. Where guys may pose hazard to pedestrians, encase wires in gray plastic rigid conduit to prevent injury.

- B. Prune plants when planted according to standard horticultural practice to preserve natural character of plant. Notify Landscape Architect prior to pruning. Landscape Architect may request additional pruning of specific plants.
- C. Use only clean, sharp tools for pruning.
- D. Remove dead wood, suckers, and broken or badly bruised branches.

3.6 WATERING & MAINTENANCE

- A. Begin watering and maintenance activities as specified to minimize plant shock and promote establishment.

- B. Coordinate plant installations with installation of temporary irrigation accessories so that it may be available to water newly installed plants.

3.7 CLEANUP

- A. Keep planted areas in clean, neat and orderly condition.
- B. Remove all ribbons, tags, labels, ropes, trash, and debris from the project site.

3.8 PROTECTION

- A. Protect newly planted areas. Take measures to reasonably reduce or minimize pedestrian traffic from bed areas throughout the plant establishment period or as required to maintain plants.
- B. Maintain adequate soil moisture for the proper establishment of all plants. Do not over water.
- C. Restore damage, resulting from lack of protection or improper installation of protection as approved by the Landscape Architect.

END OF SECTION

SECTION 334100 - STORM UTILITY DRAINAGE PIPING

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. Pipe and fittings.
 2. Nonpressure transition couplings.
 3. Channel drainage systems.
 4. Pipe outlets.

1.3 SUBMITTALS

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

1.4 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.

1.5 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 Owner no fewer than two days in advance of proposed interruption of service.
 2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PE PIPE AND FITTINGS

- A. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
 2. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
- B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294M, Type S, with smooth waterway for coupling joints.
1. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
 2. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.2 PVC PIPE AND FITTINGS

- A. PVC Type PSM Sewer Piping:
1. Pipe: ASTM D 3034, SDR 35, 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.
- B. PVC Gravity Sewer Piping:
1. Pipe and Fittings: ASTM F 679, T-1 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.

2.3 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, 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 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. Ballast and Pipe Supports: Portland cement design mix, 3000 psi 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.

2.4 PLASTIC, CHANNEL DRAINAGE SYSTEMS

- A. General Requirements for Plastic, Channel Drainage Systems:
1. Modular system of plastic channel sections, grates, and appurtenances.
 2. Designed so grates fit into frames without rocking or rattling.
 3. Number of units required to form total lengths indicated.

- B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. ACO USA.
 2. MultiDrain Systems, Inc.
 3. NDS Inc.
 4. Tuf-Tite Corporation.
 5. Zurn Light Commercial Products Operation; Zurn Plumbing Products Group.

2.5 PIPE OUTLETS

- A. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
1. Average Size: NSSGA No. R-4, screen opening 3 inches.
- B. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
- C. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 31 2000 "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 with 18 inches minimum cover.
 - 3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 4. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
 - 2. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
 - 3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
- B. Fasten grates to drains if indicated.
- C. Set drain frames and covers with tops flush with pavement surface.

3.5 CONCRETE PLACEMENT

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

3.6 CHANNEL DRAINAGE SYSTEM INSTALLATION

- A. Install with top surfaces of components, except piping, flush with finished surface.
- B. Carefully lay out curved channel drain runs as shown on plans with consistent radii and angles of deflection between adjacent units. Visible kinks, straights, and/or inconsistent radius within curved runs shall be cause for rejection of the work.
- C. Assemble channel sections to form sloping invert that flows toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
- D. Firmly secure each channel drain section to prevent movement during placement of surrounding concrete.
- E. Protect top edges of precast units from damage during installation.

- F. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides. Cover and protect open tops as necessary to prevent concrete from entering drainage channel.
- G. Fasten grates to channel sections using manufacturer's lockdown devices.
- H. Assemble channel sections with flanged or interlocking joints.

3.7 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Section 22 1413 "Facility Storm Drainage Piping."
 - 1.

3.8 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
 - 1. Remove manhole or structure and close open ends of remaining piping.
 - 2. Remove top of manhole or structure down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 31 2000 "Earth Moving."

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Section 31 2000 "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 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 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.
 - 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. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
- 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.

3.11 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

END OF SECTION