

## SECTION 311000 - SITE CLEARING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract

#### 1.2 SUMMARY

- A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants and grass to remain.
2. Demolition of concrete and bituminous pavement.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above and below-grade site improvements.
6. Disconnecting, capping or sealing, and removing site utilities.
7. Temporary erosion and sedimentation control measures.

- B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.

#### 1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials or other nonsoil materials.
- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

#### 1.4 MATERIAL OWNERSHIP

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

## 1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

## 1.6 QUALITY ASSURANCE

- A. Pre-construction Conference: Conduct conference at Project site with the owner to describe construction operations and schedule.
- B. Notify and coordinate with the County Conservation District, as applicable, for their input prior to starting clearing operations. The site limit of disturbance, shown on the plan, is less than one acre and a NPDES permit is not required for the site construction.

## 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 authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property, as applicable, will be obtained by Owner before award of Contract.
  - 1. Do not proceed with work on adjoining property until directed by Owner.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify and employ a utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving".
  - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are 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 flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction, sediment and erosion control drawings, a sediment and erosion control plan, specific to the site, that complies with EPA 832/R-92-005 or requirements of authorities having jurisdiction, whichever is more stringent.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### 3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
  2. Do not permit vehicles, equipment, or foot traffic within fenced area.
  3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
1. Cover exposed roots with burlap and water regularly.
  2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
  3. Coat cut faces of roots more than 1-1/2 inches in diameter with emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
  4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations.
1. Employ an arborist, licensed in jurisdiction where Project is located, to submit details of proposed repairs and to repair damage to trees and shrubs.
  2. Replace trees that cannot be repaired and restored to full-growth status, as determined by Owner.

### 3.4 UTILITIES

- A. Contractor will arrange with Owner for disconnecting and sealing utilities, as applicable, that serve existing structures before site clearing.
1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
1. Arrange with utility companies to shut off indicated utilities.
  2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. 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 Owner not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Owner's written permission.

- D. Excavate for and remove underground utilities indicated to be removed.

### 3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
  - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
  - 4. Use only hand methods for grubbing within tree protection zone.
  - 5. Chip removed tree branches and dispose of off-site.
- 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. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Limit height of topsoil stockpiles to 72 inches.
  - 2. Do not stockpile topsoil within tree protection zones.
  - 3. Dispose of excess topsoil as specified for waste material disposal.
  - 4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

### 3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as 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 length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

### 3.8 DISPOSAL

- A. Disposal: 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.
  - 1. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

**END OF SECTION 311000**

## SECTION 312000 - EARTH MOVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade for walks, pavements, lawns, grasses and exterior plants.
2. Drainage course for slabs-on-grade.
3. Subbase course for concrete walks and pavements.
4. Subbase course for asphalt paving.
5. Subsurface drainage backfill for walls and trenches.
6. Excavating and backfilling for utility trenches.
7. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.

- B. Related Sections include the following:

1. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
2. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
3. Division 32 Section "Turf and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.
4. Division 32 Section "Plants" for planting bed establishment and tree and shrub pit excavation and planting.
5. Division 33 Section "Subdrainage"

#### 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 an excavation.

- B. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

- C. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- D. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - 1. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
  - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Owner. Unauthorized excavation, as well as remedial work directed by Owner, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. Rock: Material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows when tested by an independent geotechnical testing agency, according to ASTM D 1586.
- 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: Course placed between the subgrade and base course for pavement or walks.
- J. Subgrade: Surface or elevation remaining after completing excavation; or top surface of a fill or backfill immediately below subbase, drainage fill, 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 the following:
  - 1. Each type of plastic warning tape.
  - 2. Geotextile.
- B. Samples: 12-by-12-inch Sample of subdrainage and separation geotextile.
- C. Material Test Reports: From a qualified geotechnical testing agency indicating and interpreting test results for compliance of the following with requirements indicated:



1. Classification according to ASTM D 2487 of each on-site and borrow soil material proposed for fill and backfill.
  2. Laboratory compaction curve according to ASTM D 1557 for each on-site and borrow soil material proposed for fill and backfill.
- D. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

## 1.5 QUALITY CONTROL

- A. Geotechnical Testing Agency Qualifications: An independent testing agency qualified according to ASTM E 329 to conduct soil materials and/or rock testing, as documented according to ASTM D 3740 and ASTM E 548, retained and paid for by the Contractor.

## 1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated.
1. Notify Owner not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Owner's written permission.
  3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Unsatisfactory Soils: Soil Classification Groups 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 at appropriate moisture content levels to achieve designated minimum acceptable compaction.

- C. Subbase Material: Naturally or artificially graded mixture of crushed gravel, crushed stone, and/or crushed sand, meeting the requirements of PADOT 2A aggregate.
- D. Engineered Fill: Naturally or artificially graded mixture of soil crushed gravel, crushed stone, and/or crushed sand, with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Bedding Course: Naturally or artificially graded mixture of crushed gravel, stone, and/or crushed sand; meeting the requirements of ASTM D 2940; with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Drainage Course: Narrowly graded mixture of washed crushed stone, or gravel; meeting the requirements of ASTM D 448; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; meeting the requirements of ASTM D 448 with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- H. Sand: Fine aggregate, natural, or manufactured sand meeting the requirements of ASTM C 33.
- I. 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 polyolefin or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Grab Tensile Strength: 157 lbf; ASTM D 4632.
  - 3. Sewn Seam Strength: 142 lbf; ASTM D 4632.
  - 4. Tear Strength: 56 lbf; ASTM D 4533.
  - 5. Puncture Strength: 56 lbf; ASTM D 4833.
  - 6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
  - 7. Permittivity: 0.2 per second, minimum; ASTM D 4491.
  - 8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefin or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.

2. Grab Tensile Strength: 247 lbf; ASTM D 4632.
3. Sewn Seam Strength: 222 lbf; ASTM D 4632.
4. Tear Strength: 90 lbf; ASTM D 4533.
5. Puncture Strength: 90 lbf; ASTM D 4833.
6. Apparent Opening Size: No. 60 sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

## 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 earthwork operations.
- B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.
- D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

### 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 EXPLOSIVES

- A. Explosives: Blasting is not permitted.

### 3.4 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. 6 inches outside of minimum required dimensions of concrete cast against grade.
    - c. 6 inches beneath bottom of concrete slabs on grade.
    - d. 6 inches beneath pipe in trenches, and the greater of 24 inches wider than pipe or 42 inches wide.

### 3.5 EXCAVATION FOR WALKS AND PAVEMENTS

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

### 3.6 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: 12 inches each side of pipe or conduit.
- C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.7 SUBGRADE INSPECTION

- A. Notify Geotechnical Testing Agency when excavations have reached required subgrade.
- B. If Geotechnical Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and 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, repeating proof-rolling in direction perpendicular to first 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 and replace with compacted backfill or fill as directed.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Owner, without additional compensation.

### 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.
  - 2. Surveying locations of underground utilities for Record Documents.
  - 3. Testing and inspecting underground utilities.
  - 4. Removing trash and debris.
  - 5. Removing temporary shoring and bracing, and sheeting.
- 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. Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches 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.
- D. Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1-inch in any dimension, to a height of 12-inches over the utility pipe or conduit.
  - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- E. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
- F. Place and compact final backfill of satisfactory soil to final subgrade elevation.

### 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.
- 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 to within an appropriate percentage of optimum moisture content that will enable achievement of specified density.
  - 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 prevents compaction 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 each layer of soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:
  1. All backfills or fills greater than 3 feet thick; compact to 90 percent to within 3 feet of finished grade or structural bottom.
  2. Under pavements, scarify and compact top 36 inches of existing subgrade and each layer of backfill or fill material at 95 percent.
  3. Under walkways, scarify and compact top 36 inches below subgrade and compact each layer of backfill or fill material at 92 percent.
  4. Under lawn or unpaved areas; scarify and compact top 36 inches below subgrade and compact each layer of backfill or fill material at 85 percent.
  5. For utility trenches, compact each layer of initial and final backfill at 95 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 Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  1. Lawn or Unpaved Areas: Plus or minus 1 inch.
  2. Walks: Plus or minus 1 inch.
  3. Pavements: Plus or minus 1/2 inch.

### 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 bedding course 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 with a minimum of two passes of a plate-type vibratory compactor.
- C. Drainage Backfill: Place and compact drainage course over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
  - 1. Compact each drainage course layer with a minimum of two passes of a plate-type vibratory compactor.
  - 2. Place and compact impervious fill over drainage backfill in 6 inch thick compacted layers to final subgrade.

### 3.16 SUBBASE AND BASE COURSES

- A. Place subbase course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase 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. Shape subbase course to required crown elevations and cross-slope grades.
  - 3. Place subbase course 6 inches or less in compacted thickness in a single layer.
  - 4. Place subbase 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.
  - 5. Compact subbase 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. Place base course material over subbase course under hot-mix asphalt pavement.

### 3.17 DRAINAGE COURSE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:



1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place drainage course 6 inches or less in compacted thickness in a single layer.
3. Place drainage 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.
4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry density according to ASTM D 1557.

### 3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor will engage a qualified independent Geotechnical testing agency to perform field quality-control testing listed in this specification.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, or 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 1 test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
  2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet or less of wall length, but no fewer than 2 tests.
  3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- D. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

### 3.19 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.

3.20 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

**END OF SECTION 312000**

## SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract

#### 1.2 SUMMARY

- A. This Section includes temporary excavation support and protection systems.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.
  - 1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - 4. Monitor vibrations, settlements, and movements.

#### 1.4 SUBMITTALS

- A. Shop Drawings: For excavation support and protection system.
- B. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Other Informational Submittals:
  - 1. Photographs: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.

2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
  - a. Note locations and capping depth of wells and well points.

## 1.5 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
  1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
  2. Do not proceed with interruption of utility without Owner's written permission.
- B. Project-Site Information:

Conduct test borings and other exploratory operations necessary for excavation support and protection.
- C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
  1. Corners: Roll-formed corner shape with continuous interlock.

- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.
- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- G. Tiebacks: Steel bars, ASTM A 722/A 722M.
- H. Tiebacks: Steel strand, ASTM A 416/A 416M.

## 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 that could develop during excavation support and protection system operations.
  - 1. Shore, support, and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

### 3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier

piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally and secure to soldier piles.

### 3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

### 3.4 TIEBACKS

- A. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
  - 1. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.
  - 2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

### 3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
  - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Owner.
  - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
  - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

### 3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
  - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlaying construction and abandon remainder.
  - 2. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
  - 3. Repair or replace, as approved by Owner, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

**END OF SECTION 315000**

## SECTION 315513 - EROSION AND SEDIMENTATION CONTROL

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This section includes the following:
  - 1. Temporary erosion three dimensional tubular stormwater runoff devices.
  - 2. Temporary seeding and mulching of all earthwork areas.
  - 3. Temporary construction entrances, where indicated or desired by the Contractor.
- B. Related sections include the following:
  - 1. Division 32 Section "Site Clearing".
  - 2. Division 32 Section "Earthwork".

#### 1.3 REFERENCE STANDARDS

- A. Commonwealth of Pennsylvania Department of Transportation (PENNDOT):
  - 1. PENNDOT Publication 408, current edition.
    - a. PENNDOT Section 703 - Aggregates.
    - b. PENNDOT Section 735 - Geotextiles.
    - c. PENNDOT Section 804 - Seeding and Soil Supplements
    - d. PENNDOT Section 805 - Mulching
    - e. PENNDOT Section 806 - Watercourse and Slope Erosion Protection
    - f. PENNDOT Section 850 - Rock Lining
    - g. PENNDOT Section 860 - Sediment Trap
    - h. PENNDOT Section 864 - Diversion Ditch
    - i. PENNDOT Section 865 - Silt Barrier Fence
    - j. PENNDOT Bulletin 15 - Approved Construction Materials
- B. Commonwealth of Pennsylvania, Department of Environmental Protection, Bureau of Soil and Water Conservation
  - 1. Erosion and Sediment Pollution Control Program Manual, March 2012 edition.



- C. The Pennsylvania State University (PSU), College of Agriculture
  - 1. "The Agronomy Guide", 1990 (PSU).

## PART 2 - PRODUCTS

### 2.1 TUBULAR SEDIMENT RUNOFF DEVICE

- A. Filtrexx SiltSoxx as manufactured by Filtrexx International, LLC (440-926-2607).

### 2.2 POSTS FOR SEDIMENT RUNOFF DEVICE

- A. Of sufficient length for 18-inch embedment in the ground; minimum 2-inches square for wood, or 1.25 x 1.00 inch steel T-sections, PENNDOT Section 865.

### 2.3 SEED MIXTURES

- A. Temporary seed mixture for all earthwork areas:

- 1. Species
  - a. Annual rye grass @ 50 lbs. per acre.
    - 1) 100 percent by weight
    - 2) 98 percent by purity
    - 3) 90 percent germination
  - b. Seed shall be clean, dry, new crop.

### 2.4 CONSTRUCTION ENTRANCE

- A. PENNDOT Section 703, AASHTO No. 1 coarse aggregate, 8-inch depth, minimum 50 feet in length, and of sufficient width to accommodate all vehicular traffic in and out of construction area.

### 2.5 MULCHES

- A. Straw shall be unrotted, small grain free of all kinds of weeds and prohibited noxious weeds such as: thistles, johnsongrass, and quackgrass.

## 2.6 WOOD CELLULOSE MULCH

- A. Wood cellulose shall be green-dyed and air-dried wood cellulos fibers, containing no growth or germination inhibiting substances, in packages not exceeding 100 pounds gross, net weight shown on package and meeting the following:

1. Moisture content: 14 percent  $\pm$  3%
2. Organic matter (oven dried basis): 98.6 percent  $\pm$  0.2%
3. Ash content: 1.4 percent  $\pm$  0.2%
4. Water holding capacity: 100% minimum

## 2.7 SHREDDED BARK MULCH

- A. Shredded bark shall be suitable fibrous ground, shredded or chunks, aged hardwood or pinewood bark, free from viable, noxious weed seeds and insect life, not decomposed and between 1/4-inch and 2-inch in dimension.

## 2.8 MULCH BINDERS

- A. Non-asphaltic emulsion shall be natural vegetable gum blended with jelling and hardening agents, (Terra Tack AR) as manufactured by Grass Growers Company or equal.
- B. Other mulch binders as approved by the local County Conservation District and the PADEP Bureau of Soil and Water Conservation.

## 2.9 MULCH NETTINGS

- A. Jute or excelsior blanket, paper, plastic and cotton mulch mattings of a kind and type approved by the local County Conservation District and the PADEP Bureau of Soil and Water Conservation. Do not use metal staples in areas to be mowed.
1. Staples shall be as recommended by netting manufacturer and local County Conservation District and PADEP Bureau of Soil and Water Conservation.
  2. Other mulch nettings as approved by the Architect and the local County Conservation District and PADEP Bureau of Soil and Water Conservation.

## 2.10 FERTILIZER

- A. Any 1-2-2 ratio fertilizer containing minimum 5 percent nitrogen, 10 percent available phosphoric acid and 10 percent soluble potash conforming to PENNDOT Standard Specifications.

## 2.11 LIMESTONE

- A. Pulverized limestone shall be composed of not less than 85 percent calcium and magnesium carbonates equivalent to not less than 40 percent calcium and magnesium oxides conforming to PENNDOT Standard Specifications.

## 2.12 WATER

- A. Suitable clean water may be used without testing.

## PART 3 - EXECUTION

### 3.1 SEDIMENT RUNNOFF DEVICE

- A. Construct temporary sediment runoff device as indicated and in accordance with manufacturer's written instructions.

### 3.2 CONSTRUCTION ENTRANCE

- A. Place geotextile over the entire area receiving stone. Lap geotextile a minimum of 24 inches at joints. Embed end of filter fabric in soil as indicated. Place aggregate at location(s) shown so that all traffic leaving the site will pass over the aggregate.
- B. All surface water flowing or diverting toward construction entrances shall be diverted away from road. A mountable berm with 5:1 slopes will be permitted.
- C. Wheels shall be cleaned to remove sediment prior to entrance onto public rights-of-way. When washing is required, it shall be done on an area stabilized with stone and which drains into an approved sediment trapping device. All sediment shall be prevented from entering storm drains, ditches or water courses.

### 3.3 TEMPORARY EROSION SEEDING

- A. Immediately after earth disturbance cease in an area, seed all earthwork areas with temporary seed mixture to prevent erosion; maintain until "final grading and seeding" is performed.
- B. Site Preparation
  1. Install needed surface water control measures. Perform all cultural operations at right angles to the slope. Apply uniformly two tons of ground limestone per acre (92 pounds per 1,000 square feet) or according to agricultural soil test results.
  2. Apply uniformly a 10-20-10 analysis fertilizer, according to soil test, at the rate of 400 pounds per acre (9.2 pounds per 1,000 square feet). Work in lime and fertilizer to a depth of 4 inches using any suitable equipment.

3. Apply temporary grass seed at a rate of one to two pounds per 1,000 sq. ft. Cover annual rye grass with about 1/2-inch of soil.
4. Additional seeding will be required until substantial catch of grass can be acquired and maintained.

### 3.4 MULCHING

- A. Place mulch, of the kind indicated, within 48 hours after seeding. Unless otherwise indicated, place only straw or wood cellulose over topsoil areas. Use hay, straw or wood cellulose in other areas, as indicated or specified.
- B. Place hay or straw uniformly, in a continuous blanket, at a minimum rate of 1,200 pounds per 1,000 square yards, or as otherwise indicated. If directed, increase the rate of application, depending upon the material used, season, soil conditions, or method of application. An acceptable mechanical blower may be used to apply mulch. Machines which cut mulch into short pieces will not be permitted. Anchor with acceptable materials at the following rates.
  1. Wood Cellulose, 160 pounds per 1,000 square yards.
  2. Non-asphaltic Emulsion, 25 pounds per 1,000 square yards.
  3. Chemical Mulch Binders, at manufacturers recommended rates.
- C. Hydraulically apply wood cellulose fiber. It may be incorporated as an integral part of the slurry after the seed and soil supplements have been thoroughly mixed. Apply uniformly at the rate of 320 pounds per 1,000 square yards, unless otherwise indicated.

### 3.5 MAINTENANCE

- A. General
  1. The Contractor shall monitor performance of sediment control measures. The Contractor shall inspect at 30 day intervals or following a rainfall, whichever is sooner. The Contractor shall remove all silt accumulation in the sediment control structures.
  2. Lawn and critical slope areas shall be monitored at weekly intervals. Any bare or eroded areas will be re-established as required. Should isolated areas repeatedly resist stabilization, Contractor shall contact local County Conservation District for assistance.
- B. Stabilized Construction Entrance
  1. The entrance shall be maintained by the Contractor in a condition which will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top dressing with additional stone as conditions demand and repair and/or clean out of any measures used to trap sediment. All sediment spilled, dropped, washed or tracked onto public rights-of-way must be removed immediately.

2. Periodic inspection and needed maintenance shall be provided by the Contractor after each rain.

C. Mulching

1. Properly maintain mulched areas until the entire project has been completed. Promptly re-apply mulch materials which become dislodged or lost due to wind, rain, fire or other causes, at initial or modified rates, as directed.

3.6 EROSION AND SEDIMENT POLLUTION CONTROL

- A. Construction operations shall be carried out in such a manner so that erosion, air and water pollution will be minimized. State and local laws concerning pollution abatement shall be followed.

**END OF SECTION 315513**

## SECTION 320516 - AGGREGATES FOR EXTERIOR IMPROVEMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes Aggregate Materials.
- B. Related Sections include the following:
  - 1. Division 32 Section "Earth Moving".
  - 2. Division 32 Section "Erosion Control."

#### 1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.
  - 1. ANSI/ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 2. ANSI/ASTM D1557 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures using 10 pound (4.54 Kg) Rammer and 18-inche (457 mm) Drop.
  - 3. ASTM D1883 – California Bearing Ratio (CBR) of Laboratory Compacted Soils
  - 4. ASTM D1556 – Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
  - 5. ASTM D2487 – Classification of Soils for Engineering Purposes.
  - 6. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 7. ASTM D3017 – Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.
  - 8. ASTM D4318 – Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition.
  - 1. AASHTO T180 – Moisture-Density Relations of Soils Using a 10-pound (4.54 Kg) Rammer and an 18-inches (457 mm) Drop.
  - 2. AASHTO M147 – Materials for Aggregate and Soil-Aggregate.

#### 1.4 QUALITY CONTROL

- A. Tests and analysis of aggregate material will be performed in accordance with standard ASTM and AASHTO procedures listed herein.

#### 1.5 SUBMITTALS

- A. Submit in air tight containers a sample of each aggregate or mixture that is to be incorporated into the project to the testing laboratory designated by the Owner. The amount of sample will depend upon the test(s) being performed. Coordinate with the testing laboratory.
- B. Submit the name of each material supplier and specific type and source of each material. Any change in source throughout the job requires approval of the Owner.
- C. Submit materials certificate to on-site independent geotechnical testing agency that is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. All construction and materials shall meet or exceed the requirements of this section and any state highway department specification section referred to or noted on the drawings that pertain to paving base course design, materials, preparation, and/or execution. All materials shall be as indicated on Drawings and shall comply with applicable state highway specification regarding source, quality, gradation, liquid limit, plasticity index, and mix proportioning.
- B. Subbase material for this project shall be PADOT 2A coarse crushed aggregate.

### PART 3 - EXECUTION

#### 3.1 STOCKPILING

- A. Stockpile onsite at locations indicated by the Owner in such a manner that there will be no standing water or mixing with other materials.

#### 3.2 TRANSPORTATION

- A. Off-site materials shall be transported to the project using well-maintained and operating vehicles. Once on the job site, all transporting vehicles shall stay on designated haul roads and shall at no time endanger any of the improvements by rutting, overloading or pumping the haul road.

### **END OF SECTION 320516**

## SECTION 320523 - CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes the following:

1. Preparation of subgrade to receive aggregate base course.
2. Place and compact aggregate base course materials.
3. Concrete pavement, clean-out pads, concrete envelopes, transformer pads, and other site related items indicated with reinforcement.
4. Surface finishing and application of curing materials.

- B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants of joints in concrete pavement and at isolation joints of concrete pavement with adjacent construction.

#### 1.3 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)/American Society for Testing and Materials (ASTM):

1. ANSI/ASTM A185 – Welded Steel Wire Fabric for Concrete Reinforcement.
2. ANSI/ASTM A615 – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
3. ANSI/ASTM C31 – Making and Curing Concrete Test Specimens in the Field.
4. ANSI/ASTM C33 – Concrete Aggregates.
5. ANSI/ASTM C94 – Ready-Mixed Concrete.
6. ANSI/ASTM C143 – Slump of Portland Cement Concrete.
7. ANSI/ASTM C150 – Portland Cement.
8. ANSI/ASTM C231 – Air Content of Freshly Mixed Concrete by the Pressure Method.
9. ANSI/ASTM C260 – Air-Entraining Admixtures for Concrete.  
ANSI/ASTM C309 – Liquid Membrane-Forming Compounds for Curing Concrete.
10. ANSI/ASTM D994 – Preformed Expansion Filler for Concrete.



- B. American Concrete Institute (ACI):
  - 1. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
  - 2. ACI 305 – Recommended Practice for Hot Weather Concreting.
  - 3. ACI 306 – Recommended Practice for Curing Concrete.
  - 4. ACI 347 – Recommended Practice for Concrete Formwork.
- C. Pennsylvania Department of Transportation, Standard Specifications, Publication 408, current edition.

#### 1.4 INSPECTION AND TESTING

- A. Inspection and testing of concrete shall be performed by an independent testing laboratory supplied and paid for by the Contractor.
- B. If tests indicate work does not meet specified requirements, remove work, replace and retest at no cost to Owner.
- C. Three concrete cylinder samples shall be taken in accordance with ANSI/ASTM C31 for every 100 or less cubic yards of concrete placed and at a minimum at least once daily for each design mix placed.
- D. One slump (ANSI/ASTM C143) and air content (ANSI/ASTM C231) test shall be taken for each 10 cubic yards of concrete placed, and whenever test cylinders are made.
- E. Concrete cylinder compressive strength testing shall be performed in accordance with the following schedule: Two cylinders, one broken at 7 days, one broken at 28 days and one extra cylinder broken if the design compressive strength requirements are not met at 28 days.

#### 1.5 SUBMITTALS

- A. Mix Design: Submit proposed mix design and obtain approval prior to commencement of concrete work.
- B. Ready-mix delivery tickets, ANSI/ASTM C94.
- C. Jointing Plan: Unless indicated, submit a jointing plan for review, prior to paving, clearly indicating types, spacing, and locations of joints.
- D. Accurately record the actual locations of embedded utilities and components which are concealed from view.

## 1.6 ENVIRONMENTAL REQUIREMENTS

### A. Allowable Concrete Temperatures:

1. Cold Weather: Conform to maximum and minimum requirements of ANSI/ASTM C94 and ACI 306.
  - a. Maintain protection against freezing for minimum 72 hours.
2. Hot Weather: Maximum concrete temperature of 90 degrees F. Conform to requirements of ANSI/ASTM C94 and ACI 305.
  - a. Prevent rapid drying during hot weather.

### B. Do not place concrete during rain, sleet, or snow unless protection to conform to ACI requirements is provided.

## PART 2 - PRODUCTS

### 2.1 AGGREGATE BASE COURSE

- #### A. Angular crushed natural stone or gravel; free from shale, clay and friable materials and debris; graded in accordance with PADOT Standard Specifications, Publication 408 for 2A aggregate:

<u>Sieve Size</u>	<u>% Passing</u>
2-inch	100
3/4-inch	52-100
3/8-inch	36-70
No. 4	24-50
No. 8	16-38
No. 16	10-30
No. 200	0-10

### 2.2 CONCRETE MATERIALS

- #### A. Concrete Ready-Mixed: Shall conform to requirements of ANSI/ASTM C94.
- #### B. Portland Cement: ANSI/ASTM C150, Type I, II, III or V. Coarse Aggregate: Conforming to requirements of PADOT.
1. Maximum aggregate size shall not be more than 1/4 the slab thickness or 3/4 - 1 inch, whichever is less.
- #### C. Fine Aggregate: Washed, hard sand complying with PADOT Specifications.

- D. Water: Potable, clean, and free from injurious amount of oil, alkali, organic matter, or other deleterious material, in accordance with ACI Specifications.
- E. Air Entrainment Admixture: Conform to ACI Specifications.
- F. Water: ASTM C 94.

## 2.3 REINFORCEMENT

- A. Reinforcing Steel: 60 ksi yield strength; deformed billet steel bars, conforming to PADOT Specifications.
- B. Welded Steel Wire Fabric: Plain type, conforming to PADOT Specifications; in flat sheets or rolls; plain finish; size as indicated.
- C. Tie Wire: Minimum 16 gauge annealed type, or patented system acceptable to Engineer.

## 2.4 FORMWORK AND ACCESSORIES

- A. Formwork: Matches, tight fitting and adequately stiffened to support weight of concrete without deflection detrimental to tolerance and appearance of concrete.
- B. Joint Filler
  - 1. 1/4-inch thick preformed asphalt for use in the construction of sidewalk slabs.
  - 2. In roadway pavement comply with the requirements of PADOT Publication 408, Section 705.
- C. Curing Compound: PADOT approved; dissipating type after curing cycle is complete (chemically breaks down after approximately 2 weeks and remaining film can be removed by brooming after an additional 3 to 4 weeks for linseed oil protection treatment).

## 2.5 CONCRETE MIX

- A. Mix concrete in accordance with requirement of ANSI/ASTM C94, only in quantities for immediate use.
- B. Paving/Slabs, and Other Site Related Items:
  - 1. Paving/Slabs: Cement Concrete mixed and proportioned to produce a minimum compressive strength of 4,000 psi after 28 days with a maximum slump of 3 inches and 4 to 6 percent air entrainment.

2. Other Site Related Items: Cement Concrete mixed and proportioned to produce a minimum compressive strength of 3,500 psi after 28 days with a maximum slump of 3 inches and 4 to 6 percent air entrainment.

C. Admixtures:

1. The use of admixtures is prohibited without prior approval.
2. Upon written approval, use accelerating admixtures in cold weather.
  - a. Use of admixtures shall not relax cold weather placement requirements.
  - b. Do not use calcium chloride.
3. Upon written approval use set-retarding admixtures during hot weather.

## PART 3 - EXECUTION

### 3.1 PREPARATION OF SUBGRADE

- A. Ensure rough grading has brought subgrade to required elevations, lines, grade, and cross sections indicated.
- B. All soft and yielding material and portions of the subgrade that will not compact readily when rolled or tamped shall be removed and replaced with suitable material.
- C. Bring subgrade to a firm and unyielding condition by compacting it to uniform density.
- D. Compact at or close to optimum moisture content.
- E. Concrete shall not be placed on a soft, spongy, frozen, otherwise unsuitable subgrade.

### 3.2 PLACEMENT OF AGGREGATE BASE COURSE

- A. Place and compact aggregate base course over prepared subgrade to lines, grade, and cross sections shown.
- B. All aggregate material in smaller areas shall be compacted with mechanical tampers to compacted depths indicated, in layers not over 4 inches. Extensive paving operations shall require rollers.

### 3.3 FORMING

- A. Form vertical surfaces to full depth and securely position to required lines and levels.
- B. Ensure form ties are not placed so as to pass through concrete.

- C. Arrange and assemble formwork to permit easy dismantling and stripping, and to prevent damage to concrete during formwork removal.

### 3.4 PLACING REINFORCING

- A. Reinforce concrete pavement, curbs, and other site related items as indicated, adequately supported and secured against displacement.
- B. Do not extend reinforcing through expansion and contraction joints, except where specifically shown or specified.
- C. Install steel bars and welded wire fabric in longest practical lengths.
- D. Lap and splice bars minimum 30 times diameter; lap wire fabric one full mesh minimum; tie splices with wire.
- E. Offset end laps in adjacent widths of wire fabric to prevent continuous laps.
- F. Keep reinforcement in its proper position during concrete replacement and operations.
- G. Provide dowelled joints through expansion and contraction joints in pavement and curbs where indicated, with one end of dowels fitted with capping sleeve to allow free movement.

### 3.5 ISOLATION, CONTROL AND CONSTRUCTION JOINTS

- A. Isolation Joints (expansion joints): Provide where concrete abuts permanent objects within paved area.
  - 1. Form isolation joint by use of pre-molded expansion joint material, full depth of concrete.
- B. Control Joints (contraction joints): Provide control joints for sectioning concrete into areas to eliminate shrinkage and thermal cracking.
  - 1. Form weakened-plane control joints to a depth equal to a minimum of 1/3 the concrete thickness, or as shown on the plans, as follows:
    - a. Tooled Joints: Form joints in fresh concrete, by hand grooving top portion using appropriate cutting tool and finishing edges with a jointer tool, while still plastic.
    - b. Sawed Joints: Form joints by using power saw equipped with shatterproof diamond-rimmed blades. Put joints into hardened concrete as soon as surface will not be torn, abraded, or otherwise damaged by the cutting action.

- C. Construction Joints: Provide at end of all pours when concreting operations are stopped for a period of more than two hour, except where such pours terminate at expansion joints.
  - 1. Form construction joints by use of wood formed or metal preformed keys.
- D. Provide joints with filler of required profiles, set perpendicular to longitudinal axis of pavement and curbs.
- E. Recess 1/4-inch below finished concrete surface.

### 3.6 PLACING CONCRETE

- A. Notify the Owner, a minimum of 24 hours, prior to commencement of concreting operations.
- B. Before placing concrete, ensure that:
  - 1. Freestanding water, snow, ice, or other foreign materials are removed.
  - 2. Subgrade is moist at time of concreting.
  - 3. All forms have been thoroughly cleaned, secured in position, and coated with a form-release agent.
- C. Ready mixed concrete hauled in truck mixers or truck agitators shall be deposited in place within 90 minutes from the time water is added to the mix.
- D. Place concrete, strike off, consolidate, and finish surfaces to plan grade, smooth and uniform, free of open texturing and exposed aggregate.
- E. Avoid working mortar to surface.
- F. Concrete pavement shall be pitched to area drains or perimeter areas for positive drainage.
- G. Provide control joints in pattern indicated, continuous across the slab, unless interrupted by full-depth premolded filler.
- H. All joints shall be completed before uncontrolled shrinkage cracking occurs.
- I. Round all edges, including edges of scored and expansion and contraction joints, with 3/8-inch radius edging tool.

### 3.7 CONCRETE FINISHING

- A. After concrete has been struck off and consolidated, a bullfloat may be used to remove any high or low spots.
  - 1. Bullfloat use shall be confined to a minimum.
- B. Provide exposed surface with a final skid-resistant finish accomplished by broom or burlap drag, alternate direction of finish on adjacent blocks, unless indicated or noted otherwise.
- C. Ensure finished surfaces do not vary from true lines, levels or grade by more than 1/8-inch in 10 feet when measured with straightedge.
- D. Apply curing compound on finished surfaces immediately after placement, in accordance with manufacturer's printed instructions and recommended procedures.

### 3.8 PROTECTION

- A. Concrete pavement shall be closed to pedestrian and/or vehicular traffic for not less than seven days after concrete is placed.
- B. In all cases approval must be obtained prior to opening of pavement to traffic.

**END OF SECTION 320523**

## SECTION 321216 - ASPHALT PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 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. Pavement-marking paint.

##### B. Related Sections:

1. Division 31 Section "Earth Moving" for aggregate subbase courses and for aggregate pavement shoulders.
2. Division 32 Section "Concrete Paving Joint Sealants" for joint sealants and fillers at paving terminations.

#### 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.
- 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 authorities having jurisdiction or the DOT of state in which Project is located.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of PADOT for asphalt paving work.
  - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- D. Pre-installation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
    - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
    - b. Review condition of subgrade and preparatory work.
    - c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
    - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

## 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. Tack Coat: Minimum surface temperature of 60 deg F.
  - 2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.
  - 3. 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 55 deg F for water-based materials, and not exceeding 95 deg F.

## 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.
- D. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

### 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.
- B. Asphalt Cement: ASTM D 946 for penetration-graded material.

- C. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- D. Water: Potable.

### 2.3 AUXILIARY MATERIALS

- A. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- B. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.
- C. Joint Sealant: ASTM D 6690, Type II or III, hot-applied, single-component, polymer-modified bituminous sealant.
- D. 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 three minutes.
  - 1. Color: White.
- E. 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 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction over the project.
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
    - a. Surface Course: 1/2 inch.
    - b. Binder Course: 1 1/2 inch.
    - c. Base Course: 2 inch.

## 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, repeating proof-rolling in direction perpendicular to first 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 Owner or representative, 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.

### 3.2 COLD MILLING

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
  - 1. Mill to a depth of 2 inches.
  - 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 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12-inches into adjacent sound pavement, unless otherwise indicated. Cut

excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal. /sq. yd.
  - 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.
- C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

### 3.4 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
  - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
  - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
  - 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.
  - 3. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

### 3.5 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.

### 3.6 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.

### 3.7 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.

### 3.8 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, 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.

### 3.9 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Surface Course: Plus  $\frac{1}{4}$  inch, no minus.
  - 2. Binder Course: Plus or minus  $\frac{1}{2}$  inch.

3. Base Course: Plus or minus ½ inch.
- 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: ¼ 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 ¼ inch.

### 3.10 PAVEMENT MARKING

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

### 3.11 WHEEL STOPS

- A. Install wheel stops in bed of adhesive as recommended by manufacturer.
- B. 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.

### 3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage and pay for 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.



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.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

### 3.13 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 321216**

## SECTION 321373 - CONCRETE PAVING JOINT SEALANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Expansion and contraction joints within cement concrete pavement.
  - 2. Joints between cement concrete and asphalt pavement.
- B. Related Sections include the following:
  - 1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
  - 2. Division 32 Section "Cement and Concrete for Exterior Improvements" for constructing joints in concrete pavement.

#### 1.3 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples in 1/2-inch wide joints formed between two 6-inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
  - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  - 2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
  - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  - 4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
  - 5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
- D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the Notice to Proceed with the Work.
  - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

## 1.6 PROJECT CONDITIONS

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

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.
- B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

### 2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

### 2.3 COLD-APPLIED JOINT SEALANTS

- A. Multi-component Jet-Fuel-Resistant Sealant for Concrete: Pourable, chemically curing elastomeric formulation complying with the following requirements for formulation and with ASTM C 920 for type, grade, class, and uses indicated:
  - 1. Urethane Formulation: Type M; Grade P; Class 12-1/2; Uses T, M, and, as applicable to joint substrates indicated, O.
    - a. Available Products:
      - 1) Pecora Corporation; Urexpan NR-300.

2. Coal-Tar-Modified Polymer Formulation: Type M; Grade P; Class 25; Uses T and, as applicable to joint substrates indicated, O.
    - a. Available Products:
      - 1) Meadows, W. R., Inc.; Sealtight Gardox.
  3. Bitumen-Modified Urethane Formulation: Type M; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
    - a. Available Products:
      - 1) Tremco Sealant/Waterproofing Division; Vulkem 202.
- B. Single-Component Jet-Fuel-Resistant Urethane Sealant for Concrete: Single-component, pourable, coal-tar-modified, urethane formulation complying with ASTM C 920 for Type S; Grade P; Class 25; Uses T, M, and, as applicable to joint substrates indicated, O.
1. Available Products:
    - a. Sonneborn, Div. of ChemRex, Inc.; Sonomeric 1.
- C. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
1. Available Products:
    - a. Crafcoc Inc.; RoadSaver Silicone.
    - b. Dow Corning Corporation; 888.
- D. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
1. Available Products:
    - a. Crafcoc Inc.; RoadSaver Silicone SL.
    - b. Dow Corning Corporation; 890-SL.
- E. Multicomponent Low-Modulus Sealant for Concrete and Asphalt: Proprietary formulation consisting of reactive petropolymer and activator components producing a pourable, self-leveling sealant.
1. Available Products:
    - a. Meadows, W. R., Inc.; Sof-Seal.

## 2.4 HOT-APPLIED JOINT SEALANTS

- A. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
  - 1. Available Products:
    - a. Crafcoc Inc.; Superseal 444/777.
    - b. Meadows, W. R., Inc.; Poly-Jet 3406.
- B. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
  - 1. Available Products:
    - a. Koch Materials Company; Product No. 9005.
    - b. Koch Materials Company; Product No. 9030.
    - c. Meadows, W. R., Inc.; Sealtight Hi-Spec.

## 2.5 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

## 2.6 PRIMERS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

### 3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of backer materials.
  - 2. Do not stretch, twist, puncture, or tear backer materials.
  - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses provided for each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

- E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealants from surfaces adjacent to joint.
  - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

#### 3.4 CLEANING

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

#### 3.5 PROTECTION

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

**END OF SECTION 321373**



## SECTION 321726 - TACTILE WARNING SURFACING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes cast-in-place detectable warning tiles for installation in new exterior concrete paving.

#### 1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Shop Drawings: Products specified showing fabrication details, composite structural system, tile surface profile, sound on cane contact amplification feature, and plans of tile placement including joints.
- C. Maintenance Instructions: Submit copies of manufacturer's specified installation and maintenance practices for Detectable Warning Tile and accessories as required.

#### 1.3 QUALITY ASSURANCE

- A. Americans with Disabilities Act Accessibility Guidelines (ADAAG): Provide materials that comply with detectable warnings on walking surfaces section of ADAAG (Title III Regulations, 28 CFR Part 36 ADA STANDARDS FOR ACCESSIBLE DESIGN, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's recommendations for delivery, storage, and handling procedures.
- B. Be suitably packaged or crated to prevent damage in shipment or handling. Protect finished surfaces by sturdy plastic wrappings to protect tile from concrete residue during installation and identify tile type by part number.
- C. Deliver to location at building site for proper storage prior to installation.

#### 1.5 WARRANTY

- A. Furnish manufacturer's standard written warranty against defective work, breakage, deformation, fading and loosening of tiles.

- B. Length of Warranty: Five years from date of substantial completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design: The design for the detectable warning tile is based on product as manufactured by Advantage Tactile Systems; Buffalo, NY; Telephone: 800-679-4022. Subject to compliance with requirements, provide the named product, a comparable product by an approved equal.

### 2.2 MATERIALS

- A. General: Stainless steel, with tiles having the following characteristics:
  1. Have an integral non-slip surface stamped into the stainless steel plate on the top of the domes and in the field surface between the domes.
  2. Have an ultra violet stabilized coating.
  3. Incorporate an in-line pattern of truncated domes measuring nominal 0.2 inch height, 0.9 inches base diameter, and 0.45 inch top diameter, spaced center-to-center 2.4 inch as measured on a diagonal and 1.7 inch as measured side by side.
  4. For wheelchair and high heel shoe safety the field area shall consist of an integral non-slip surface within the stainless steel plate that measures 0.03 inches above the adjacent surface.
  5. Sizes: 24 inch width by lengths as required, nominal.
- B. Performance Requirements:
  1. Slip Resistance - Wet and Dry Static Coefficients of Friction: Not to be less than 0.80 on top of domes and field area when tested by ASTM C 1028.
  2. Chemical Stain Resistance: Withstand saturated calcium chloride, red enamel spray paint, red lipstick, red wax crayon, black liquid ink, chewing gum, mustard, ketchup, urine, coffee, diesel fuel, asphalt, tobacco juice, hydraulic oil and motor oil without discoloration or staining when tested by ASTM D 543.
  3. Abrasive Wear: Average wear depth shall not exceed 0.010 after 1,000 abrasion cycles when measured on the top surface of the dome representing the average of three measurement locations per sample when tested by BYK - Gardener Tester ASTM D 2486 with reciprocating linear motion of 37± cycles per minute over a 10 inches travel. The abrasive medium, a 40 grit Norton Metallite sand paper, to be fixed and leveled to a holder. The combined mass of sled, weight and wood block shall be 3.2 lb.
  4. Abrasive Wear: Average wear index shall be a minimum of 480 after 1,000 abrasion cycles with ASTM C 501 parameters when measured on top surface of dome representing the average of four sample measurements when tested by

Taber Tester ASTM C 501 with H22 coarse Calibrade Wheels with each testing coupon weighed to the nearest 0.01 gram.

5. Gardner Impact to Geometry: Have a mean failure energy expressed as a function of specimen thickness of not less than 550 in. lbf/in. when tested by ASTM D 5420. A failure is noted when a crack is visible in coating or a 3mm depression on domes for coated tile.
6. Accelerated Weathering: Exhibit a result of  $-\Delta E < 2.6$ , as well as no deterioration, fading, or chalking of surface of federal yellow color tile (Federal No. 33538) when tested by ASTM G 155 for 3,000 hours.
7. Accelerated Aging and Freeze Thaw Test: Show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other detrimental defects when tested to ASTM D 1037.
8. Salt and Spray Performance: Show no deterioration or other defects after 1,000 hours of exposure when tested to ASTM B 117.
9. Tensile Bond Strength of Concrete Repair and Overlay Materials by Direct Pull-off Method: Be not less than 160 psi when tested by ASTM C 153.
10. Cracking Resistance: No failure up to 450 degrees Fahrenheit by thermal shock with breaches in coating when tested by ASTM C 554.
11. AASHTO HB-17 single wheel HS20-44 loading "Standard Specifications for Highways and Bridges". Exhibit no visible damage when Cast-In-Place Tile is mounted on a concrete platform and then subjected to specified maximum load of 10,400 lbs., corresponding to an 8,000 lb individual wheel load and a 30% impact factor.

C. Color: Dark Grey (Federal Color No. 36118).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of surfacing system materials.
- B. Report any discrepancies or unacceptable conditions that have been corrected. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Verify that shop drawings indicate that tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

### 3.2 PREPARATION

- A. Coordinate installation of detectable/tactile warning surface materials with installation of new concrete sidewalks and curbs provided under a Division 32 Section.

- B. Properly locate warning surface materials according to approved shop drawings and in compliance with ADAAG guidelines.
- C. During installation procedures, ensure adequate guidelines are in place and that they are in accordance with applicable industry and government standards.
- D. Prior to placement review manufacturer's and contract drawings.

### 3.3 INSTALLATION

- A. Install materials according to manufacturer's installation instructions.
- B. Leave factory-installed plastic sheeting in place during entire installation process to prevent splashing of concrete onto finished surface of tile.

### 3.4 PROTECTION AND CLEANING

- A. Protect tiles against damage during construction period to comply with manufacturer's specification.
- B. Clean tiles for inspection at substantial completion in each area of project. Clean tile by method specified by tile manufacturer.
- C. Comply with manufacturer's maintenance manual for cleaning and maintaining tile surface.

**END OF SECTION 321726**

## SECTION 329200 - TURF AND GRASSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. Section Includes:

- 1. Seeding.
- 2. Hydroseeding.
- 3. Planting soils.

- B. Related Sections:

- 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
- 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
- 3. Division 33 Section "Subdrainage" for subsurface drainage.

#### 1.3 REFERENCE STANDARDS

- A. Commonwealth of Pennsylvania Department of Transportation (PennDOT):

- 1. PENNDOT Standard 408.

- B. Pennsylvania Department of Environmental Protection (PADEP):

- 1. Clean Fill.
- 2. Stormwater Best Management Practices.

- C. American Society for Testing and Materials (ASTM):

- 1. ASTM C602 – Agricultural Liming Materials.

- D. Association of Official Analytical Chemists (AOAC):

- 1. AOAC – Official Method of Analysis.

- E. FS O-F-241 – Fertilizers, Mixed, Commercial.

#### 1.4 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Seed Mixes: From seed vendor for each monostand or mixture, stating the botanical and common name(s); 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 identifying source, including name and telephone number of supplier.
- C. Qualification Data: For Landscape Installer.
- D. Product Certificates: For soil amendments and fertilizers, signed by product manufacturer.
- E. Material Test Reports: For existing surface soil, and imported or manufactured topsoil.
- F. Planting Schedule: Indicating anticipated planting dates for each type of seeding.
- G. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of lawns and other seeded areas during a calendar year. Submit before expiration of required maintenance periods.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of lawns and seed mixes, of comparable size as scope as designed.

1. Installer's Field Supervisor: Require Installer to maintain an experienced full-time supervisor on Project Site when planting is in progress.
  - a. The field supervisor must ensure that sufficient planting soil has been provided and that the planting soil is of the quality and depth in accordance with the specifications.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of soil.
- D. Report suitability of soil for turf grass seeding, and rain garden mix growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil.
- E. Review fertilizer and mulch maintenance plans based on soil test results by qualified soil-testing laboratory or manufacturer.
- F. Fertilizer shall be in bags showing weight, analysis, and manufacturer's name.
- G. Source Limitations: Obtain each type of seed through one source from a single manufacturer.
- H. Provide seed mixtures in containers showing percentage of seed mix; producer's tests for purity and germination of seed, dated within nine months of sewing; net weight; date of packaging; and locations of packaging.
- I. Seed shall be clean, fresh, and shall be blue tagged certified. The seed must not contain more than 0.1% by weight weed seed, no more than 1.5% inert matter, no more than 0.1% other crop seed, and no noxious weed seed or undesirable grass species.
- J. Pre-installation Conference: Conduct conference at Project Site to discuss seeding operations and schedule.

## 1.7 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

- C. Comply with Commonwealth of Pennsylvania Department of Transportation standard specifications.
- D. All seed and seed labels shall be in accordance with State and Federal laws, rules and regulations including Article 9, Section 137, of the Agricultural and Markets Law.
- E. Posting Requirements: Comply with PA Department of Agriculture requirements for posting relative to application of herbicides and pesticides. Coordinate scheduling and execution of posting with Owner.
- F. Comply with Pennsylvania DEP "Clean Fill" requirements.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.
- B. Fertilizer: Deliver in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- C. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

#### 1.9 SCHEDULING

- A. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Seeding operations shall be performed in a timely fashion, at the discretion of the Contractor, because it is their responsibility to establish a healthy, weed free stand of growth for the lawns, and rain garden areas.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit. Do not perform seeding operations when wind velocity exceeds 5 mph.

#### 1.10 LAWN / SLOPE / SWALE MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:



1. Seeded Lawns / Slopes / Swales: 60 days from date of Substantial Completion.
  - a. When full maintenance period has not elapsed before end of planting season, or if seeding is not fully established, continue maintenance during next planting season.
- B. Maintain and establish seeded areas by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
  1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn 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. Water seeded areas at a minimum rate of 1 inch per week.
  3. Keep soil moist during seed germination period.
  4. The above watering schedule is a minimum and may be changed at the discretion of the Owner according to climatic conditions.
- D. Mowing: Mow lawn as soon as top growth is 3 inches tall (exception: see mowing requirements for Formula L below). Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent 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 lawn grass to 2 inches high.
  2. Mow Formula L areas to 6 inches high (no lower), not more than two mowing cycles per year. Per PA DOT Publication 13M (DM-2).
- E. Reworking and reseeding of any areas that fail to show a uniform stand of grass shall be done at the Contractor's expense with the same mixture applied at the rate originally used and repeated until all areas are covered with a satisfactory stand of turf grass.
- F. Make weekly inspections to determine the moisture content of the soil and adjust the watering schedule if necessary. Watering shall be done in such a manner and as frequently as is deemed necessary by the Owner to assure continued growth of healthy grass. All areas of the site shall be watered in such a way as to prevent erosion due to

excessive quantities applied over small areas, and to avoid damage to the finished surface due to the watering equipment.

- G. Reseed, fertilize and mulch areas larger than 5-inches by 5-inches not having uniform stand of grass.
- H. If any portion of the seeded surface becomes gullied or otherwise damaged following seeding, the affected areas shall be regraded and reseeded as specified herein.

#### 1.11 RAIN GARDEN SEEDING MAINTENANCE

- A. Begin maintenance immediately after each area is seeded and continue until acceptable growth is established, but for not less than the following periods:
  - 1. Rain garden areas: 60 days from date of Substantial Completion.
    - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
- B. Maintain and establish seed mixes by watering, weeding, trimming, replanting, and performing other operations as required to establish healthy viable, weed free vegetative cover. Roll, regrade, and replant bare or eroded areas and remulch. 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 meadow damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep meadow 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.
- C. Watering: Install and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep rain gardens and detention areas uniformly moist.
  - 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.
  - 1. Water rain gardens areas with fine spray at a minimum rate of 1/2 inch per week. Keep soil moist during seed germination period.
  - 2. The above watering schedule is a minimum and may be changed at the discretion of the Owner according to climatic conditions.

- D. Reworking and reseeding of any areas that fail to show a uniform stand of rain garden area mixes shall be done at the Contractor's expense with the same mixture applied at the rate originally used and repeated until all areas are covered with a satisfactory stand of vegetative cover.
- E. Make weekly inspections to determine the moisture content of the soil and adjust the watering schedule if necessary. Watering shall be done in such a manner and as frequently as is deemed necessary by the Owner to assure continued growth of healthy grasses and wildflowers. All areas of the site shall be watered in such a way as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to the finished surface due to the watering equipment.
- F. Reseed, fertilize and mulch areas larger than 5-inches by 5-inches not having a healthy and full stand of rain garden mixes.
- G. If any portion of the seeded surface becomes gullied or otherwise damaged following seeding, the affected areas shall be regraded and reseeded as specified herein.

#### 1.12 INSPECTION REQUIREMENTS

- A. Following list of minimal compliance standards are to be inspected and brought into compliance by Contractor during construction. Discovery and correction of non-complying work is the responsibility of Contractor. Contractor shall identify and correct all non-complying items prior to requesting the processing of the Certificate of Substantial Completion.
- B. Complying turf and grasses work shall be capable of withstanding dead and live loads under normal use.
- C. Non-complying work includes but is not limited to the following:
  - 1. Dead grass and wildflowers.
  - 2. Sparse grass (can see topsoil beneath 3-inch high mown grass).
  - 3. Erosion gullies with grass missing.
  - 4. Top soil not rolled prior to seeding

### PART 2 - PRODUCTS

#### 2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed.
- B. Seed Species: State-certified seed of grass species, as follows:

1. Temporary Seeding Grass. The temporary grass seed mixture shall be seeded at a rate of 1 pound per 1000 sf.

<u>Species</u>	<u>% By Weight</u>	<u>% Purity</u>	<u>% Germination</u>
Annual Ryegrass	100	98	90

2. Lawn Seed Mixture. (PennDOT Formula B). Seed at a rate of 5 pounds per 1000 sf.

<u>Species</u>	<u>% By Weight</u>	<u>% Purity</u>	<u>% Germination</u>
Kentucky Bluegrass Mixture* (Poa pratensis)	50	98	80
Perennial Ryegrass Mix- ture** (Lolium perenne)	20	98	90
Creeping Red Fescue or Spreading Fescue	30	98	85

\*A combination of improved certified varieties with no one variety exceeding 25% of the Bluegrass component.

\*\*A combination of improved certified varieties with no one variety exceeding 50% of the total Ryegrass component.

3. PennDOT Formula D. Seed at a rate of 21 pounds per 1000 sy.

<u>Species</u>	<u>% By Weight</u>	<u>% Purity</u>	<u>% Germination</u>
Tall Fescue (Festuca Arundinacea var. Kentucky 31)	70	98	85
Creeping Red Fescue or Chewings Fescue	30	98	85

4. PennDOT Formula L. Seed at a rate of 24 pounds per 1000 sy.

<u>Species</u>	<u>% By Weight</u>	<u>% Purity</u>	<u>% Germination</u>
Hard Fescue Mixture* (Festuca longifolia)	55	98	85
Creeping Red Fescue	35	98	85
Annual Ryegrass (Lolium Multiflorum)	10	98	90

\*A combination of improved certified varieties with no one variety exceeding 50% of the total Hard Fescue component.

5. Rain Garden Seed Mixture. Seed at a rate of 1/2 pound per 1000 sf.
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide ERNMX-180 as manufactured by Ernst Conservation Seed, a comparable product or an approved equal:

<u>Species</u>	<u>% By Weight</u>
Fox Sedge	13
Virginia Wild Rye	12
Fowl Bluegrass	11
Blue Vervain	9
Soft Rush	6
New England Aster	5
Golden Alexanders	5
Black Eyed Susan	4
Bottlebrush Grass	4
Common Sneezeweed	4
Zigzag Aster	4
Flat Topped White Aster	3
Ticklegrass (Rough Bentgrass)	3
Square Stemmed Monkey Flower	3
Tall White Beard Tongue	3
Showy Tick Trefoil	2
Wild Bergamot	2
Swamp Milkweed	2
Rough Avens	2
Ditch Stonecrop	1
Turtlehead	1
Seedbox	1

## 2.2 PLANTING SOIL

- A. Planting Soil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth. Planting soil shall be free of toxic and noxious substances harmful to plant life and growth, and in accordance with Pennsylvania DEP "Clean Fill" criteria.
  1. Reused surface soil stockpiled on-site: Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
    - a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

2. Imported topsoil or manufactured topsoil from off-site sources: Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
3. Amended existing in-place surface soil to produce topsoil: Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
  - a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

### 2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
  1. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
  2. Provide lime in form of dolomitic limestone.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- G. Sand: Clean, washed, natural or manufactured, free of toxic materials.
- H. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

### 2.4 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch

sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 20 to 30 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

## 2.5 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

## 2.6 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; percent of nitrogen and percent of phosphoric acid. Per soil test results.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  1. Commercial Composition: 10 percent nitrogen, 20 percent phosphorous, and 20 percent potassium, by weight, and ureaform 38 percent nitrogen.
  2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

## 2.7 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- weed and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley free of foreign matter detrimental to plant life.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 14 percent +/- 3%, pH range of 4.5 to 6.5, ash content 1.4 percent +/- 0.2 percent, and a 1,000 percent minimum water holding capacity.

- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors. Use natural gum blended with jelling and hardening agents (Terra Tack AR) as manufactured by Grass Growers Company or approved equal.
- D. Cut-back asphalt shall conform to PennDOT Standards.
- E. Other mulch binders as approved by the local County Conservation District and PA Department of Environmental Protection (PADEP).
- F. Mulch Nettings:
  - 1. Jute or excelsior blanket, paper, plastic and cotton mulch mattings of a kind and type approved by the local County Conservation District and the PADEP. Do not use metal staples in areas to be mowed.
    - a. Staples shall be as recommended by the netting manufacturer and local County Conservation District and the PADEP.
    - b. Other mulch nettings as approved by the local Conservation District and PADEP.
  - 2. Use SC150 erosion control matting by North American Green or an approved equal on all sloped areas greater than 3:1.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. 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.
  - 1. Protect adjacent and adjoining areas from seeding overspray.
- B. Provide 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.



### 3.3 LAWN / SLOPE / SWALE PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
  - 1. Spread planting soil mix to a depth of 4 inches at all disturbed areas, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread planting soil if subgrade is frozen, muddy, or excessively wet.
    - a. Spread approximately one-half the thickness of planting soil mix over loosened subgrade. Mix thoroughly into top 3 inches of subgrade. Spread remainder of planting soil mix.
  - 2. Apply soil amendments and fertilizer to surface and thoroughly blend planting soil mix.
    - a. Delay mixing fertilizer with planting soil if planting will not proceed within 2 days.
    - b. Apply lime if required by soil test at the rate recommended. Mix lime with dry soil before mixing fertilizer. Wait at least one full week after lime has been spread before applying fertilizer.
    - c. Add organic matter 1 inch deep (if required by soil test).
    - d. Till soil with a spike drag or rototiller and loosen surface at least 3 inches deep and then hand-rake to a smooth, even surface.
- C. Unchanged Subgrades: If lawns or other seed mixes are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
  - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
  - 2. Loosen surface soil to a depth of at least of 6 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 3 inches of soil. Till soil to a homogeneous mixture of fine texture.
    - a. Apply fertilizer in accordance with soil test results directly to surface soil before loosening.
  - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
  - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll

and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.

- E. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

### 3.4 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph, in adverse weather conditions, or when ground is wet or frozen. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow various seed mixtures at rates indicated in Section 2.1.
- C. Rake seed lightly into top 1/8-inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 3:1 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 3:1 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
  - 1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.
  - 2. Bond straw mulch by spraying with non-asphaltic tackifier at the rate recommended by the manufacturer. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

### 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.
  - 1. Mix slurry with nonasphaltic tackifier.
  - 2. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 1500 pounds/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.
  - 3. Apply slurry uniformly to all areas to be seeded in a two-step process. Apply first slurry application at a minimum rate of 500 pounds/acre dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1000 pounds/acre.

### 3.6 SATISFACTORY SEEDED AREAS

- A. Satisfactory Seeded Lawn, Slopes, Swales, and Rain Gardens: At end of maintenance period, a healthy, uniform, close stand of grass and vegetative cover 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.
- B. Reestablish any seeded areas that do not comply with requirements and continue maintenance until all seeded areas are satisfactory.

### 3.7 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Erect barricades and warning signs as required to protect newly planted areas from foot and vehicular traffic. Maintain barricades throughout maintenance period and remove after lawn is established.

**END OF SECTION 329200**

## SECTION 329300 - PLANTS

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Trees

B. Related Sections:

1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.
3. Division 32 Section "Turf and Grasses" for lawn and meadow planting.

#### 1.2 REFERENCES

A. American Joint Committee on Horticultural Nomenclature (AJCHN):

1. AJCHN Standardized Plant Names.

B. United States Department of Agriculture (USDA):

1. USDA Standards for Nursery Stock.

C. American Association of Nurserymen, Inc. (AAN).

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

1. ASTM C602 – Agricultural Liming Materials.

E. Association of Official Analytical Chemists (AOAC):

1. AOAC – Official Method of Analysis.

F. FS O-F-241 – Fertilizers, Mixed, Commercial.

### 1.3 DEFINITIONS

- A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.
- B. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.
- C. Finish Grade: Elevation of finished surface of planting soil.
- D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- E. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become planting soil; mixed with soil amendments.
- F. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
- G. Root Flare: The lower area of the tree trunk that needs to be exposed and not covered by soil or mulch after planting.

### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis for standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Qualification Data: For landscape Installer.
- D. Material Test Reports: For imported soil and for existing surface soil as requested.
- E. Planting Schedule: Indicating anticipated planting dates for exterior plants.
- F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plant materials during a calendar year. Submit before

expiration of required maintenance periods. Maintenance instructions shall be type-written.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when exterior planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Planting Soil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity, sodium absorption ratio, deleterious material; pH; and mineral and plant-nutrient content of soil.
  - 1. Report suitability of soil for plant growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory planting soil.
- D. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."
- E. Tree and Shrub Measurements: Measure according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes. Take caliper measurements 6 inches above ground for trees up to 4-inch caliper size, and 12 inches above ground for larger sizes. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip. Requirements for the measurement, branching, grading, quality, balling, and burlapping of plants in the plant list shall follow the code of standards currently recommended by the American Association of Nurserymen, Inc. in the American Standard for Nursery Stock, amended to date.
- F. Observation: Owner shall observe trees and shrubs either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Owner retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project Site.
  - 1. Notify Owner of sources of planting materials seven days in advance of delivery to site.

2. All plants shall equal or exceed the measurements specified in the plant list, which are minimum acceptable sizes.
- G. Pre-installation Conference: Conduct conference at Project site to discuss installation and schedule.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not prune trees and shrubs before delivery, except as approved by Owner. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.
- B. Handle planting stock by root ball.
- C. Deliver exterior plant materials after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plant materials and trees in shade, protect from weather and mechanical damage, and keep roots moist.
1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  2. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.
  3. Remove any excess soil over the plant root flare.

## 1.7 COORDINATION

- A. Planting Restrictions: Unless the ground is frozen, plants can be planted at most times of the year if proper care is used. Ultimately, the Contractor is responsible for the initial survivability of the plants. However, caution should be exercised when transplanting flowering plants after they bloom and certain plants in the fall. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit. Do not install plants when average wind speeds exceed 15 mph.
- C. Coordination with Lawns: Plant trees after finish grades are established and before planting lawns.
1. When planting trees after lawns, protect lawn areas, and promptly repair damage caused by planting operations.

## 1.8 WARRANTY

- A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.
1. Warranty Period for Trees: One year from date of Substantial Completion.
  2. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season. All replacements shall be the same genus, species and size as the original.
  3. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
  4. A limit of one replacement of each exterior plant will be required, except for losses or replacements due to failure to comply with requirements.

## 1.9 MAINTENANCE

- A. Trees: Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease.
1. Maintenance Period: One year from date of Substantial Completion.
- B. No spraying of herbicides, insecticides, fungicides, nematicides, fumigants or other chemicals shall be done without first submitting a spray program to the Owner for approval. After approval, application will only be permitted by licensed applicators. Applicators should follow Notification Requirements and consult any Chemical Hypersensitivity Registries for the area.

## PART 2 - PRODUCTS

### 2.1 TREE MATERIAL

- A. General: Furnish nursery-grown trees complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Grade: Provide tree of sizes and grades complying with ANSI Z60.1 for type of trees required. Tree of a larger size may be used if acceptable to Owner, with a proportionate increase in size of roots or balls.



- C. Label each tree with securely attached, waterproof tag bearing legible designation of botanical and common name.
- D. Label at least one tree of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.
- E. If formal arrangements or consecutive order of trees is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

## 2.2 SHADE AND FLOWERING TREES

- A. Shade Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, complying with ANSI Z60.1 for type of trees required.
  - 1. Provide balled and burlapped or container-grown trees as indicated.
  - 2. Branching Height: One-third to one-half of tree height.
- B. Small Upright Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
  - 1. Stem Form: Single stem.
  - 2. Provide balled and burlapped or container-grown trees as indicated.
- C. Multistem Trees: Branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1; stem form as follows:
  - 1. Stem Form: Clump or multistem; number of canes as indicated.
  - 2. Provide balled and burlapped or container-grown trees as indicated.

## 2.3 CONIFEROUS EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required, complying with ANSI Z60.1.
- B. Form and Size: Specimen-quality, exceptionally heavy, tightly knit, symmetrically shaped coniferous evergreens and the following grade:
  - 1. Provide balled and burlapped or container-grown trees as indicated.

## 2.4 PLANTING SOIL

- A. Planting Soil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 6 percent organic material content; free of stones 1-inch or larger in any dimension and other extraneous materials harmful to plant growth.
1. Reused surface soil stockpiled on-site. Verify suitability of stockpiled surface soil to produce planting soil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
    - a. Supplement with imported or manufactured topsoil from off-site sources when quantities are insufficient. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
  2. Imported topsoil or manufactured topsoil from off-site sources: Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.
  3. Amended existing in-place surface soil to produce topsoil: Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
    - a. Surface soil may be supplemented with imported or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes.

## 2.5 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
1. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
  2. Provide lime in form of dolomitic limestone.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.

- F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- G. Sand: Clean, washed, natural or manufactured, free of toxic materials.
- H. Diatomaceous Earth: Calcined, diatomaceous earth, 90 percent silica, with approximately 140 percent water absorption capacity by weight.
- I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

## 2.6 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 50 to 60 percent of dry weight.
  - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.
- C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

## 2.7 FERTILIZER

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent of phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight and 16-8-16 analysis controlled release for trees, shrubs and ground covers.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

## 2.8 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees, consisting of one of the following:
  - 1. Type: Double-shredded hardwood bark.
  - 2. Color: Dark brown.

## 2.9 STAKES AND GUYS

- A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 2 by 2 inches by length indicated, pointed at one end.
- B. Guy and Tie Wire: ASTM A 641, Class 1, galvanized-steel wire, 2-strand, twisted, 0.106 inch in diameter.
- C. Guy Cable: 5-strand, 3/16-inch- diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3-inches long, with two 3/8-inch galvanized eyebolts.
- D. Hose Chafing Guard: Reinforced rubber or plastic hose at least 1/2-inch in diameter, black, cut to lengths required to protect tree trunks from damage.
- E. Flags: Standard surveyor's plastic flagging tape, white, 6-inches long.

## 2.10 MISCELLANEOUS PRODUCTS

- A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

## 2.11 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with the following soil amendments and fertilizers in the following quantities, as applicable to planting material.
1. Ratio of Loose peat to Topsoil by Volume: 1:3.5.
  2. Weight of aluminum sulfate 1 lb. per 20 sq. ft. for broadleaf evergreen.
  3. Weight of Bonemeal per 4 lbs. for flowering shrubs.
  4. Weight of Superphosphate: 1/4 cup superphosphate per each bushel of planting soil for deciduous trees.
  5. Weight of slow release commercial fertilizer per 2 pounds of 20-10-5 per inch of tree diameter of the tree trunk and 16-8-16 analysis controlled release for trees, shrubs and vines.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.
- B. Provide 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. Lay out individual tree locations and areas for multiple exterior plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner's acceptance of layout before planting. Make minor adjustments as required.
- D. Lay out exterior plants at locations shown on plans or as directed by Owner. Stake locations of individual trees and outline areas for multiple plantings.
- E. Upon delivery to the site, all nursery stock shall be planted at once. If this is not feasible, plants shall be heeled in with roots well covered. Protect plants from the sun and wind, and keep roots moist. During the planting operations, the nursery stock shall not be exposed to the sun or to drying wind.

- F. Apply antidesiccant to trees using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
  - 1. If deciduous trees are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.

### 3.3 TREE EXCAVATION

- A. All plant pits shall be excavated to the depth of the existing root ball and planted on undisturbed soil. All construction debris such as plaster, concrete, stone, brick, and wood shall be removed.
- B. Pits and Trenches: Excavate circular pits with vertical sides. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
  - 1. Excavate approximately two times the diameter of root ball diameter for balled and burlapped or container grown stock.
- C. Subsoil removed from excavations may be used as backfill.
- D. Obstructions: Notify Owner if unexpected rock or obstructions detrimental to trees are encountered in excavations.
  - 1. Hardpan Layer: Drill 6-inch diameter holes into free-draining strata or to a depth of 10-feet, whichever is less, and backfill with free-draining material.
- E. Drainage: Notify Owner if subsoil conditions evidence unexpected water seepage or retention in tree or shrub pits.
- F. Fill excavations with water and allow to percolate away before positioning trees.

### 3.4 TREE PLANTING

- A. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
  - 1. Remove burlap, wire baskets, or other bindings from tops of root balls and partially from sides, but do not remove from under root balls. All rot-proof, rot resistant, plastic burlap shall be removed before planting. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no

more water is absorbed. Water again after placing and tamping final layer of planting soil mix. Fill remainder of hole with loose planting soil without further packing. Provide a soil berm around the edge of each plant pit to form a shallow saucer.

- B. Set balled stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.
  - 1. Carefully remove root ball from container without damaging root ball or plant.
  - 2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix. Fill remainder of hole with loose planting soil without further packing. Provide a soil berm around the edge of each plant pit to form a shallow saucer.
- C. Organic Mulching: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of planting pit or trench. Do not place mulch within 6 inches of trunks or stems.

### 3.5 TREE PRUNING

- A. Prune, thin, and shape trees as directed by Owner.
- B. Prune, thin, and shape trees according to standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise indicated by Owner, do not cut tree leaders; remove only injured or dead branches from flowering trees.

### 3.6 GUYING AND STAKING

- A. Upright Staking and Tying: Stake trees of 2-inch through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip-out. Use a minimum of 2 stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend at least 72 inches above grade. Set vertical stakes and space to avoid penetrating root balls or root masses. Support trees with two strands of tie wire encased in hose sections at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree. Use the number of stakes as follows:
  - 1. Use 2 stakes for trees up to 12 feet high and 2 1/2-inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
- B. Guying and Staking: Guy and stake trees exceeding 14-feet in height and more than 3-inches in caliper, unless otherwise indicated. Securely attach no fewer than three guys to stakes 30-inches long, driven to grade.

1. For trees more than 6 inches in caliper, anchor guys to pressure-preservative-treated deadmen 8 inches in diameter and 48 inches long buried at least 36 inches below grade. Provide turnbuckles for each guy wire and tighten securely.
2. Attach flags to each guy wire, 30 inches above finish grade.
3. Paint turnbuckles with luminescent white paint.

### 3.7 CLEANUP AND PROTECTION

- A. During exterior planting, keep adjacent pavement and construction clean and work area in an orderly condition.
- B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

### 3.8 DISPOSAL

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

### 3.9 FINAL COMPLETION

- A. At the end of the maintenance period and prior to final inspection, the Contractor shall remove remaining tags from plant materials, shall remove plant saucers from around plants on level terrain, shall cut smooth edge between planting areas and lawn areas and shall restore and top-dress all mulched areas.
- B. At the end of the warranty period, inspection will be made by the Owner and the Contractor. Any plant required under this contract that is dead or not in satisfactory growth, as determined by the Owner, shall be removed from the site and replaced at the Contractor's expense. Replace these plants as soon as conditions permit during a normal planting season.

**END OF SECTION 329300**



## SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping joining materials.
  - 2. Piped utility demolition.
  - 3. Piping system common requirements.

#### 1.3 DEFINITIONS

- A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
- B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

## PART 2 - PRODUCTS

### 2.1 PIPING JOINING MATERIALS

- A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

## PART 3 - EXECUTION

### 3.1 PIPED UTILITY DEMOLITION

- A. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
  - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - 2. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
  - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 PIPING INSTALLATION

- A. Install piping according to the following requirements and Division 33 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
- C. Install piping at indicated slopes.

- D. Install piping free of sags and bends.
- E. Install fittings for changes in direction and branch connections.
- F. Verify final equipment locations for roughing-in.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 33 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

**END OF SECTION 330500**

## SECTION 334100 - STORM UTILITY DRAINAGE PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes gravity-flow, non-pressure storm drainage outside the building, with the following components:
  - 1. Cleanouts.
  - 2. Drains.
  - 3. Precast concrete manholes.

#### 1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene-monomer rubber.
- C. LLDPE: Linear low-density, polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Non-pressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least soil-tight, unless otherwise indicated.

#### 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Drains.
  - 2. Channel drainage systems.

- B. Shop Drawings: For the following:
  - 1. Manholes: Include plans, elevations, sections, details, and frames and covers.
  - 2. Catch Basins and Stormwater Inlets. Include plans, elevations, sections, details, and frames, covers, and grates.
  - 3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames and covers, and design calculations.
- C. Field quality-control test reports.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.
- D. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide HDPE products by one of the manufacturers specified with soiltight joints:
    - A. Advanced Drainage Systems, Inc: "ADS N-12", phone: 800/733-9554.
    - B. Hancor, Inc: "Hi-Q", phone: 800/847-5880.
    - C. Lane Enterprises: "Type S", phone: 717/249-8342
- B. PE PIPE AND FITTINGS
  - 1. Corrugated PE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.
    - A. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
  - 2. Corrugated PE Pipe and Fittings NPS 12 to NPS 48: AASHTO M 294M, Type S, with smooth waterway for coupling joints.

- A. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

## 2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

## 2.3 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  - 1. Diameter: 48 inches minimum, unless otherwise indicated.
  - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  - 3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  - 4. Riser Sections: 4-inch minimum thickness and lengths to provide depth indicated.
  - 5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  - 6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  - 7. Resilient Pipe Connectors: ASTM C 923 cast or fitted into manhole walls, for each pipe connection.
  - 8. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on 1 step (16") and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 40 inches.
  - 9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
  - 10. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
  - 11. Manhole Frames and Covers: Ferrous; 30-inch ID by 7 to 9-inch riser with 4-inch minimum width flange and 30-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
    - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.

## 2.4 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 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. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

## 2.5 CATCH BASINS

- A. Standard Precast Concrete Catch Basins: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
  2. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
  3. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  4. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  5. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
  6. Grade Rings: Include 2 or 3 reinforced-concrete rings, of 6- to 9-inch total thickness, that match frame and grate.
  7. Steps: Individual FRP steps or FRP ladder ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step (16") and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 40 inches.
  8. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
- B. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.

1. Size: 24 by 24 inches minimum, unless otherwise indicated.
  2. Grate Free Area: Approximately 50 percent, unless otherwise indicated.
- C. Frames and Grates: ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch- diameter flat grate with small, square or short-slotted drainage openings.
1. Grate Free Area: Approximately 50 percent, unless otherwise indicated.

## 2.6 STORMWATER INLETS

- A. Gutter Inlets (PADOT Type M): Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
- B. Combination Inlets (PADOT Type C): Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
- C. Frames and Grates: Heavy-duty frames and grates according to utility standards.

## 2.7 PIPE OUTLETS

- A. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap Basins: Broken, irregular size and shape, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
  1. Average Size: NSSGA No. R-4, screen opening 3 inches or as required on the drawings.
- C. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size, graded stone, or as required.
- D. 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 Division 31 Section "Earth Moving."



### 3.2 PIPING APPLICATIONS

- A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
  - 1. Use non-pressure-type flexible couplings where required to join gravity-flow, non-pressure sewer piping, unless otherwise indicated.
    - a. Shielded flexible couplings for same or minor difference OD pipes.
- B. Gravity-Flow, Non-pressure Sewer Piping: Use the following pipe materials for each size range:
  - 1. NPS 3: Corrugated PE drainage pipe and fittings, soil-tight couplings, and coupled joints.
  - 2. NPS 4 and NPS 6: Smooth lined, corrugated PE drainage pipe and fittings, soil-tight couplings, and coupled joints.
  - 3. NPS 8 to NPS 12: Smooth lined, corrugated PE drainage pipe and fittings in NPS 8 and NPS 10 and corrugated PE pipe and fittings in NPS 12, soil-tight couplings, and coupled joints.
  - 4. NPS 18 to NPS 36: Smooth lined, corrugated PE pipe and fittings, soil-tight couplings, and coupled joints.

### 3.3 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 design considerations into account. 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. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- F. Install gravity-flow, non-pressure drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
  - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
  - 3. Install piping with 36-inch minimum cover or as shown on the drawings.
  - 4. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."

### 3.4 PIPE JOINT CONSTRUCTION

- A. Basic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, non-pressure drainage piping according to the following:
  - 1. Join corrugated PE piping according to CPPA 100 and the following:
    - a. Use soil-tight couplings for Type 2, soil-tight joints.
  - 2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
  - 3. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
  - 4. Join dissimilar pipe materials with non-pressure-type flexible or rigid couplings.
- C. Join dissimilar pipe materials with pressure-type couplings.

### 3.5 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  - 1. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.
- B. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade.

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

### 3.6 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections according to ASTM C 891.
- C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 1-inch above finished surface elsewhere, unless otherwise indicated.

### 3.7 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.
- C. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- D. Construct riprap of broken stone, as indicated.
- E. Install outlets that spill onto grade, anchored with concrete, where indicated.
- F. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- G. Construct energy dissipaters at outlets, as indicated.

### 3.8 CONCRETE PLACEMENT

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

### 3.9 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24-inches 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. Crushed, broken, cracked, or otherwise damaged piping.
3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  4. Re-inspect 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 authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate report for each test.
  5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Exception: Piping with soil-tight joints 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. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### 3.10 CLEANING

- A. Clean interior of piping of dirt and superfluous materials.

**END OF SECTION 334100**

## SECTION 334600 - SUBDRAINAGE

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract.

#### 1.2 SUMMARY

- A. This Section includes subdrainage systems for the following:
  - 1. Site areas designated on the drawings.

#### 1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. HDPE: High-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PP: Polypropylene plastic.
- E. PVC: Polyvinyl chloride plastic.
- F. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

#### 1.4 SUBMITTALS

- A. Product Data: For the following:
  - 1. Perforated-wall pipe and fittings.
  - 2. Solid-wall pipe and fittings.
  - 3. Geotextile filter fabrics.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 2.2 PIPING MATERIALS

- A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

### 2.3 PERFORATED-WALL PIPES AND FITTINGS

- A. Perforated HDPE Pipe and Fittings:
  - 1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
  - 2. NPS 8 and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
  - 3. Couplings: Manufacturer's standard, band type.
- B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

### 2.4 SOLID-WALL PIPES AND FITTINGS

- A. PE Drainage Tubing and Fittings: AASHTO M 252, Type S, corrugated, with smooth waterway, for coupled joints.
  - 1. Couplings: AASHTO M 252, corrugated, band type, matching tubing and fittings.
- B. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.

1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.
- C. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.
1. Gaskets: ASTM F 477, elastomeric seal.

## 2.5 SPECIAL PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.
1. Sleeve Materials:
    - a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - b. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

## 2.6 CLEANOUTS

- A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.
- B. Copper-Alloy Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing with clamping device; and scoriated, Medium-Duty Loading class, copper-alloy cover. Include countersunk, brass cleanout plug.

## 2.7 SOIL MATERIALS

- A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

## 2.8 GEOTEXTILE FILTER FABRICS

- A. Description: Fabric of polypropylene, polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.
1. Structure Type: Nonwoven, needle-punched continuous filament or woven, monofilament or multifilament.
  2. Style(s): Flat and sock.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

### 3.3 PIPING APPLICATIONS

- A. Underground Subdrainage Piping:
  - 1. Perforated HDPE pipe and fittings, couplings, and coupled joints.
  - 2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.
- B. Header Piping:
  - 1. HDPE drainage tubing and fittings, couplings, and coupled joints.
  - 2. PVC sewer pipe and fittings, couplings, and coupled joints.

### 3.4 CLEANOUT APPLICATIONS

- A. In Underground Subdrainage Piping:
  - 1. At Grade in Earth: Cast-iron cleanouts.
  - 2. At Grade in Paved Areas: Cast-iron cleanouts.

### 3.5 DRAINAGE INSTALLATION

- A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.



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

### 3.6 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - 1. Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
  - 2. Lay perforated pipe with perforations down.
  - 3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install PE piping according to ASTM D 2321.
- D. Install PVC piping according to ASTM D 2321.

### 3.7 PIPE JOINT CONSTRUCTION

- A. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."
- B. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
- C. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.
- D. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.
- E. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

### 3.8 CLEANOUT INSTALLATION

- A. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:
  - 1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - 2. In vehicular-traffic areas, use NPS 4 cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
  - 3. In nonvehicular-traffic areas, use NPS 4 cast-iron pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches in depth. Set top of cleanout plug 1 inch above grade.

### 3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.

### 3.10 FIELD QUALITY CONTROL

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

### 3.11 CLEANING

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

**END OF SECTION 334600**