

SECTION 311000
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 MATERIAL OWNERSHIP

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

1.3 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- E. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

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

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site according to drawings.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

3.4 EXISTING UTILITIES

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

3.5 CLEARING AND GRUBBING

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

3.6 TOPSOIL STRIPPING

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

3.7 SITE IMPROVEMENTS

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

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

- B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 312000
EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

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

1.2 QUALITY ASSURANCE

- A. Referenced Standards: Unless otherwise indicated, all referenced standards shall be the latest edition available at the time of bidding. Any requirements of these Specifications shall in no way invalidate the minimum requirements of the referenced standards. Comply with the provisions of the following codes and standards, except as otherwise shown in Geotechnical Report – Proposed GTC-Benson Campus Amphitheater and Student Plaza prepared for: Grimbball Cotterill Landscape Architects by GS2 Engineering. GS2 Project# 18-1931-G, dated May 9, 2018.

1. ASTM D 698 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb. Rammer and 12 inch Drop
2. ASTM D 3282 Recommended Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes

- B. Soil Testing and Inspection: All compaction tests of all fill areas will be made by an Owner-provided testing agency. The testing agency to be contracted directly with owner for their services, but coordination of all of their work shall be the responsibility of the contractor

- C. Rework any fill areas which fail to meet the compaction requirements as herein specified and perform this work at no additional cost to the Owner. Testing of fill areas will be provided by the Owner, except that tests which reveal nonconformance with the Specifications and all succeeding tests for the same area, until conformance with the Specifications is established, shall be at the expense of the Contractor

1.3 DEFINITIONS

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

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

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

- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
 - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 - 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock Excavation and Ripping Criteria: Removal and disposal of rock material and obstructions encountered that cannot be removed by the following heavy-duty rock excavating equipment without systematic drilling, blasting, or ripping. Rock material includes boulders 1 cu. yd. or more in volume and rock in beds, ledges, unstratified masses, and conglomerate deposits.
 - 1. Massive Rock Excavation: Where partially weathered rock may be encountered, these materials will require pre-loosening with a large bulldozer, such as a Caterpillar D8R, or equivalent, equipped with a single tooth ripper. Any material that cannot be excavated with a single tooth ripper drawn and occupying an original volume of at least one cubic yard shall be classified as rock excavation.
 - 2. Trench Excavation: Any material that cannot be excavated with a Caterpillar 315C or equivalent, and occupying an original volume of at least 1 cubic yard or more.
 - 3. Limited Excavation: Any material that cannot be excavated with a large front end loader, such as a Caterpillar 953C or equivalent.
- I. 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.
- J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 PROJECT CONDITIONS

- A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth moving operations.
- B. Do not commence earth moving operations until plant-protection measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.
 - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.
- F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.
- G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
- H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- I. Flowable Fill: Self-compacting, low-density, flowable concrete material produced from the followings:
 - 1. Portland Cement: ASTM C 150, Type I, Type II, or Type III.
 - 2. Fly Ash: ASTM C 618, Class C or F.

3. Normal-Weight Aggregate: ASTM C 33, 3/8-inch nominal maximum aggregate size.
4. Water: ASTM C94/C 94M.
5. Air-Entraining Admixture: ASTM C 260.

2.2 ACCESSORIES

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

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, pavements, other obstructions visible on surface, underground structures, utilities, and other items indicated to be demolished or removed; together with soil and other materials encountered that are not classified as rock or unauthorized excavation. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions. Intermittent drilling or ripping to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation.
 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
- B. Rock Excavation
 1. Do not excavate rock until it has been classified and quantities verified by Testing Firm. Rock excavation must be performed under the supervision of the testing firm.
 2. Notify the Engineer upon encountering rock or similar material which cannot be removed or excavated by conventional earth moving or ripping equipment.
 3. Do not use explosives without written permission from the Engineer.

4. When explosives are permitted, use only experienced powdermen or person who are licensed or otherwise authorized to use explosives. Store, handle and use explosives in strict accordance with all regulatory bodies and the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc.
5. The Contractor shall be solely responsible for any damage resulting from the use of explosives.
6. The Contractor shall be solely responsible for securing all permits required in performing this work.

3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
 1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

3.4 EXCAVATION FOR WALKS AND PAVEMENTS

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

3.5 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit.
 1. Clearance: The width of trench excavation for pipe shall be equal to the pipe diameter plus 16 inches.
- C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
 1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material, 4 inches deeper elsewhere, to allow for bedding course.
- D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.6 SUBGRADE INSPECTION

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

3.7 UNAUTHORIZED EXCAVATION

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

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 finished grade including, where applicable, sub drainage, damp proofing, waterproofing, and perimeter insulation.
 2. Testing and inspecting underground utilities.
 3. 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. Trenches under Footings: After installing and testing, completely encase piping or conduit in polyethylene wrap and backfill with flowable fill to bottom of footings.
- D. Trenches under Roadways: After installing and testing, completely encase piping or conduit in polyethylene wrap and backfill with flowable fill to within 4-inches of surface of roadways. Remaining 4-inches shall be of specified base course and surface course for roadway system.
- E. Place and compact initial backfill of subbase material or bedding course material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
 - 1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
- F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 SOIL FILL

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

3.12 SOIL MOISTURE CONTROL

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

3.13 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
 - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 18 inches of existing subgrade and each layer of backfill or fill soil material at 98 percent.
 - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 90 percent.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at 98 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. Fill low spots and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
 - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
 - 2. Walks: Plus or minus 1/2 inch.
 - 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch.

3.15 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
 - 1. Shape subbase course and base course to required crown elevations and cross-slope grades.
 - 2. Place subbase course and base course (that exceeds 6 inches in compacted thickness) in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 98 (subbase) and 100 (base course) percent of maximum dry unit weight according to ASTM D 698.

3.16 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

- A. Place drainage course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 1. Place drainage course (that exceeds 6 inches in compacted thickness) in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
 2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 98 percent of maximum dry unit weight according to ASTM D 698.

3.17 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall provide results of field tests and inspections.
- B. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. When testing reports indicate that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

- A. Use of Vibratory Rollers or Other Vibratory Equipment: The Owner has performed a Base Line Study of nearby structures and improvements as a basis of determining damage caused by project compaction and construction operations. A copy of the Base Line Study will be provided to the successful Bidder/Contractor. Contractor shall be aware of the possible impact of vibratory compaction to existing structures and site improvements during construction operations. The Contractor shall perform vibration monitoring during construction compaction operations and adjust operations in a manner that negates and minimizes impact damage and/or risk in the event that compaction activities have a negative physical impact on existing facilities and improvements.
- B. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- C. 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.
- D. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION

SECTION 312500

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY: Work outlined in this section includes:

- A. Installation of silt barriers such as silt fence.
- B. Installation of sediment tubes and rock check dams.
- C. Seeding for the purpose of slope stabilization or erosion control.
- D. Installation of rip-rap for slope stabilization.
- E. Removal of erosion control devices.

1.2 REFERENCED STANDARDS

- A. South Carolina State Department of Transportation (SCDOT): Standard Specification for Highway Construction, 2007 Edition.
- B. South Carolina Code of Regulations, Chapter 72, Article 2 (Erosion & Sediment Reduction & Stormwater Management Regulations)
- C. Guide to Site Development and Best Management Practices for Storm Water Management and Sediment Control (SCLRCC).
- D. South Carolina DHEC Storm Water Management BMP Handbook, August 2005 Edition.
- E. Greenville County Stormwater Management Design Manual, January 2018 Edition.

1.3 SUBMITTALS

- A. Proposed materials to be employed, for siltation control and preventing erosion damage shall be submitted for approval. Submittals shall include a list of proposed materials including manufacturer's product data.

1.4 EROSION CONTROL PRINCIPLES: The following erosion control principles shall apply to the land grading and construction phases:

- A. Stripping of vegetation, grading, or other soil disturbance shall be done in a manner which will minimize soil erosion.
- B. Whenever feasible, natural vegetation shall be retained and protected.
- C. Extent of area which is exposed and free of vegetation shall be kept within practical limits.

- D. Temporary seeding, mulching, or other suitable stabilization measures shall be used to protect exposed critical areas during prolonged construction or other land disturbance.
 - E. Drainage provisions shall accommodate increased runoff resulting from modifications of soil and surface conditions during and after development or disturbance. Such provisions shall be in addition to existing requirements.
 - F. Sediment shall be retained on-site.
 - G. Erosion control devices shall be installed as early as possible in the construction sequence prior to start of clearing and grubbing operations and excavation work.
 - H. Cut and fill slopes and stockpiled materials shall be protected to prevent erosion. Slopes shall be protected with permanent erosion protection when erosion exposure period is expected to be greater than or equal to two (2) weeks, and temporary erosion protection when erosion exposure period is expected to be less than two (2) weeks.
 - I. Permanent erosion protection shall be accomplished by seeding with grass and covering with an erosion protection material, as appropriate for prevailing conditions.
 - J. Temporary erosion protection shall be accomplished by covering with erosion protection materials, as appropriate for prevailing conditions.
 - K. Except where specified slope is indicated on Drawings, fill slopes shall be limited to a grade of 2:1 (horizontal: vertical) cut slopes shall be limited to a grade of 1.5:1.
- 1.5 SECTION DESCRIPTION: Provide all equipment and materials, and do all work necessary to construct a complete erosion and sediment control program for minimizing erosion and siltation during the construction phase of the project. The Contractor shall provide additional erosion and sediment control materials and methods as required to affect the erosion and siltation control principles specified herein.

PART 2 - PRODUCTS:

- 2.1 SILT FENCE: Silt fence shall consist of woven filter fabric attached to steel posts with wire or nylon ties. Fence shall be a minimum of two (2) ft. high measured from the ground surface, and shall have eight (8) inches of the woven fabric embedded in the ground per the details on the plans. The posts shall be five (5) feet long 1.25 lb per foot steel "T" section fence posts with stabilization plate spaced welded to the post near the bottom. Posts shall be installed at a maximum of six (6) feet apart. Filter fabric shall be selected from one of the products listed on SCDOT's Qualified Products List 34, or an approved equal.
- A. Filter fabric shall be one of the following, or approved equal:

<u>Product</u>	<u>Manufacturer</u>
MIRAFI Silt Fence	MIRAFI, Charlotte, NC 28224
 - B. Silt fence shall be supported by steel posts, driven a minimum of 18 inches. into the ground. Posts shall be spaced 6 ft. o.c. maximum.

- C. Fencing other than that specified above shall be subject to review and acceptance by the Engineer.
- 2.2 TEMPORARY SEED COVER: Grass seed for temporary seed cover shall be previous year's crop. Not more than 0.5% by weight shall be weed seed and not more than 1.75% by weight crop seed. Seed shall be delivered to site in sealed containers, labeled with name of seed grower and seed formula, in form stated below. Seed shall be dry and free of mold. Seed shall meet the requirements of SCDOT Standard Specifications Sections 810.03 and 810.04 for temporary vegetation.
- A. Seed for temporary seed cover shall conform to the following requirements:
- 1 All seed must meet the requirements of the state seed laws including the labeling requirements for showing pure live seed, (PLS - purity x germination), name and type of seed.
 - 2 Seed furnished shall be of the previous season's crop and the date of analysis shown on each bag shall be within nine months of the time of use on the project. Each variety of seed shall be furnished and delivered in separate bags or containers.
 - 3 A sample of each variety of seed shall be furnished for analysis and testing when directed by the Architect/Engineer. The amount and type of seed planted per acre shall be as specified below.
 - 4 All seed shall be treated with fungicide approved by the Engineer.
 - 5 Seed application rate shall conform to SCDOT Standard Specifications Section 810.04.
- 2.3 RIP-RAP: Rip-rap shall consist of hard quarry of field stone and shall be of such quality that it will be resistant to exposure to the action of water and air. Stone shall consist of well graded mixture of 6" to 8" stone.
- 2.4 SEDIMENT TUBE: Sediment tubes shall be a minimum of 10 feet long, 12 inches in diameter and shall conform to the material and installation requirements in SCDOT Standard Specifications including 80% Total Suspended Solids filtering efficiency performance measured per ASTM D5141 or ASTM D7351.
- 2.5 CHECK DAM: Check dams may be placed in swale and ditch sections to reduce velocities and erosion. Check dams shall consist of 12 inch or hand placed sized rip rap. The Contractor shall place the stone at locations shown on the plans and in other areas as approved by the Engineer where erosion occurs. The check dams shall be cleaned and otherwise maintained by the Contractor on a regular basis.

PART 3 - EXECUTION

- 3.1 TEMPORARY SEED COVER: Grass seed shall be spread by mechanical spreader at the specified rate. Following seeding, area shall be lightly raked to mingle seed with the top 1/8 to 1/4 in. of soil. Areas shall then be smoothed and rolled.

- A. Following rolling, entire area shall be watered until equivalent of a 2 in. depth of water has been applied to entire seeded surface, at a rate which will not dislodge seed. Watering shall be repeated thereafter as frequently as required to prevent drying of surface, until grass attains an average height of 1-1/2 in.
 - B. At the Contractor's option, seed may be spread by the hydroseeding method, utilizing power equipment commonly used for that purpose. Seed and mulch shall be mixed and applied to achieve application quantities specified herein for the conventional seeding method, with mulch applied at the rate of 2700 lb. dry weight of mulch per acre. A mulching machine, acceptable to the Engineer, shall be equipped to eject the thoroughly wet mulch material at a uniform rate to provide the mulch coverage specified. Other provisions specified above for conventional seeding shall apply to hydroseeding.
 - 1 If the results of hydroseeding application are unsatisfactory, the mixture and/or application rate and methods shall be modified to achieve the required results.
 - 2 After the grass has appeared, all areas and parts of areas which fail to show a uniform stand of grass, for any reason whatsoever, shall be re-seeded and such areas and parts of areas seeded repeatedly until all areas are covered with a satisfactory growth of grass.
- 3.2 SILT FENCE: Silt fence shall be constructed and installed as shown on the plans, prior to start of clearing and grubbing operations.
- 3.3 MAINTENANCE AND REMOVAL OF EROSION CONTROL DEVICES: Wetland areas, water courses, and drainage swales adjacent to construction activities shall be monitored twice each month for evidence of silt intrusion and other adverse environmental impacts, which shall be corrected immediately upon discovery.
- 3.4 CULVERTS AND DRAINAGE DITCHES: shall be kept clean and clear of obstructions during construction period.
- 3.5 EROSION CONTROL DEVICES:
- A. Sediment behind the erosion control device shall be checked twice each month and after each heavy rain. Silt shall be removed if greater than 6 in. deep.
 - B. Condition of erosion control device shall be checked twice each month or more frequently as required. Damaged and/or deteriorated items shall be replaced. Erosion control devices shall be maintained in place and in effective condition.
 - C. Sediment tubes shall be inspected frequently and maintained or replaced as required to maintain both their effectiveness and essentially their original condition. In ditch applications, underside of tubes shall be keyed into the earth below at all times, as required to prevent water from washing beneath bales. At gutter inlet applications, tubes shall be properly held in place by weigh, blocks, or other acceptable means to prevent tubes from shifting.
 - D. Sediment deposits shall be disposed of off-site, in a location and manner which will not cause sediment nuisance elsewhere.
- 3.6 REMOVAL OF EROSION CONTROL DEVICES:

- A. Erosion control devices shall be maintained until all disturbed earth has been paved or vegetated, at which time they shall be removed. After removal, areas disturbed by these devices shall be re-graded and seeded.
- B. Erosion protection material shall be kept securely anchored until acceptance of completed slope or entire Project, whichever is later.

END OF SECTION

SECTION 315000

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 INFORMATIONAL SUBMITTALS

- A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.3 FIELD CONDITIONS

- A. 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
 - 1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

PART 3 - EXECUTION

3.1 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 at locations indicated on Drawings and secure to soldier piles.

3.2 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. 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.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.3 TIEBACKS

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

3.4 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 Architect.
 - 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.

3.5 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
 - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

- B. Leave excavation support and protection systems permanently in place.

END OF SECTION

SECTION 321216

HOT-MIXED ASPHALT PAVING

PART 1 - GENERAL

- 1.1 This Section includes provisions for Type C hot-mixed asphalt paving over prepared sub-base.
- 1.2 Proof rolling of prepared sub-base is included in this Section.
- 1.3 Submittals: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
 - A. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.
 - B. Pavement marking plan indicating lane separations and defined parking spaces. Note dedicated handicapped spaces with international graphics symbol.
- 1.4 Site Conditions
 - A. Weather Limitations: Apply prime and tack coats when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (1 deg C) for 12 hours immediately prior to application. Do not apply when base is wet or contains an excess of moisture.
 - B. Construct hot-mixed asphalt surface course when atmospheric temperature is above 40 deg F (4 deg C) and when base is dry. Base course may be placed when air temperature is above 30 deg F (minus 1 deg C) and rising.

PART 2 – PRODUCTS

- 2.1 Grade Control: Establish and maintain required lines and elevations.
- 2.2 Materials: Use locally available materials and gradations that exhibit a satisfactory record of previous installations.
 - A. Coarse Aggregate: Sound, angular crushed stone, or crushed gravel.
 - B. Fine Aggregate: Sharp-edged natural sand or sand prepared from stone.
 - C. Asphalt Cement: ASTM D 3381 for viscosity-graded material; ASTM D 946 for penetration-graded material.
 - D. Prime Coat: Cut-back asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.
- 2.3 Herbicide Treatment: Commercial chemical for weed control, registered and approved for this use by Environmental Protection Agency. Provide granular, liquid, or wettable powder form. Lane Marking Paint: Alkyd-resin type, ready-mixed complying with AASHTO M 248, Type I.

Colors Required:	White. (for parking)
	Yellow. (for no parking)
	Blue. (for handicapped)
- 2.4 Wheel Stops: 2,500-psi compressive strength precast, air-entrained concrete, approximately 5 inches high, 8 inches wide, and 7 feet long. Provide chamfered corners and drainage slots on underside.
- 2.5 Asphalt-Aggregate Mixture: Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with ASTM D 3515 and as recommended by local paving authorities to suit project conditions.

PART 3 – EXECUTION

- 3.1 Surface Preparation: Remove loose material from compacted sub-base surface immediately before applying herbicide treatment or prime coat.

- A. Proof-roll prepared sub-base surface to check for unstable areas and areas requiring additional compaction.
- B. Notify Architect of unsatisfactory conditions. Do not begin paving work until deficient sub-base areas have been corrected and are ready to receive paving.
- 3.2 Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry sub-base prior to application of prime coat.
- 3.3 Prime Coat: Apply at rate of 0.25 to 0.30 gal. per sq. yd., over compacted sub-grade. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile. Allow to dry until at proper condition to receive paving.
- 3.4 Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and/or clean damaged surfaces.
- 3.5 Placing Mix: Place hot-mixed asphalt mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 225 deg F. Place areas inaccessible to equipment by hand. Place each course to required grade, cross-section, and compacted thickness.
- 3.6 Paver Placing: Place in strips not less than 10 feet wide, unless otherwise acceptable to Architect/Engineer. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete base course for a section before placing surface course.
 - A. Immediately correct surface irregularities in finish course behind paver. Remove excess material forming high spots with shovel or lute.
- 3.7 Joints: Make joints between old and new pavements, or between successive days' work, to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of hot-mixed asphalt course. Clean contact surfaces and apply tack coat.
- 3.8 Rolling: Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
 - A. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling, if required, with hot material.
 - B. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been evenly compacted.
 - C. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained 95 percent laboratory density.
- 3.9 Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.
- 3.10 Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
 - A. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
- 3.11 Cleaning: Sweep and clean surface to eliminate loose material and dust.
- 3.12 Striping: Use chlorinated-rubber base traffic lane-marking paint, factory-mixed, quick-drying, and non-bleeding. Do not apply traffic and lane marking paint until layout and placement have been verified with Architect/Engineer. Apply paint with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates to provide minimum 12 to 15 mils dry thickness.

- 3.13 Wheel Stops: Secure wheel stops to hot-mixed asphalt surface with not less than two 3/4-inch-diameter galvanized steel dowels embedded in pre-cast concrete at 1/ 3 points. Size length of dowel to penetrate at least 1/2 hot-mixed asphalt depth.
- 3.14 Field Quality Control: Testing in-place hot-mixed asphalt courses for compliance with requirements for thickness and surface smoothness will be done by the Architect's testing laboratory.
- A. Repair or remove and replace unacceptable paving as directed by Architect/Engineer.
- 3.15 Thickness: In-place compacted thickness tested in accordance with ASTM D 3549 will not be acceptable if exceeding following allowable variations:
- A. Base Course: Plus or minus 1/2 inch.
- B. Surface Course: Plus or minus 1/4 inch.
- 3.16 Surface Smoothness - Texture: Finished surface shall be smooth and free from irregularities in texture such as voids, honeycombs and exposed coarse aggregate to provide a consistently smooth and blemish free appearance. Only closed surface pavement will be accepted. Ponding will not be accepted.
- 3.17 Surface Smoothness: Test finished surface of each hot-mixed asphalt course for smoothness, using 10-foot straightedge applied parallel with and at right angles to centerline of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:
- A. Base Course Surface: 1/4 inch.
- B. Wearing Course Surface: 3/16 inch.
- 3.18 Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

END OF SECTION

SECTION 321313

PORTLAND CEMENT CONCRETE PAVING

PART 1 - GENERAL

- 1.1 This Section includes exterior portland cement concrete paving for the following:
 - A. Parking lots.
 - B. Parking apron/loading dock.
 - C. Material storage area.
 - D. Curbs and gutters.
 - E. Walkways.
- 1.2 Submittals:
 - A. Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- 1.3 Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, joint systems, curing compounds, dry-shake finish materials, and others if requested by Architect/Engineer.
- 1.4 Design mixes for each class of concrete. Include revised mix proportions when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
- 1.5 Laboratory test reports for evaluation of concrete materials and mix design tests.
- 1.6 Quality Assurance
 - A. Concrete Standards: Comply with provisions of the following standards, except where more stringent requirements are indicated.
 1. American Concrete Institute (ACI) 301, "Specifications for Structural Concrete for Buildings"
 2. ACI 318, "Building Code Requirements for Reinforced Concrete"
 3. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice"
 4. South Carolina State Department of Transportation (SCDOT): Standard Specification for Highway Construction, Latest Edition.
 - B. Concrete Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.
 - C. Concrete Testing Service: Utilize the Architect's testing agency to perform materials evaluation tests and to design concrete mixes.

PART 2 – PRODUCTS

- 2.1 Forms
 - A. Form Materials: Plywood, metal, metal-framed plywood, or other acceptable panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - B. Use flexible or curved forms for curves of a 100-foot or less radius.
 - C. Form Release Agent: Use water, vegetable or soy based form release agent containing low or no volatile organic compounds (VOC) in lieu of petroleum based form release agents.
- 2.2 Reinforcing Materials
 - A. Reinforcing Bars and Tie Bars: ASTM A615, Grade 60, deformed.

- B. Welded Steel Wire Fabric: ASTM A185, furnished in flat sheets, not rolls, unless otherwise acceptable to Architect/Engineer.
- C. Joint Dowel Bars: Plain steel bars, ASTM A615, Grade 60. Cut bars true to length with ends square and free of burrs.
- D. Supports for Reinforcement: Chairs, spacers, dowel bar supports and other devices for spacing, supporting, and fastening reinforcing bars, welded wire fabric, and dowels in place. Use wire bar-type supports complying with CRSI specifications.
- E. Use supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 Concrete Materials

- A. Portland Cement: ASTM C150, Type I, use one brand of cement throughout Project unless otherwise acceptable to Architect/Engineer.
- B. Fly Ash: ASTM C618, Type F.
- C. Normal-Weight Aggregates: ASTM C33, Class 4, and as follows. Provide aggregates from a single source.
- D. Maximum Aggregate Size: 1-1/2 inches, do not use fine or coarse aggregates that contain substances that cause spalling.
- E. Local aggregates not complying with ASTM C33 that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Architect/Engineer.

2.4 Water: Potable.

2.5 Admixtures: Provide concrete admixtures that contain not more than 0.1 percent chloride ions.

- A. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
- B. Water-Reducing Admixture: ASTM C494, Type A.
- C. High-Range Water-Reducing Admixture: ASTM C494, Type F or Type G.
- D. Water-Reducing and Accelerating Admixture: ASTM C494, Type E.
- E. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
- F. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Air-Entraining Admixture: Darex AEA or Daravair; W.R. Grace & Co.
MB-VR or Micro-Air; Master Builders, Inc.
Sika AER; Sika Corp.
 - 2. Water-Reducing Admixture: WRDA; W.R. Grace & Co.
Pozzolith Normal or Polyheed; Master Builders, Inc.
Plastocrete 161; Sika Corp.
 - 3. High-Range Water-Reducing Admixture: WRDA 19 or Daracem; W.R. Grace & Co.
Rheobuild or Polyheed; Master Builders, Inc.
Sikament 300; Sika Corp.
 - 4. Water-Reducing and Accelerating Admixture: Daraset; W.R. Grace & Co.
Pozzutec 20; Master Builders, Inc.
 - 5. Water-Reducing and Retarding Admixture: Daratard-17; W.R. Grace & Co.
Pozzolith R; Master Builders, Inc.

Plastiment; Sika Corporation.

2.6 Curing Materials

- A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- B. Moisture-Retaining Cover: One of the following, complying with ASTM C171.
 - 1. Waterproof paper.
 - 2. Polyethylene film.
 - 3. White burlap-polyethylene sheet.
- C. Clear Solvent-Borne Liquid Membrane-Forming Curing Compound: ASTM C309, Type I, Class A or B, wax free.
- D. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
- E. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Clear Solvent-Borne Liquid Membrane-Forming Curing Compound:
 - a. Masterkure; Master Builders, Inc.
 - b. Kure-N-Seal; Sonneborn-Chemrex.
 - c. Horn Clear Seal; Tamms/A.C. Horn.
 - 2. Clear Waterborne Membrane-Forming Curing Compound:
 - a. Masterkure 100W; Master Builders, Inc.
 - b. Kure-N-Seal WB; Sonneborn-Chemrex.
 - c. Horncure 100; Tamms/A.C. Horn.
 - 3. Evaporation Control: Confilm; Master Builders, Inc., or approved equal.

2.7 Related Materials

- A. Bonding Agent: Acrylic or styrene butadiene.
- B. Epoxy Adhesive: ASTM C881, two-component material suitable for dry or damp surfaces. Provide material type, grade, and class to suit requirements.
- C. Available Products: Subject to compliance with requirements, products that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Bonding Agent:
 - Daraweld C; W.R. Grace & Co.
 - Acryl-Set; Master Builders Inc.
 - Sonocrete; Sonneborn-Chemrex.
 - 2. Epoxy Adhesive:
 - Concresive Standard Liquid; Master Builders, Inc.
 - Sikadur 32 Hi-Mod; Sika Corp.
 - Epoxitite Binder 2390; Tamms/A.C. Horn, Inc.

PART 3 – EXECUTION

3.1 Concrete Mix

- A. Prepare design mixes for each type and strength of normal-weight concrete by either laboratory trial batch or field experience methods as specified in ACI 301. For the trial batch method, use the Architect's testing agency for preparing and reporting proposed mix designs.
- B. Use only Owner's field quality-control testing agency as the independent testing agency.

- C. Limit use of fly ash to 25 percent of cement content by weight.
- D. Proportion mixes according to ACI 211.1 and ACI 301 to provide normal-weight concrete with the following properties:
 - 1. Compressive Strength (28-Day): 3500 psi: Loading Area Aprons
 - 2. Compressive Strength (28-Day): 3000 psi: Curb & Curb, Walkways
- E. Maximum Water-Cement Ratio at Point of Placement: 0.45.
- F. Slump Limit at Point of Placement: 3 inches.
- G. Slump limit for concrete containing high-range water-reducing admixture (super plasticizer): Not more than 8 inches after adding admixture to site-verified 2 -to-3-inch slump concrete.
- H. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content as follows with a tolerance of plus or minus 1- 1/2 percent:
Air Content: 5.5 percent for 1-1/2-inch maximum aggregate.

3.2 Concrete Mixing

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C94.
- B. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- C. Surface Preparation: Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.
- D. Remove loose material from compacted subbase surface immediately before placing concrete.
- E. Edge Forms And Screed Construction: Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for paving to required lines, grades, and elevations. Install forms to allow continuous progress of work and so that forms can remain in place at least 24 hours after concrete placement. Check completed formwork and screeds for grade and alignment to following tolerances:
 - 1. Top of Forms: Not more than 1/8 inch in 10 feet.
 - 2. Vertical Face on Longitudinal Axis: Not more than 1/4 inch in 10 feet.
- F. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

3.3 Placing Reinforcement: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for placing and supporting reinforcement.

- A. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- B. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- C. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 Joints: Construct contraction, construction, and isolation joints true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to the centerline, unless indicated otherwise.

- A. **Contraction Joints:** Provide weakened-plane contraction joints, sectioning concrete into areas as shown on Drawings. Construct contraction joints for a depth equal to at least 1/4 of the concrete thickness, as follows:
- B. **Tooled Joints:** Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a radiused jointer tool.
- C. **Sawed Joints:** Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into hardened concrete when cutting action will not tear, abrade, or otherwise damage surface and before development of random contraction cracks.
- D. **Inserts:** Form contraction joints by inserting premolded recycled rubber expansion joint (equal to ASTM D1752) strips into fresh concrete until top surface of strip is flush with paving surface. Radius each joint edge with a jointer tool. Carefully remove strips or caps of two-piece assemblies after concrete has hardened. Clean groove of loose debris.
- E. **Construction Joints:** Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than 1/2 hour, unless paving terminates at isolation joints.
- F. Continue reinforcement across construction joints unless indicated otherwise. Do not continue reinforcement through sides of strip paving unless indicated.
- G. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- H. **Isolation Joints:** Form isolation joints of Recycled Rubber Expansion Joint equal to ASTM D1752 abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
- I. Locate expansion joints at intervals of 50 feet, unless indicated otherwise.
- J. Extend joint fillers full width and depth of joint, not less than 1/2 inch or more than 1 inch below finished surface where joint sealant is indicated. Place top of joint filler flush with finished concrete surface when no joint sealant is required.
- K. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.
- L. Protect top edge of joint filler during concrete placement with a metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
- M. **Joint Schedule:**

Expansion:	Every 50 feet for walkways
Contraction:	Every 10 feet for walkways unless indicated on drawings
	Every 20 feet for loading aprons unless indicated on drawings

3.5 Concrete Placement:

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcing before placing concrete. Do not place concrete on surfaces that are frozen.
- C. Moisten subbase to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements and with ACI 304R for measuring, mixing, transporting, and placing concrete.

- E. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- F. When concrete placing is interrupted for more than 1/2 hour, place a construction joint.
- G. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- H. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete complying with ACI 309R.
- I. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcing, dowels, and joint devices.
- J. Screed paved surfaces with a straightedge and strike off. Use bull floats or darbies to form a smooth surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces prior to beginning finishing operations.
- K. Curbs And Gutters: When automatic machine placement is used for curb and gutter placement, submit revised mix design and laboratory test results that meet or exceed requirements. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete.
- L. Cold-Weather Placement: Comply with provisions of ACI 306R and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- M. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
- N. Do not use frozen materials or materials containing ice or snow.
- O. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- P. Hot-Weather Placement: Place concrete complying with ACI 305R and as specified when hot weather conditions exist.
- Q. Cool ingredients before mixing to maintain concrete temperature at time of placement to below 90 deg F. Mixing water may be chilled or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
- R. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
- S. Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 Concrete Finishing:

- A. Float Finish: Begin floating when bleed water sheen has disappeared and the concrete surface has stiff granular texture.
- B. Burlap Finish: Drag a seamless strip of damp burlap across concrete, perpendicular to line of traffic, to provide a uniform gritty texture finish.
- C. Medium-To-Fine-Textured Broom Finish: Draw a soft bristle broom across concrete surface perpendicular to line of traffic to provide a uniform fine line texture finish.

- D. Medium-To-Coarse-Textured Broom Finish: Provide a coarse finish by striating surface 1/16 inch to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.
- E. Final Tooling: Tool edges of paving, gutters, curbs, and joints formed in fresh concrete with a jointing tool to the following radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.

Radius: 1/4 inch.

3.7 Concrete Protection And Curing: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with the recommendations of ACI 306R for cold weather protection and ACI 305R for hot weather protection during curing.

- A. Evaporation Control: In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply according to manufacturer's instructions after screeding and bull floating, but before floating.
- B. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- C. Curing Methods: Cure concrete by moisture curing, moisture- retaining-cover curing, curing compound, or a combination of these as follows:
- D. Moisture Curing: Keep surfaces continuously moist for not less than 7 days with the following materials:
- E. Water: Continuous water-fog spray. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with a 12-inch lap over adjacent absorptive covers.
- F. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- G. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.8 Field Quality Control Testing: Utilize the Owner's testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. The Contractor will utilize the Architect's testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include the following:

- A. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
- B. Slump: ASTM C143; one test at point of placement for each compressive-strength test but no less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
- C. Air Content: ASTM C231, pressure method; one test for each compressive-strength test but no less than one test for each day's pour of each type of air-entrained concrete.
- D. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F (4 deg.C) and below and when 80 deg F (27 deg.C) and above, and one test for each set of compressive-strength specimens.
- E. Compression Test Specimens: ASTM C31; one set of four standard cylinders for each compressive-strength test, unless directed otherwise. Mold and store cylinders for laboratory-cured test specimens except when field-cured test specimens are required.
- F. Compressive-Strength Tests: ASTM C39; one set for each day's pour of each concrete class exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. Test one

- specimen at 7 days, test two specimens at 28 days, and retain one specimen in reserve for later testing if required.
- G. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
 - H. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - I. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi.
 - J. Test results will be reported in writing to Architect/Engineer, concrete manufacturer, and Contractor.
 - K. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
 - L. Additional Tests: The testing agency will make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect/Engineer. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. Testing of materials not in compliance with project requirements will be at the expense of the Contractor.
- 3.9 Repairs And Protection: Remove and replace concrete paving that is broken, damaged, or defective, or does not meet the requirements of this Section.
- A. Drill test cores where directed by Architect/Engineer when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to paving with epoxy adhesive.
 - B. Protect concrete from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
 - C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep concrete paving not more than 2 days prior to date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 331100
WATER DISTRIBUTION

PART 1 – GENERAL

- 1.1 GENERAL: These specifications apply to the installation of certain water mains, valves and appurtenances incident to the construction of water mains.
- A. Pipe work shall be installed at the locations shown on the plans and to the position, alignment and grade shown thereon, or in the event of grade conflict, as directed by the Engineer.
 - B. All pipe, special castings and fittings for water distribution shall be furnished in weights, classes, and/or thicknesses in accordance with specifications as outlined herein.
 - C. All materials furnished by the Contractor shall be delivered and distributed at the site by the Contractor.
 - D. Cast iron, fittings, valves, hydrants and accessories shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped.
 - E. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench.
 - F. Pipe shall be handled so that the coating and lining will not be damaged. If, however, the coating or lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Engineer.
 - G. The water main shall be laid and maintained to the required lines and grades with fittings, valves, and hydrants at the required locations, spigots centered in bells; and all valve and hydrant stems plumb.
 - H. The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined, and he shall be held responsible for the repair of such structures when broken or otherwise damaged.
 - I. All pipe shall be laid to the depth shown on the contract drawings. Any variation therefrom shall be made only at the order of the Engineer.
 - J. Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least six inches below and on each side of all pipe, valves, and fittings for pipes 24 inches in diameter or less, and nine inches for pipes larger than 24 inches in diameter. The specified minimum clearances are the minimum clear distances that will be permitted between any part of the pipe and appurtenances being laid and any part, projection, or point of such rock, boulder or stone.
 - K. The trench shall be dug so that the pipe can be laid to the alignment and depth required, and it shall be excavated only so far in advance of pipelaying as specified or permitted by the Engineer. The trench shall be so braced and drained that the workmen may work in it safely and efficiently. It is essential that the discharge of the trench dewatering pumps be conducted to natural drainage channels, drains, or storm sewers.
 - L. The width of the trench shall be ample to permit the pipe to be laid and joined properly, and the backfill to be placed and compacted as specified. Trenches shall be of such extra width, when required, as will permit the convenient placing of timber supports, sheeting

and bracing, and handling of specials.

- M. Lubricants which will support microbiological growth shall not be used for slip-on joints. Vegetable shortening shall not be used to lubricate joints.
- N. All materials/products that contact potable water must be third party certified as meeting the specifications of ANSI/NSF Standard 61.
- O. Natural rubber or other material which will support microbiological growth may not be used for any gaskets, O-rings, and other products used for jointing pipes, setting meters or valves, or other appurtenances which will expose the material to the water.
- P. Where PVC, polyethylene, or any other non-metallic pipe is used in water main construction, a continuous #12 gauge blue insulated copper tracer wire, approved by the manufacturer for direct burial, shall be installed in the trench a minimum of 6" above the top of the water line. The tracer wire shall terminate at each valve or meter and tracking pipe and prevent interference of operating the valve or meter.
- Q. Contractor is responsible for coordinating payment with Owner of any tap fees associated with the construction of the water system. Contractor to provide all necessary drawings, "record drawing," notes, calculations required to insure that building(s) site and appurtenances are approved for use as designed.

1.2 SUBMITTALS

- A. Product Data: For each type of water main appurtenance including yard hydrant, drinking fountain, valves, and valve boxes.

1.3 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1.3 PROJECT CONDITIONS

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

PART 2 – PRODUCTS

- 2.1 CONSTRUCTION MATERIAL: "Lead free" pipe, pipe fittings, solder and flux must be used in installation of all water mains. Pipe and pipe fittings containing no more than 8.0 percent lead are considered "lead free". Solder and flux containing no more than 0.2 percent lead are considered "lead free".

- A. POLYVINYL CHLORIDE (PVC) PIPE:
 - 1. Polyvinyl chloride pipe shall conform to the specifications of the American Water Works Association Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4" through 12", for water, specification C900 (latest revision), with the following

supplemental specifications.

2. All polyvinyl chloride pipe shall be Pressure Class 200. Joints shall be Bell and Spigot, similar to Johns-Manville's "Blue Brute", Robintech's "White Knight", or approved equal.
3. Water mains two inches through four inches shall be rigid, unplasticized polyvinyl chloride pipe manufactured from virgin materials. Pipe shall be designed for use at a maximum hydrostatic pressure of 200 psi at 73 1/4 degrees F. The pipe shall meet the requirements of Commercial Standard CS256-63, Type I, Grade I. Joints may be of bell and spigot design, sealed with a rubber ring, or joints may be of the coupling type sealed with a rubber ring at each end.
4. Installations shall be in accordance with ANSI/ASTM D 2321-74. Only approved embedment materials may be used in bedding, haunching or initial backfill.
5. PVC piping must be approved and marked by the National Sanitation Foundation (NSF).

B. DUCTILE IRON PIPE: Ductile iron pipe will be designed in accordance with ANSI specification A 21.50 (AWWA C150) of latest revision for a normal working pressure of 200 PSI and Laying Condition "B". The pipe shall be manufactured in accordance with ANSI specifications 21.51 (AWWA C151) of latest revision. Joints shall be Bell and Spigot, Push-on (Glamorgan Tyton, American Fastite, Clow Bell-Tite or equivalent), or Mechanical; unless otherwise called for on the proposal form. Pipe will be cement-lined and seal-coated in accordance with ANSI specification A 21.4 (AWWA C104) of latest revision.

C. CAST IRON FITTINGS:

1. All cast iron fittings shall be in accordance with ANSI specification A21.10 (AWWA C110) of latest revision and ANSI specification A 21.11 (AWWA C111) of latest revision. The joints shall be Bell and Spigot, Push-on (Glamorgan Tyton, American Fastite, Clow Bell-Tite or equivalent), or Mechanical; unless otherwise called for on the proposal form. Compact ductile iron mechanical joint fittings, four inch through twelve inch size, shall be in accordance with ANSI specifications A21.53 (AWWA C153) of latest revision.
2. Fittings will be cement-lined and seal-coated in accordance with ANSI specification A21.4 (AWWA C104) of latest revision.
3. Gray cast iron fittings, 4 inch through 12 inch sizes, shall be Pressure Class 250 and 14 inch through 24 inch sizes shall be Pressure Class 150.
4. Ductile iron fittings, 4 inch through 12 inch sizes, shall be rated for 350 PSI working pressure and 14 inch through 24 inch sizes shall be rated for 150 PSI working pressure.

D. FIRE HYDRANTS:

1. All fire hydrants shall conform to the American Water Works Association's Standard C502-85 and shall be guaranteed for one hundred fifty (150) pounds of working water pressure. Each hydrant shall have a 6 inch hub connection, one standard pumper nozzle and two nozzles for 2 1/2 inch diameter hose. Hose threads to be National Standard.
2. Hydrants shall be of the size commercially recognized as 5 inch hydrants with 5 1/4 inch valve opening. Hydrants shall include all materials necessary to bring the hydrant to its location above finished grade, including extensions.

3. Hydrants shall be open left and acceptable to the Greenville County Land Development Department and Blue Ridge Rural Water & Sewer. Hydrants shall be Mueller Company "Centurion", American Valve and Hydrant Model "B-62-B quick Fix", U.S. Pipe and Foundry Model "H-205", Kennedy Valve Company "Guardian", or approved equal.

E. FIRE LINES & SPRINKLER SYSTEMS

1. Fire line sprinkler systems and dedicated fire lines, except those in the high hazard category shall be protected by an approved double check valve assembly.
2. All valves located at the sprinkler double check valve assembly, including post indicator valve, to be electrically supervised and tied to fire alarm system. Coordinate work with electrical contractor.

- F. GATE VALVES: Gate Valves shall be of the double gate pattern with parallel seat, hub ends, iron body, bronze stemmed, designed for 150 PSI normal working pressure from both directions and conforming to the American Water Works Association Standard Specification C500-86 or subsequent revision. Valves 24 inches and larger shall be equipped with by-pass valves.

- G. BUTTERFLY VALVES: Butterfly valves shall meet the American Water Works Associates Standard Specification C505-58 - steel seat and C504-87 - rubber seat for Class 150B or subsequent revision. The butterfly valves shall be mechanical joint, flanged, push-on or combinations thereof, and furnished with manual operators. Valves shall open left.

- H. CONCRETE: This section includes all concrete work required, of every description, shown or specified, including pavements, bedding concrete, thrust blocks, etc. All materials incorporated in the concrete shall conform to the South Carolina Department of Highways and Public Transportation Standard Specifications for Highway Construction, latest edition.

- I. REINFORCING STEEL: Reinforcing steel shall be of new billet steel intermediate grade made by the open hearth process, conforming to the requirements of the "Standard Specifications for Billet Steel Concrete Reinforcement Bars", Serial Designation C15-33 of the ASTM. Bars must be deformed in rolling, and the design of the deformation shall be in accordance with ASTM Designation A615-68. In addition to the reinforcing indicated on the plans, the Contractor shall furnish all necessary support bars, tie bars, etc., required for properly supporting and spacing the bars in the forms. The reinforcement will be subject to field inspection for rust, shape and dimensions.

J. PIPING INSTALLATION

1. Water-Main Connection: Coordinate with the Greenville County Land Development Department and Blue Ridge Rural Water & Sewer for tap of size and in location indicated on drawings. Tap to be made by a contractor approved by these offices.
2. Comply with NFPA 24 for fire-service-main piping materials and installation.
3. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
4. Install PVC, AWWA pipe according to ASTM F645 and AWWA M23.

K. BACKFLOW PREVENTER INSTALLATION

1. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install an approved backflow device as approved by SCDHEC. Conduct Test of Backflow Devices in accordance with SCDHEC requirements and provide copy of test results to Engineer. Backflow preventers must be on Greenville County Land Development Department and Blue Ridge Rural Water & Sewer approved lists.
2. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
3. Do not install bypass piping around backflow preventers.
4. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

L. PROTECTIVE ENCLOSURE INSTALLATION

1. Install concrete base level and with top approximately 2 inches above grade.
2. Install protective enclosure over valves and equipment.
3. Anchor protective enclosure to concrete base.

M. ALARM DEVICE INSTALLATION

1. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
2. Supervisory Switches: Supervise valves in open position.
 - a. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
 - b. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
3. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in the Fire Consultant's specifications.

PART 3 – EXECUTION**3.1 CLEARING AND GRUBBING**

- A. The Contractor shall do all necessary clearing and grubbing along the line of the work; however, he will not be allowed to remove or otherwise damage any trees or shrubbery other than those which in the opinion of the Engineer, are necessary for the protection of the work.
- B. Upon completion of the work, the Contractor will be required to dispose of all surplus material and rubbish and to restore all property which has been damaged in the course of the work.

3.2 TRENCHING

- A. All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The backfill material shall be selected and deposited with special attention to proper bedding of the pipe. Except where special methods of bedding and tamping are provided for, clean earth, sand or rock dust

shall be solidly tamped about the pipe. Minimum cover shall be 36 inches.

- B. Trenching shall be in accordance with AWWA C-600-77, Sections "Clearing and Grubbing" and "Trenching". Maximum trench width shall be pipe diameter plus 2 feet. All excavated materials which are unsuitable for backfilling the trench shall be wasted in an area provided by the Contractor and Engineer.
- C. The bottom of the trenches shall be graded in such a manner as to provide a firm bearing for the pipe. The use of boards or other materials to support the pipe will not be permitted. Any soft or unstable foundations encountered shall be removed and replaced with suitable material, thoroughly compacted, at the Contractor's expense. Bell holes shall be of sufficient size to allow proper construction.
- D. The Contractor shall perform all excavation of every description and of whatever substances encountered, to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. OSHA regulations shall govern.
- E. To protect persons from injury and to avoid property damage, adequate barricades, construction signs, torches, red lanterns and guards as required shall be placed and maintained during the progress of the construction work until it is safe for traffic to use the highway or street. All material piles, equipment, and pipe that may serve as obstructions to traffic shall be enclosed by fences or barricades and shall be protected by proper lights when the visibility is poor. Safety rules and regulations of local authorities shall be observed.
- F. All excavations shall be dewatered properly before laying pipe.

3.3 SEPARATION OF WATER MAINS AND SEWER

- A. Parallel Installation: Water mains shall be laid at least 10 feet horizontally from any existing or proposed sewer. The distance shall be measured edge to edge. In cases where it is not practical to maintain a 10 foot separation, a deviation may be allowed on a case by case basis, if supported by data from the design engineer. Such deviation may allow installation of the water main closer to a sewer, provided that the water main is laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer.
- B. Crossings: Water mains crossing sewers shall be laid to provide a minimum vertical distance of 18 inches between the invert of the water main and the top of the sewer. Where a water line crosses under a sewer line, both the water and sewer line must be ductile iron. At crossing, one full length of water pipe shall be located so both joints will be as far from the sewer as possible. Special structural support for the water and sewer pipes may be required.
- C. Exception: SCDHEC must specifically approve any variance from the requirements of "Parallel Installations" and "Crossings" when it is impossible to obtain the specified separation distances.

- D. Force Mains: There shall be at least a 10 foot horizontal separation between water mains and sanitary sewer force mains. There shall be an 18 inch vertical separation at crossing as required in Part 1 and 2.
- E. Sewer Manholes: No water pipe shall pass through or come in contact with any part of a sewer manhole.

3.4 BACKFILLING:

- A. Backfilling shall be in accordance with Section 3.5 of AWWA C-600-77 or subsequent revisions thereof except as indicated below.
- B. In backfilling trenches the material shall first be carefully placed around the pipe and thoroughly tamped up to the elevation of the top of the pipe in layers not exceeding 8 inches in thickness by means of power driven tampers; the remainder of the trench shall then be filled in layers not more than 8 inches in thickness and each layer thoroughly tamped. Where backfilling material is too wet for satisfactory tamping, the material shall be allowed to dry or dry material shall be hauled in. The Contractor will be held responsible for settlement over all trenches and, where necessary, he shall add material which shall be thoroughly tamped in the prescribed manner. Backfill should be compacted to 98% Standard Proctor unless otherwise noted.
- C. Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface of the ground. Backfilling shall be carefully performed and the original surface restored to the full satisfaction of the Engineer.

3.5 CONNECTION TO THE EXISTING WATER MAIN: The Contractor will be required to connect the proposed mains with certain existing mains and connections as noted on plans but it will be incumbent upon the Contractor to ascertain the exact locations of these mains.

3.6 EARTH CUSHIONS: Where water mains are laid over rock or under sanitary sewers, storm drains, gas lines, water mains, telephone ducts or other buried structures, the water mains shall be laid so as to provide a minimum 12 inch earth cushion between the proposed mains and the existing structures. In any case minimum separation required for sanitary sewers shall conform to SCDHEC regulations and these specifications.

3.7 PIPE LAYING: Pipe laying shall be in accordance with AWWA C-600-77, Section 3.3 and 3.4 or latest revision.

3.8 SETTING VALVES, FITTINGS AND HYDRANTS: Valves, fittings and hydrants shall be set in accordance with AWWA C-600-77 Sections 3.6 and 3.7 or latest revision. Appurtenances not covered therein shall be set in a manner approved by the Engineer.

3.9 CONCRETE THRUST BLOCKS

- A. Thrust blocking must be installed at all bends, ties, wyes, and hydrants to prevent movement in the line. The engineer will direct the Contractor as to the size, shape and extent of such concrete blocking.

- B. Before placing metal reinforcement it shall be free from rust, scale or other coatings that will destroy or reduce the bond. Reinforcement shall be formed to the dimensions indicated on the plans. Cold bends shall be made around a pin having a diameter of four or more times the least dimensions of the bar. Metal reinforcement shall not be bent or straightened in a manner that will injure the material. Metal reinforcement shall be accurately placed and secured, and shall be design approved by the Engineer.
- 3.10 SAMPLING OUTLETS: 3/4 inch outlets shall be provided as required to insure adequate sampling of water during sterilization tests.

3.11 TESTING AND STERILIZATION

- A. Sterilization: All pipe, fittings and valves shall be thoroughly cleaned before being placed in the line. Before any section of line is placed in service, it shall be thoroughly sterilized. The Contractor shall continue the sterilization until water in the line has been approved. After sterilization, the line shall be drained and thoroughly flushed. Sterilization by the Contractor shall produce a disinfection solution of 50 PPM available chlorine in the system and allow the solution to be retained for a period of at least 24 hours. At the end of this 24 hour period the treated water shall contain no less than 10 PPM chlorine throughout the length of the main. 3/4 inch outlets shall be provided as required to insure adequate sampling of water during sterilization tests. After flushing with potable water, 2 satisfactory samples for bacteriological analysis should be taken from a number of sampling sites depending upon the amount of new construction but must include all dead-end lines and be representative of the newly constructed water system. These samples should be taken at least 24 hours apart and tested at a laboratory approved by the SCDHEC. At each sample site, chlorine residual must be measured and reported. If the membrane filter method of coliform analysis is used, non-coliform growth must be reported.
- B. Hydrostatic Tests: The Contractor will be required to test each section of line between valves at a pressure of 150 PSI. This pressure shall be maintained for not less than 2 hours or as much longer as the Engineer may require in order to detect any leakage or defective material. The test pump, pipe connections, pressure gauges and all other necessary equipment shall be furnished by the Contractor. All air shall be removed from the line prior to initiating the tests. Any makeup water required shall be carefully measured and the leakage shall not exceed the allowable amount determined by the following:

PVC:

$$L = [ND(P)^{1/2}] / 7,400$$

Where L = allowable leakage (gal/hr)

N = number of joints in length of pipeline tested

D = nominal diameter of pipe (inches)

P = average test pressure which should be no less than that specified for the pressure test (psig)

Ductile Iron:

$$L = [SD(P)^{1/2}] / 133,200$$

Where L = allowable leakage (gal/hr)

S = length of the pipeline tested (feet)

D = nominal diameter of pipe (inches)

P = average test pressure which should be no less than that specified for the pressure test (psig)

Any leaking or sweating joints shall be corrected. This specification is to be used for all types of pipe. These tests must be witnessed by the Engineer or Director of Public Works.

- C. The pressure test must be specified to be conducted in accordance with AWWA Standard C600-87, Section 4.
 - D. Two successive satisfactory bacteriological samples taken at least 24 hours apart shall be obtained and the results submitted with the Engineer's letter of certification. The samples shall be analyzed by a state approved private laboratory. The results shall include both coliform and non-coliform growth. Do not perform samples until record drawings have been supplied to Engineer.
 - E. The disinfection of all new mains shall be conducted in accordance with AWWA C651 (including Section 4.8).
- 3.12 RECORD DRAWINGS: Contractor to provide "Record Drawings" of all water mains and appurtenances.

END OF SECTION

SECTION 333000
SANITARY SEWERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes gravity-flow, nonpressure and force-main, pressure sanitary sewerage outside the building, with the following components:
 - 1. Cleanouts.
- B. Regulatory Requirements: Comply with requirements of the South Carolina Department of Health and Environmental Control. Comply with requirements of the Taylors Fire and Sewer District, the local wastewater utility.

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.
- B. DIP: Ductile Iron Pipe

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Pipe Compliance
- B. Shop Drawings: For the following:
 - 1. Sanitary Manholes
- C. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

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

2.2 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

- A. Pipe: AWWA C151, Class 150, Thickness Class 50
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Gaskets: AWWA C111, push on.
- D. Protecto 401 Lining Specification:

- 1. Condition of Ductile Iron Prior to Surface Preparation

- All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been to the first six inches of the exterior of the spigot ends.

- 2. Lining Material

- The Standard of Quality if Protecto Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for service, a test report verifying the properties and a certification of the test results.

- 3. A permeability rating of 0.0 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

- 4. Application:

- a. Applicator

- The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

- b. Surface Preparation

- Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance which can be removed by solvent, shall be cleaned to remove those substances. After the surface has been made free of grease, oil, or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.

- c. Lining

- After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

- d. Coating of Bell Sockets and Spigot Ends

- Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto Joint Compound. The Joint Compound shall be applied

by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

e. Number of Coats

The number of linings material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.

f. Touch-Up & Repair: Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

2.3 PVC PIPE AND FITTINGS

- A. PVC Gravity Sewer Pipe and Fittings: SDR 26, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals. Pipe and fittings must meet ANSI/ASTM D3034-78 and shall be installed in accordance with ANSI/ASTM D 2321-74. Only Class I, II, and III embedment materials may be used in bedding, haunching, and initial backfill.

2.4 NONPRESSURE-TYPE 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.
- B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
 2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

2.5 PRESSURE-TYPE PIPE COUPLINGS

- A. PIPE JOINTS. Slip joints shall be manufactured in accordance with AWWA Specification C111.
- B. Bell shall be shaped to receive the circular gasketed coupling. Spigot ends shall have tapered ends. Rubber gasketing shall conform to ASTM D1869, latest revision.
- C. Connections shall be made by installing manufacturer's lubricant guiding tapered end into bell until contact with gasket, and applying steady force sufficient to make solid contact between tapered end and base of bell.

2.6 CLEANOUTS

- A. Gray-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
1. Manufacturers:
 - a. Josam Company.
 - b. Smith, Jay R. Mfg. Co.
 - c. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
 2. Top-Loading Classification: Heavy duty.
 3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

1. Manufacturers:
 - a. Canplas Inc.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities, Inc.
 - e. Zurn Light Commercial Specialty Plumbing Products; Zurn Plumbing Products Group.

2.7 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 of length 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 wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals.
 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 (150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
 11. Protective Coating: Plant-applied, 10-mil minimum thickness applied to interior surfaces.
 12. Manhole Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch- (100-mm-) minimum width flange and 26-inch- diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
 - a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise indicated.

2.8 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. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.

1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1percent through manhole.
2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 4 percent.

PART 3 - EXECUTION

3.1 EARTHWORK

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

3.2 PIPING APPLICATIONS

- A. Gravity-Flow, Nonpressure Sewer Piping: Use the any of the following pipe materials for each size range:
 1. NPS 8: ductile-iron, gravity sewer pipe; ductile-iron standard fittings; gaskets; and gasketed joints. Or PVC SDR 26 pipe and fittings, gaskets, and gasketed joints.
 2. NPS 4: PVC SDR 26 pipe and fittings, gaskets, and gasketed joints.

3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage 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 using lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install ductile-iron, gravity sewer piping according to ASTM A 746.
 2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.4 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
 1. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on 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 dissimilar pipe materials with nonpressure-type, flexible[or rigid] couplings.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.

- C. Form continuous concrete channels and benches between inlets and outlet.
 - D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.
 - E. Install manhole cover inserts in frame and immediately below cover.
- 3.6 CONCRETE PLACEMENT
- A. Place cast-in-place concrete according to ACI 318/318R.
- 3.7 CLEANOUT INSTALLATION
- A. Install cleanouts and riser extensions from sewer pipes to cleanouts 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 all areas.
 - B. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.
- 3.8 CONNECTIONS
- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22 Section "Sanitary Waste and Vent Piping."
 - B. Make connections to existing piping and underground manholes.
 - 1. Make branch connections from side into existing underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 2. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- 3.9 IDENTIFICATION
- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
 - 1. Use detectable warning tape over nonferrous piping and over edges of underground manholes.
- 3.10 FIELD QUALITY CONTROL
- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.

- e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
 - B. Test new gravity 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. Contractor is required to Air Test completed piping systems in the presence of the Engineer and pull mandrel through 8 inch mains.
 - 3. Schedule tests and inspections with Engineer and authorities having jurisdiction with at least 48 hours' advance notice.
 - a. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6.
 - C. Leaks and loss in test pressure constitute defects that must be repaired.
 - D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
 - E. Contractor to flush all new sewer service lines and mains. Immediately after flushing, perform video inspection of all exterior sanitary service lines and mains. Provide digital copy of video to engineer for inspection prior to requesting final inspections.
- 3.11 CLEANING
- A. Clean interior of piping of dirt and superfluous material.
- 3.12 RECORD DRAWINGS: Contractor to provide "Record Drawings" of all sanitary sewer and appurtenances.

END OF SECTION

SECTION 334100

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pipe and fittings.
 - 2. Channel drainage systems.
 - 3. Encasement for piping.
 - 4. Manholes.
 - 5. Cleanouts.
 - 6. Nonpressure transition couplings.
 - 7. Expansion joints.
 - 8. Catch basins.
 - 9. Stormwater inlets.
 - 10. Pipe outlets.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
 - 1. Catch basins and Manholes: Include plans, elevations, sections, details, frames, covers, and grates.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- C. Field quality-control reports.
- D. As-built Survey: Contractor to provide as-built drawing with digital file to the engineer for verification and close-out.

1.4 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 DUCTILE-IRON, CULVERT PIPE AND FITTINGS

- A. Pipe: ASTM A 716, for push-on joints.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, for push-on joints.
- D. Gaskets: AWWA C111, rubber.

2.2 PVC PIPE AND FITTINGS

A. PVC Corrugated Sewer Piping:

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

2.3 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76.

1. Tongue-and-groove ends and gasketed joints with ASTM C 443, rubber gaskets
2. Unless otherwise specified in the Special Provisions or shown on the drawings, provide Class III RCP.
3. Pipe Lengths: Provide pipe in nominal 4 foot lengths. Shorter lengths may be used where required by Construction details or when approved by the Engineer.
4. Lift Holes: Lift holes will not be permitted in pipe.
5. Cement: Use Type I cement conforming to ASTM C 150.
6. All new pipes within SCDOT R/W shall be a minimum of 18" RCP, complying with SCDOT Standard Specification for Highway Construction, 2007 Edition and SCDOT standard drawings.

2.4 NONPRESSURE TRANSITION COUPLINGS

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

B. Sleeve Materials:

1. For Concrete Pipes: ASTM C 443, rubber.
2. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
3. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
4. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded, Flexible Couplings:

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

D. Shielded, Flexible Couplings:

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

E. Ring-Type, Flexible Couplings:

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

2.5 CLEANOUTS

A. Plastic Cleanouts:

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

2.6 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: High-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

2.7 MANHOLES

- A. General: Unless otherwise noted on the Drawings, the Contractor has the option of providing manholes constructed of brick or precast concrete.
- B. Standard Precast Concrete Manholes:
 - 1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Diameter: 48 inches minimum unless otherwise indicated.
 - 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
 - 4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 - 5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
 - 6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
 - 7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 - 8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
 - 9. Steps: Individual FRP steps; or 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 one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 48 inches.
 - 10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
 - 11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
 - 12. Provide 1 percent slope through manhole.
- C. Manhole Frames and Covers:
 - 1. Description: Ferrous; Size as indicated on the drawings. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
 - 2. Material: ASTM A 48/A 48M, Class 35 gray iron, unless otherwise indicated.

2.8 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350/350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.
- C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 deformed steel.

2.9 CATCH BASINS

- A. General: Unless otherwise noted on the Drawings, the Contractor has the option of providing catch basins constructed of brick or precast concrete.
- B. Standard Precast Concrete Catch Basins:
 - 1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
 - 3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
 - 4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 - 5. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 - 6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
 - 7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch- diameter frame and grate.
 - 8. Steps: Individual FRP steps or 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 one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12-inch intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 48 inches.
 - 9. Pipe Connectors: ASTM C 923, resilient, of size required, for each pipe connecting to base section.
 - 10. Provide 1 percent slope through catch basin.
- C. 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: As indicated on Construction Drawings.

2.10 STORMWATER INLETS

- A. Curb Inlets: Made with vertical curb opening.
- B. Gutter Inlets: Made with horizontal gutter opening. Include heavy-duty frames and grates.
- C. Combination Inlets: Made with vertical curb and horizontal gutter openings. Include heavy-duty frames and grates.
- D. Frames and Grates: Heavy duty.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves,

- and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
 - D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
 - E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
 - F. Install gravity-flow, nonpressure drainage piping according to the following:
 - 1. Install piping pitched down in direction of flow.
 - 2. Install piping NPS 6 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.
 - 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 5. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
 - 6. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
 - 7. Install PE corrugated sewer piping according to ASTM D 2321.
 - 8. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 9. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - 10. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
 - G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
 - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless cast-iron soil pipe and fittings.
 - 3. Ductile-iron pipe and fittings.
 - 4. Expansion joints.

3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following:
 - 1. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - 2. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
 - 3. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
 - 4. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
 - 5. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
 - 6. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
 - 7. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
 - 8. Join nonreinforced-concrete sewer piping according to ASTM C 14 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 9. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
 - 10. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

- A. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface. Set cleanout frames and covers in earth in cast-in-place or pre-cast concrete collars measuring 18"x18"x12".

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

- A. Set frames and grates to elevations indicated.

3.7 STORMWATER INLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
- B. Construct riprap of broken stone, as indicated.
- C. Install outlets that spill onto grade, anchored with concrete, where indicated.
- D. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- E. Construct energy dissipaters at outlets, as indicated.

3.8 CONCRETE PLACEMENT

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

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Section 31 20 00 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 - 1. Use warning tape or detectable warning tape over ferrous piping.
 - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to requirements of authorities having jurisdiction.
 3. 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 soiltight joints unless required by authorities having jurisdiction.
 - b. Option: Test plastic piping according to ASTM F 1417.
 - c. Option: Test concrete piping according to ASTM C 924.
 - C. Leaks and loss in test pressure constitute defects that must be repaired.
 - D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- 3.11 RECORD DRAWINGS: Contractor to provide "Record Drawings" of all storm drain and appurtenances.

END OF SECTION