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SECTION 026329 - DRILLED CONCRETE PIERS AND SHAFTS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Dry-installed drilled piers.
 - 2. Slurry displacement-installed drilled piers.
 - 3. Dry-installed or slurry displacement-installed drilled piers at Contractor's choice.
- B. Related Sections:
 - 1. Section 311110 "Site Clearing" for preparation of subgrade for drilled-pier operations including removal of asphalt, vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface.

1.03 UNIT PRICES

- A. Drilled Piers: Actual net volume of drilled piers in place and approved. Actual length, shaft diameter, and bell diameter if applicable, may vary, to coincide with elevations where satisfactory bearing strata are encountered. These dimensions may also vary with actual bearing value of bearing strata determined by an independent testing and inspecting agency. Adjustments will be made on net variation of total quantities, based on design dimensions for shafts and bells.
 - 1. Base bids on indicated number of drilled piers and, for each pier, the design length from top elevation to bottom of shaft, extended through the bell, if applicable, and the diameter of shaft and bell.
 - 2. Unit prices include labor, materials, tools, equipment, and incidentals required for excavation, trimming, shoring, casings, dewatering, reinforcement, concrete fill, testing and inspecting, and other items for complete drilled-pier installation.
- B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed outside dimensions of drilled piers cast against rock. Unit prices for rock excavation include replacement with approved materials.
- C. Trial Drilled Pier: Unit price as indicated for drilled pier, including backfilling.

1.04 ACTION SUBMITTALS

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

- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
- C. Shop Drawings: For concrete reinforcement detailing fabricating, bending, supporting, and placing.
- D. Soil boring analysis/report
- E. Geotechnical report

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer
- B. Welding certificates.
- C. Material Certificates: For the following, from manufacturer:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Steel reinforcement and accessories.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates
- E. Field quality-control reports.
- F. Other Informational Submittals
 - 1. Record drawings.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in drilled-pier work.
- B. Testing Agency Qualifications: Qualified according to ASTM C 1077, ASTM D 3740, and ASTM E 329 for testing indicated.
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.4, "Structural Welding Code - Reinforcing Steel."
- D. Drilled-Pier Standard: Comply with ACI 336.1 unless modified in this Section.

- E. Trial Drilled Pier: If required by Structural Engineer, construct trial drilled pier of diameter and depth and at location indicated or, if not indicated, of same diameter and depth as largest drilled piers, located at least three diameters clear of permanent drilled piers, to demonstrate Installer's construction methods, equipment, standards of workmanship, and tolerances.
 - 1. If Structural Engineer determines that trial drilled pier does not comply with requirements, excavate for and cast another until it is accepted.
- F. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to drilled piers including, but not limited to, the following:
 - a. Review geotechnical report.
 - b. Discuss existing utilities and subsurface conditions.
 - c. Review coordination with temporary controls and protections.

1.07 PROJECT CONDITIONS

- A. Existing Utilities: Locate existing underground utilities before excavating drilled piers. If utilities are to remain in place, provide protection from damage during drilled-pier operations.
 - 1. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, adapt drilling procedure if necessary to prevent damage to utilities. Cooperate with Owner and utility companies in keeping services and facilities in operation without interruption. Repair damaged utilities to satisfaction of utility owner.
- B. Interruption of Existing Utilities: Do not interrupt any utility to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
 - 1. Notify Architect and Owner no fewer than two days in advance of proposed interruption of utility.
 - 2. Do not proceed with interruption of utility without Owner's written permission.
- C. Project-Site Information: A geotechnical report is not available for this project, electrical contractor shall retain the services of a soils boring company to provide a soil boring in the vicinity of the proposed emergency generator and prepare soil analysis report. Contractor shall retain the services of a geotechnical firm to provide a geotechnical engineering report. Report shall be submitted for review and approval by engineer prior to excavation for drilled piers and concrete pad.
- D. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.
 - 1. Record and maintain information pertinent to each drilled pier and cooperate with Owner's testing and inspecting agency to provide data for required reports.

PART 2 – PRODUCTS

2.01 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), ASTM A 706/A 706M, deformed bars, ASTM A 767/A 767M, Class I zinc coated after fabrication and bending.
- D. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), ASTM A 706/A 706M, deformed bars, ASTM A 775/A 775M or ASTM A 934/A 934M, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
- E. Plain-Steel Wire: ASTM A 82, galvanized.
- F. Deformed-Steel Wire: ASTM A 496.
- G. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain steel wire, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.
- H. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain. Cut bars true to length with ends square and free of burrs.

2.02 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Supplement with the following:
 - a. Fly Ash: ASTM C 618 or approved substitute
 - 2. Blended Hydraulic Cement: ASTM C 595, Type IS, Portland blast-furnace slag cement.
- B. Normal-Weight Aggregate: ASTM C 33, graded, 3/4-inch (19-mm) nominal maximum coarse-aggregate size. Provide aggregate from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
 - 1. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.
- D. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 3. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 4. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- E. Sand-Cement Grout: Portland cement, ASTM C 150, Type II; clean natural sand, ASTM C 404; and water to result in grout with a minimum 28-day compressive strength of 1000 psi (6.9 MPa), of consistency required for application.

2.03 STEEL CASINGS

- A. Steel Pipe Casings: ASTM A 283/A 283M, Grade C, or ASTM A 36/A 36M, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.
- B. Corrugated-Steel Pipe Casings: ASTM A 929/A 929M, steel sheet, zinc coated.
- C. Liners: Comply with ACI 336.1.

2.04 SLURRY

- A. Slurry: Pulverized bentonite pulverized attapulgite or polymers mixed with water to form stable colloidal suspension; complying with ACI 336.1 for density, viscosity, sand content, and pH.

2.05 CONCRETE MIXTURES

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 limits as if concrete were exposed to deicing chemicals.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Proportion normal-weight concrete mixture as follows:
 1. Compressive Strength (28 Days): As indicated on Drawings
 2. Maximum Water-Cementitious Materials Ratio: As indicated on Drawings
 3. Minimum Slump: Capable of maintaining the following slump until completion of placement:
 - a. 4 inches (100 mm) for dry, uncased, or permanent-cased drilling method.
 - b. 6 inches (150 mm) for temporary-casing drilling method.
 - c. 7 inches (175 mm) for slurry displacement method.
 4. Air Content: Do not air entrain concrete.

2.06 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice.

2.07 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.
 - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by drilled-pier operations.

3.02 EXCAVATION

- A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions.
 - 1. Obstructions: Unclassified excavation may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. No changes in the Contract Sum or the Contract Time will be authorized for removal of obstructions.
 - 2. Obstructions: Unclassified excavated materials may include removal of unanticipated boulders, concrete, masonry, or other subsurface obstructions. Payment for removing obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.
- B. Classified Excavation: Excavation is classified as standard excavation, special excavation, and obstruction removal and includes excavation to bearing elevations as follows:
 - 1. Standard excavation includes excavation accomplished with conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work.
 - 2. Special excavation includes excavation that requires special equipment or procedures above or below indicated depth of drilled piers where drilled-pier excavation equipment used in standard excavation, operating at maximum power, torque, and downthrust, cannot advance the shaft.

- a. Special excavation requires use of special rock augers, core barrels, air tools, blasting, or other methods of hand excavation.
 - b. Earth seams, rock fragments, and voids included in rock excavation area will be considered rock for full volume of shaft from initial contact with rock.
3. Obstructions: Payment for removing unanticipated boulders, concrete, masonry, or other subsurface obstructions that cannot be removed by conventional augers fitted with soil or rock teeth, drilling buckets, or underreaming tools attached to drilling equipment of size, power, torque, and downthrust necessary for the Work will be according to Contract provisions for changes in the Work.
- C. Prevent surface water from entering excavated shafts. Conduct water to site drainage facilities.
- D. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation.
1. Excavate bottom of drilled piers to level plane within 1:12 tolerance.
 2. Remove water from excavated shafts before concreting.
 3. Excavate rock sockets of dimensions indicated.
 4. Cut series of grooves about perimeter of shaft to height from bottom of shaft, vertical spacing, and dimensions indicated.
- E. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Architect.
1. Do not excavate shafts deeper than elevations indicated unless approved by Architect.
 2. Payment for additional authorized excavation will be according to Contract provisions for changes in the Work.
- F. End-Bearing Drilled Piers: Probe with auger to a depth below bearing elevation, equal to diameter of the bearing area of drilled pier. Determine whether voids, clay seams, or solution channels exist.
1. Test first three drilled piers and one of every six drilled piers thereafter.
 2. Fill auger probe holes with grout.
- G. Excavate shafts for closely spaced drilled piers and for drilled piers occurring in fragile or sand strata only after adjacent drilled piers are filled with concrete and allowed to set.
- H. Slurry Displacement Method: Stabilize excavation with slurry maintained a minimum of 60 inches (1500mm) above ground-water level and above unstable soil strata to prevent caving or sloughing of shaft. Maintain slurry properties before concreting.
1. Excavate and complete concreting of drilled pier on same day if possible, or redrill, clean, and test slurry in excavation before concreting.
 2. Clean bottom of each shaft before concreting.

- I. Temporary Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
 - 1. Remove temporary casings, maintained in plumb position, during concrete placement and before initial set of concrete.
- J. Bells: Excavate bells for drilled piers to shape, base thickness, and slope angle indicated. Excavate bottom of bells to level plane and remove loose material before placing concrete.
 - 1. Shore bells in unstable soil conditions to prevent cave-in during excavation, inspection, and concreting.
- K. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.
 - 1. If location or out-of-plumb tolerances are exceeded, provide corrective construction. Submit design and construction proposals to Architect for review before proceeding.

3.03 PERMANENT STEEL CASINGS

- A. Install permanent steel casings, if required, of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.
 - 1. Install casings as excavation proceeds, to maintain sidewall stability.
 - 2. Fabricate bottom edge of lowest casing section with cutting shoe capable of penetrating rock and achieving water seal.
 - 3. Connect casing sections by continuous penetration welds to form watertight, continuous casing.
 - 4. Remove and replace or repair casings that have been damaged during installation and that could impair strength or efficiency of drilled pier.
 - 5. Fill annular void between casing and shaft wall with grout.
- B. Corrugated-Steel Casings: Provide corrugated-steel casings formed from zinc-coated steel sheet.
 - 1. Corrugated casings may be delivered in sections or panels of convenient length and field connected according to manufacturer's written instructions.

3.04 STEEL REINFORCEMENT

- A. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy bond with concrete.
- C. Fabricate and install reinforcing cages symmetrically about axis of shafts in a single unit.
- D. Accurately position, support, and secure reinforcement against displacement during concreting. Maintain minimum cover over reinforcement.

- E. Use templates to set anchor bolts, leveling plates, and other accessories furnished in work of other Sections. Provide blocking and holding devices to maintain required position during final concrete placement.
- F. Protect exposed ends of extended reinforcement, dowels, or anchor bolts from mechanical damage and exposure to weather.

3.05 CONCRETE PLACEMENT

- A. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by Owner's independent testing and inspecting agency.
 - 1. Construct a construction joint if concrete placement is delayed more than one hour. Level top surface of concrete and insert joint dowel bars. Before placing remainder of concrete, clean surface laitance, roughen, and slush concrete with commercial bonding agent or with sand-cement grout mixed at ratio of 1:1.
- B. Dry Method: Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
 - 1. Where concrete cannot be directed down shaft without striking reinforcement, place concrete with chutes, tremies, or pumps.
 - 2. Vibrate top 60 inches (1500 mm) of concrete.
- C. Slurry Displacement Method: Place concrete in slurry-filled shafts by tremie methods or pumping. Control placement operations to ensure that tremie or pump pipe is embedded no fewer than 60 inches (1500 mm) into concrete and that flow of concrete is continuous from bottom to top of drilled pier.
- D. Coordinate withdrawal of temporary casings with concrete placement to maintain at least a 60-inch (1500-mm) head of concrete above bottom of casing.
 - 1. Vibrate top 60 inches (1500 mm) of concrete after withdrawal of temporary casing.
- E. Screed concrete at cutoff elevation level and apply scoured, rough finish. Where cutoff elevation is above the ground elevation, form top section above grade and extend shaft to required elevation.
- F. Protect concrete work, according to ACI 301, from frost, freezing, or low temperatures that could cause physical damage or reduced strength.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other mineral-containing antifreeze agents or chemical accelerators.
- G. If hot-weather conditions exist that would seriously impair quality and strength of concrete, place concrete according to ACI 301 to maintain delivered temperature of concrete at no more than 90 deg F (32 deg C).

1. Place concrete immediately on delivery. Keep exposed concrete surfaces and formed shaft extensions moist by fog sprays, wet burlap, or other effective means for a minimum of seven days.

3.06 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections
 1. Drilled piers.
 2. Excavation.
 3. Concrete.
 4. Steel reinforcement welding.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
 1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities will be determined by testing and inspecting agency. Final evaluations and approval of data will be determined by Architect.
- D. Concrete Tests and Inspections: ASTM C 172 except modified for slump to comply with ASTM C 94/C 94M.
 1. Slump: ASTM C 143/C 143M; one test at point of placement for each compressive-strength test but no fewer than one test for each concrete load.
 2. Concrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.
 3. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test unless otherwise indicated. Mold and store cylinders for laboratory-cured test specimens.
 4. Compressive-Strength Tests: ASTM C 39; one set for each drilled pier but not more than one set for each truck load. One specimen will be tested at 7 days, 2 specimens will be tested at 28 days, and 1 specimen will be retained in reserve for later testing if required.
 5. If frequency of testing will provide fewer than five strength tests for a given class of concrete, testing will be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 6. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive

- strength and no compressive strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
7. Report test results in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. List Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests in reports of compressive-strength tests.
 8. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 9. Additional Tests: Testing and inspecting agency will make additional tests of concrete if test results indicate that slump, compressive strengths, or other requirements have not been met, as directed by Architect.
 - a. Continuous coring of drilled piers may be required, at Contractor's expense, if temporary casings have not been withdrawn within specified time limits or if observations of placement operations indicate deficient concrete quality, presence of voids, segregation, or other possible defects.
 10. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.
 11. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. An excavation, concrete, or a drilled pier will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports for each drilled pier as follows:
1. Actual top and bottom elevations.
 2. Actual drilled-pier diameter at top, bottom, and bell.
 3. Top of rock elevation.
 4. Description of soil materials.
 5. Description, location, and dimensions of obstructions.
 6. Final top centerline location and deviations from requirements.
 7. Variation of shaft from plumb.
 8. Shaft excavating method.
 9. Design and tested bearing capacity of bottom.
 10. Depth of rock socket.
 11. Levelness of bottom and adequacy of cleanout.
 12. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
 13. Ground-water conditions and water-infiltration rate, depth, and pumping.

14. Description, purpose, length, wall thickness, diameter, tip, and top and bottom elevations of temporary or permanent casings. Include anchorage and sealing methods used and condition and weather tightness of splices if any.
15. Description of soil or water movement, sidewall stability, loss of ground, and means of control.
16. Bell dimensions and variations from original design.
17. Date and time of starting and completing excavation.
18. Inspection report.
19. Condition of reinforcing steel and splices.
20. Position of reinforcing steel.
21. Concrete placing method, including elevation of consolidation and delays.
22. Elevation of concrete during removal of casings.
23. Locations of construction joints.
24. Concrete volume.
25. Concrete testing results.
26. Remarks, unusual conditions encountered, and deviations from requirements.

3.07 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 026329

SECTION 033100 - CAST-IN-PLACE CONCRETE FOR SITE WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections:
 - SECTION 017329 - MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK
 - SECTION 312316 - EARTHWORK FOR STRUCTURES AND UTILITIES
 - SECTION 321216 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321413 - REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321313 - REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330130 - REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330160 - REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 323113 - CHAIN LINK FENCES AND GATES
 - SECTION 329113 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT

1.02 SUMMARY

- A. This Section specifies cast-in place concrete, including framework, reinforcing, mix design, placement procedures, and finishes for the following:
 - 1. Concrete encasement for conduits and pipes.
 - 2. Concrete encasement for service feeders.
 - 3. Concrete encasement for electric ductbank.
 - 4. Concrete paving and walks are specified in Division 2.
 - 5. Vapor barrier, joint fillers, non-slip aggregate.

6. All other items of cast-in-place concrete work shown, specified, or reasonably inferred to make the work under this Section complete.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Design Professional.
- C. Shop drawings for reinforcement, for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual", showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Shop drawing for formwork, prepared by a registered Professional Engineer licensed in New York State for fabrication and erection of forms for specific finished special form joint or reveals, location and pattern of form tie placement and other items that affect exposed concrete visually.
 1. Design Professional review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility.
- E. The Contractor and his Sub-Contractors must submit in writing any request for modifications to the plans and specifications. Shop drawings that are submitted to the Design Professional for his review do not constitute "in writing" unless it is brought to the attention of the Design Professional that specific changes are being suggested. In any event, changes to the plans and specifications by means of shop drawings become the responsibility of the person initiating such changes.
- F. Shop drawings with reviewed stamp of Design Professional shall be available at site at all times.
- G. Samples of materials as requested by Design Professional, including names, sources, and descriptions, as follows:
 1. Normal weight aggregates.
 2. Fibrous reinforcement.
 3. Reglets.
 4. Waterstops.
 5. Vapor retarder.
- H. Laboratory test reports for concrete materials and mix design test.

- I. Materials certificates in lieu of materials laboratory test reports when permitted by Design Professional. Materials certificates shall be signed by manufacturer and Contractor certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturer that chloride content complies with specification requirements. The use of calcium chloride in concrete is prohibited.
- J. Minutes of pre-construction conference.
- K. Provide special finish mock-ups required.

1.04 QUALITY ASSURANCE

- A. Conform to all New York State Codes, Rules, Regulations, and Ordinances.
- B. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified.
 - 1. ACI 318, "Building Code Requirements for Reinforced Concrete".
 - 2. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard".
- C. Concrete Testing Service: Engage a testing laboratory acceptable to the College to perform material evaluation tests and to design concrete mixes.
- D. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- E. Pre-Construction Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" and the following:
 - 1. At least 35 days prior to submittal of design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Request that representatives of each entity directly concerned with cast-in-place concrete attend conference, including, but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Laboratory responsible for concrete design mixes.
 - c. Laboratory responsible for field quality control.
 - d. Ready-mix concrete producer.
 - e. Concrete subcontractor.
 - f. Primary admixture manufacturers.
 - g. The Design Professional.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surface. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Use overlaid plywood complying with U.S. Product Standard P.S-1 "A-C or B-B High Density Overlaid Concrete Form", Class I.

OR

Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Design Professional control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Form Coatings: Provide commercial formulation form-coating compounds with a maximum VOC complying with all codes, and that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- E. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.

2.02 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf) OR (Class I for heavier (3 oz.) zinc coating) hot-dip galvanized, after fabrication and bending.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 775.
- D. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- E. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- F. Welded Deformed Steel Wire Fabric: ASTM A 497.
- G. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) of stainless steel protected (CRSI, Class 2).
- H. Portland Cement: ASTM C 150, Type I.
1. Use one brand of cement throughout project.
- I. Normal Weight Aggregates: ASTM C 33 and as herein specified. Provide aggregates from a single source for exposed concrete.
1. Nominal maximum size of coarse aggregate shall not be large than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, three-fourths of minimum clear distance between reinforcing bars or between bars and forms, whichever is least, nor 3/4".
 2. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 3. Local aggregates not complying with ASTM C 33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to the Design Professional.
- J. Water: Potable, clean, free of oil, acid and injurious amounts of vegetable matter, alkalies, or other salts.
- K. Expansion joint fillers conform to ASTM Designation D 1752, closed cell resilient, non-bituminous, type I.
- L. Admixtures, General: Provide admixtures for concrete that contain no chloride ions.
- M. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

"Air-Tite", Cormix.
"Air-Mix" or "Perma-Air", Euclid Chemical Co.
"Darex AEA" or "Daravair", W.R. Grace & Co.
"MB-VR" or "Micro-Air", Master Builders, Inc.
"Sealtight AEA", W.R. Meadows, Inc.
"Sika AER", Sika Corp.

2.03 RELATED MATERIALS

- A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217 inch thick (26-gage) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. Waterstops: Provide flat, dumbbell-type or center bulb-type waterstops at construction joints and other joints as indicated size to suit joints.
- C. Rubber Waterstops: Corps of Engineers CRD-C 513.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

The Burke Co.
Progress Unlimited.
Williams Products, Inc.
- D. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

The Burke Co.
Greenstreak Plastic Products Co.
W.R. Meadows, Inc.
Progress Unlimited
Schlegel Corp.
Vinylex Corp.
- E. Granular Base: Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.
- F. Sand Cushion: Clean, manufactured or natural sand.
- G. Vapor Retarder: Provide vapor retarder cover over prepared base material where indicated below slabs on grade. Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
 - 1. Polyethylene sheet not less than 8 mils thick.

OR

Water-resistant barrier consisting of heavy Kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.
 - a. Product: "Moistop", Fortifiber Corp.
- H. Vapor Barrier: Premoulded membrane, seven-ply construction consisting of reinforced core

and carrier sheet with fortified bitumen layers, protective weathercoating, and plastic antistick sheet. Water vapor transmission rate of 0.00 grains/sq. ft./hr. when tested in accordance with ASTM E 96, Method B. Provide manufacturer's recommend mastics and gusset tape.

1. Product: "Sealtight Premoulded Membrane with Plasmatic Core", W.R. Meadows, Inc.
- I. Nonslip Aggregate Finish: Provide fused aluminum oxide granules or crushed emery as abrasive aggregate for nonslip finish graded fine 1/32 to 1/4 inch, with emery aggregate containing not less than 60-70% aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, and nonglazing and is unaffected by freezing, moisture, and cleaning materials.
- J. Colored Wear-Resistant: Packaged, dry, combination of materials consisting of portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, nonfading mineral oxides, interground with cement. Color as selected by Design Professional from manufacturers' standards, unless otherwise indicated.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

"Conshake 600 Colortone", Conspec Marketing & Mfg. Co.
"Floorcron", Cormix.
"Surflez", Euclid Chemical Co.
- K. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
OR
Moisture-Relating Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- L. Liquid Membrane-Forming Curing Compound: Liquid-type membrane forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

"A-H 3 Way Sealer", Anti-Hydro Co., Inc.
"Spartan-Cote", The Burke Co.
"Conspec #1", Conspec Marketing & Mfg. Co.
"Hardtop", Cormix.
- M. Water-Base Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
1. Available Products: Subject to compliance with requirements, products that may be

incorporated in the work include, but are not limited to, the following

"Highseal", Conspec Marketing & Mfg. Co.
"Safe Cure and Seal", Dayton Superior Corp.
"Aqua-Cure", Euclid Chemical Co.

- N. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

"Aquafilm", Conspec Marketing and Mfg., Co.
"Eucobar", Euclid Chemical Co.
"E-Con", L & M Construction Chemicals, Inc.
"Confilmm", Master Builders, Inc.
- O. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from one inch thick to feathered edges.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

"K-15", Ardex, Inc.
"Conflow", Conspec Marketing and Mfg., Co.
"LevelLayer II", Dayton Superior Corp.
"Flo-Top", Euclid Chemical Co.
- P. Bonding Compound: Polyvinyl acetate or acrylic base.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

Polyvinyl Acetate (Interior Only):

"Superior Concrete Bonder", Dayton Superior Corp.
"Euco Weld", Euclid Chemical Co.
"Weld-Crete", Larsen Products Corp.
"Everweld", L & M Construction Chemicals, Inc.

Acrylic or Styrene Butadiene:

"Acrylic Bondcrete", The Burke Co.
"Stongbond", conspec Marketing and Mfg., Co.
"Day-Chem As Bond", Dayton Superior Corp.
"SBR Latex", Euclid Chemical Co.
- Q. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following
"Burke Epoxy M.V.", The Burke Co.
"Spec-Bond 100", Conspec Marketing and Mfg., Co.
"Euco Epoxy System #452 or #620", Euclid Chemical Co.
"Epoxtite Binder 2390", A.C. Horn, Inc.
- R. Floor Hardener: "Labidolith" by Sonneborn Building Products, Inc.; "Hornolith" by A.C. Horn Co.; "Samiseal 50" by Master Builders Co.
- S. Dovetail Anchor Slots: 20 gauge galvanized sheet metal, with filled face. Provide at all concrete walls, columns or beams which are faced with masonry. Slots to be spaced at maximum 24" on center.
- T. Grout: Non-metallic, nonshrink with a minimum 28 day compressive strength of 7000 psi and a minimum 7 day compressive strength of 4000 psi.

2.04 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Design Professional for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
 1. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Design Professional of each proposed mix for each class concrete at least 15 days prior to start to work. Do not begin concrete production until proposed mix designs have been reviewed by Design Professional.
- C. Design mixes to provide normal weight concrete with the following properties:
 1. 4000-psi, 28-day compressive strength; W/C ratio, 0.44 maximum (non-air-entrained), 0.35 maximum (air-entrained).

The following shall be 4000 psi-air entrained: pavements, curbs, lighting poles (foundation).
 2. 3000-psi, 28-day compressive strength; W/C ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).

The following services shall be 3000 psi non-air-entrained: foundation walls, retaining walls, slabs on grade, slabs, interior bearing walls, exterior bearing walls columns, joists, beams, girders, lintels, interior modular components, and equipment bases. The following shall be 3000 psi air-entrained concrete: fill, topping walks, pavements curbs, bollards, manholes, electrical ductbank encasement, electric service feeder encasement and electric conduit encasement.
- D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances

warrant, as accepted by Design Professional. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Design Professional before using in work.

2.05 ADMIXTURES

- A. Use water-reducing admixtures or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.
- B. Use nonchloride accelerating admixture in concrete slabs places at ambient temperatures below 50°F (10°C).
- C. Use high-range water-reducing admixture (HRWR) in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water/cement ratios below 0.50.
- D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within following limits:
 - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
 - 4.5 percent (moderate exposure); 5.5 percent (severe exposure) 1-1/2-inch max. aggregate.
 - 4.5 percent (moderate exposure); 6.0 percent (severe exposure) 1-inch max. aggregate.
 - 5.0 percent (moderate exposure); 6.0 percent (severe exposure) 3/4-inch max. aggregate.
 - 5.5 percent (moderate exposure); 7.0 percent (severe exposure) 1/2-inch max. aggregate.
 - 2. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to receive a surface hardener: 2 percent to 4 percent air.
- E. Use admixtures for water reduction and set control in strict compliance with manufacturer's direction.
- F. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:
 - Subjected to freezing and thawing: W/C 0.45.
 - Subjected to deicers/watertight: W/C 0.40.

Subjected to brackish water, salt spray, or deicers: W/C 0.40.

- G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

Ramps, Slabs, and Sloping Surfaces: Not more than 3 inches.

Reinforced Foundation Systems: Between 4 and 6 inches.

Concrete Containing HRWR Admixture (Superplasticizer): Not more than 8 inches after addition of HRWR to site-verified 2-inch to 3-inch slump concrete.

2.06 CONCRETE MIXING

- A. Job-Site Mixing: Mix materials for concrete in appropriate drum-type batch machine mixer. For mixers of one cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd. or fraction thereof.
- B. Provide batch ticket, to the Owner's Representative, for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- C. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as specified.
 - 1. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 GENERAL

- A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

3.02 FORMS

- A. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- C. Provide temporary openings where interior area of framework is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate

- temporary openings in forms at inconspicuous locations.
- D. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
 - E. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
 - F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.03 VAPOR RETARDER/BARRIER INSTALLATION

- A. General: Following leveling and tamping of granular base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal vapor barrier joints with manufacturer's recommended mastic and pressure-sensitive tape.
- C. After placement of vapor retarder/barrier, cover with sand cushion and compact to depth as shown on drawings.

3.04 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement and supports and as herein specified.
- B. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Design Professional.
- E. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- F. Install welded wire fabric in as long lengths 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.

- G. Form accurately to dimensions indicated. Make bends and splices according to CRSI Standard Specifications. Injurious rebending or straightening not allowable. Use no bar with kinks or bends not shown. Heating not allowable unless approved by Design Professional.
- H. Do not splice reinforcement at points of maximum stress. At points where bars lap or splice, including distribution steel, provide sufficient lap to transfer stress between bars by bond and shear.

3.05 **JOINTS**

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Design Professional.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Accepted bulkheads designed for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions.
- F. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - 1. Joint filler and sealant materials are specified in Division 7 Sections of these specifications.
- G. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/8 inch wide by 1/4 slab depth or inserts 1/4 inch wide by 1/4 of slab depth, unless otherwise indicated.
 - 1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface to strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 - 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
 - 3. If joint pattern not shown, provide joints not exceeding 15 feet in either direction and

located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

- H. Joint sealant material is specified in Division 7 Sections of these specifications.

3.06 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.
- B. Install reglets to receive top edge of foundation sheet waterproofing and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.07 PREPARATION OF FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, unresidual, low-VOC, form-coating compound before reinforcement is placed.
- B. Do not allow excess form-coating material to accumulate in forms or to come in contact in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.08 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperated with other trades in setting such work.
- B. General: Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
- C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Bring slab surfaces to correct level with straight edge and strike off. Use bull floats or derbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position during concrete placement.
- F. Cold-Weather Placing: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.
1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 2. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- G. Hot-Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). 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. Use of liquid nitrogen to cool concrete is Contractor's option.
 2. 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 embedment in concrete.

3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to Design Professional.

3.09 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar systems. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment, not later than one day after form removal.
 1. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
- D. Grout-Cleaned Finish: Provide grout-cleaned finish to schedule concrete surfaces that have received smooth form finish treatment.
 1. Combine one part portland cement to 1-1/2 parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-base bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amount determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 2. Thoroughly Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before

power floating and troweling. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
- C. Provide moisture curing by following methods.
 - 1. Keep concrete surface continuously wet covering with water.
 - a. Use continuous water-fog spray.
 - b. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
- D. Provide moisture-cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- E. Provide curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs as follows:
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with 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.
 - 2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- F. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- G. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed by Engineers of record.

3.11 REMOVAL OF FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed less than 14 days and until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.12 REUSE OF FORMS

- A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-facing compound as specified for new formwork. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces except as acceptable to Design Professional.

3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings, or as specified.

3.14 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Design Professional.
 - 1. Cut out honeycomb, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding

- agent. Place patching mortar before bonding compound has dried.
2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Design Professional. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.
1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- C. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified.

Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Design Professional.
 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- D. Repair isolated random cracks and single holes not over 1 inch in diameter by dry-pack

method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack before bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

- E. Perform structural repairs with prior approval of Design Professional for method and procedure, using specified epoxy adhesive and mortar.
- F. Repair methods not specified above may be used, subject to acceptance of Design Professional.

3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner may employ and pay for a testing laboratory to perform tests and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Design Professional.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slum to comply with ASTM C 94.
 - 1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - 2. Air Content: ASTM C 173; volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - 3. Concrete Temperature: Test hourly when air temperature is 40°F (4°C) and below, when 80°F (27°C) and above, and each time a set of compression test specimens is made.
 - 4. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
 - 5. Compression Strength Test: ASTM C 39; one set of four cylinders for each 50 cu. yds. of each type of concrete for each days pour. One specimen tested at 7 days, three specimens tested at 28 days.
 - 6. When frequency of testing will provide fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 - 7. When total quantity of a given class of concrete is less than 50 cu. yds., Design Professional may waive strength test if adequate evidence of satisfactory strength is provided.

8. 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.
 9. 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.
- D. Test results will be reported in writing to Design Professional, Ready-Mix Producer, and Contractor within 24 hours after test. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive breaking days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- E. 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.
- F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have been attained in the structure, as directed by Design Professional. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

3.16 CLEAN UP

- A. Immediately prior to final inspection, preliminary to acceptance, wash and clean all exterior concrete wearing surfaces and interior uncovered wearing surfaces. Leave all concrete in clean acceptable condition.
- B. Upon the completion of the installation all debris created by the installation shall be removed from the premises of the Owner or disposed of as directed by the Owner.

END OF SECTION 033100

SECTION 311110 - SITE CLEARING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this Section.
- B. Related Sections:
 - SECTION 017329 - MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK
 - SECTION 311316 - TREE AND SHRUB PROTECTION AND TRIMMING
 - SECTION 312316 - EARTHWORK FOR STRUCTURES AND UTILITIES
 - SECTION 321216 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321413 - REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321313 - REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330130 - REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330160 - REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 323113 - CHAIN LINK FENCES AND GATES
 - SECTION 329113 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT
- C. Contractor shall refer to Section 1010 - "Summary of Work", Section 1500 - "Temporary Facilities" and the "Temporary Power and Sequence of Connections" notes for each building as shown on drawings inclusive, for the sequencing required to accomplish the work.

1.02 SUMMARY

- A. This Section generally includes, but is not necessarily limited to, the following site clearing work:
 - 1. Protection of existing trees.
 - 2. Removal of trees and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Removing and restoration above-grade improvements.

5. Removing and restoration below-grade improvements.
6. Stripping topsoil.
7. Removal and restoration of existing sidewalks, roads and pavement.

1.03 PROJECT CONDITIONS

- A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, pavements and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, pavements or other occupied or used facilities without permission from authorities having jurisdiction.
- B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements.
 1. Protect improvements adjoining the work site.
 2. Restore damaged improvements to their original condition, as acceptable to Design Professional.
- C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide 4' high snow fence to protect trees and vegetation to be left standing. Install fence at drip line of trees.
 1. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
 2. Provide protection for roots over 1-1/2 inch diameter that are cut during construction operations. Cover exposed roots with earth as soon as possible.
 3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Design Professional. Employ a qualified, per 02122 arborist to repair damages.
 4. Replace trees which cannot be repaired and restored to full-growth status, as determined by arborist.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.01 SITE CLEARING

- A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. "Removal" includes digging out and off-site disposing of stumps and roots.

1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.
- B. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.
1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
 - a. Remove heavy growths of grass from areas before stripping.
 - b. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.
 2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.
 3. Dispose of unsuitable or excess topsoil, same as specified for disposal of waste material.
- C. Clearing and Grubbing: Where shown, clear site of trees, shrubs and other vegetation, which may interfere with the new construction indicated to be left standing.
1. Completely remove stumps, roots, and other debris protruding through ground surface.
 2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
 - a. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.
- D. Removal and Restoration of Improvements: Remove and restore existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
1. Abandonment or removal of certain underground pipe or conduits may be indicated on mechanical or electrical drawings, and is included under work of related Division 23 and 26 sections. Removal of abandoned underground piping or conduit interfering with construction is included under this Section.

3.02 DISPOSAL OF WASTE MATERIALS

- A. Burning on Owner's Property: Burning is not permitted on Owner's property.
- B. Removal from Owner's Property: Remove waste materials from Owner's property.
- C. Debris removal shall be performed by the close of the work date that debris was unearthed.

END OF SECTION 311100

SECTION 033100 - CAST-IN-PLACE CONCRETE FOR SITE WORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections:
 - SECTION 017329 - MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK
 - SECTION 312316 - EARTHWORK FOR STRUCTURES AND UTILITIES
 - SECTION 321216 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321413 - REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321313 - REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330130 - REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330160 - REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 323113 - CHAIN LINK FENCES AND GATES
 - SECTION 329113 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT

1.02 SUMMARY

- A. This Section specifies cast-in place concrete, including framework, reinforcing, mix design, placement procedures, and finishes for the following:
 - 1. Concrete encasement for conduits and pipes.
 - 2. Concrete encasement for service feeders.
 - 3. Concrete encasement for electric ductbank.
 - 4. Concrete paving and walks are specified in Division 2.
 - 5. Vapor barrier, joint fillers, non-slip aggregate.

6. All other items of cast-in-place concrete work shown, specified, or reasonably inferred to make the work under this Section complete.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product Data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, dry-shake finish materials, and others as requested by Design Professional.
- C. Shop drawings for reinforcement, for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual", showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Shop drawing for formwork, prepared by a registered Professional Engineer licensed in New York State for fabrication and erection of forms for specific finished special form joint or reveals, location and pattern of form tie placement and other items that affect exposed concrete visually.
 1. Design Professional review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is Contractor's responsibility.
- E. The Contractor and his Sub-Contractors must submit in writing any request for modifications to the plans and specifications. Shop drawings that are submitted to the Design Professional for his review do not constitute "in writing" unless it is brought to the attention of the Design Professional that specific changes are being suggested. In any event, changes to the plans and specifications by means of shop drawings become the responsibility of the person initiating such changes.
- F. Shop drawings with reviewed stamp of Design Professional shall be available at site at all times.
- G. Samples of materials as requested by Design Professional, including names, sources, and descriptions, as follows:
 1. Normal weight aggregates.
 2. Fibrous reinforcement.
 3. Reglets.
 4. Waterstops.
 5. Vapor retarder.
- H. Laboratory test reports for concrete materials and mix design test.

- I. Materials certificates in lieu of materials laboratory test reports when permitted by Design Professional. Materials certificates shall be signed by manufacturer and Contractor certifying that each material item complies with or exceeds specified requirements. Provide certification from admixture manufacturer that chloride content complies with specification requirements. The use of calcium chloride in concrete is prohibited.
- J. Minutes of pre-construction conference.
- K. Provide special finish mock-ups required.

1.04 QUALITY ASSURANCE

- A. Conform to all New York State Codes, Rules, Regulations, and Ordinances.
- B. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified.
 - 1. ACI 318, "Building Code Requirements for Reinforced Concrete".
 - 2. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard".
- C. Concrete Testing Service: Engage a testing laboratory acceptable to the College to perform material evaluation tests and to design concrete mixes.
- D. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- E. Pre-Construction Conference: Conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings" and the following:
 - 1. At least 35 days prior to submittal of design mixes, conduct a meeting to review detailed requirements for preparing concrete design mixes and to determine procedures for satisfactory concrete operations. Review requirements for submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Request that representatives of each entity directly concerned with cast-in-place concrete attend conference, including, but not limited to, the following:
 - a. Contractor's superintendent.
 - b. Laboratory responsible for concrete design mixes.
 - c. Laboratory responsible for field quality control.
 - d. Ready-mix concrete producer.
 - e. Concrete subcontractor.
 - f. Primary admixture manufacturers.
 - g. The Design Professional.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surface. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Use overlaid plywood complying with U.S. Product Standard P.S-1 "A-C or B-B High Density Overlaid Concrete Form", Class I.

OR

Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Forms for Textured Finish Concrete: Units of face design, size, arrangement, and configuration to match Design Professional control sample. Provide solid backing and form supports to ensure stability of textured form liners.
- D. Form Coatings: Provide commercial formulation form-coating compounds with a maximum VOC complying with all codes, and that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- E. Form Ties: Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface.
 - 1. Provide ties that, when removed, will leave holes not larger than 1-inch diameter in concrete surface.

2.02 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Galvanized Reinforcing Bars: ASTM A 767, Class II (2.0 oz. zinc psf) OR (Class I for heavier (3 oz.) zinc coating) hot-dip galvanized, after fabrication and bending.
- C. Epoxy-Coated Reinforcing Bars: ASTM A 775.
- D. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- E. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- F. Welded Deformed Steel Wire Fabric: ASTM A 497.
- G. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type supports complying with CRSI specifications.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) of stainless steel protected (CRSI, Class 2).
- H. Portland Cement: ASTM C 150, Type I.
1. Use one brand of cement throughout project.
- I. Normal Weight Aggregates: ASTM C 33 and as herein specified. Provide aggregates from a single source for exposed concrete.
1. Nominal maximum size of coarse aggregate shall not be large than one-fifth of narrowest dimension between sides of forms, one-third of depth of slabs, three-fourths of minimum clear distance between reinforcing bars or between bars and forms, whichever is least, nor 3/4".
 2. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
 3. Local aggregates not complying with ASTM C 33 but that special tests or actual service have shown to produce concrete of adequate strength and durability may be used when acceptable to the Design Professional.
- J. Water: Potable, clean, free of oil, acid and injurious amounts of vegetable matter, alkalies, or other salts.
- K. Expansion joint fillers conform to ASTM Designation D 1752, closed cell resilient, non-bituminous, type I.
- L. Admixtures, General: Provide admixtures for concrete that contain no chloride ions.
- M. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

"Air-Tite", Cormix.
"Air-Mix" or "Perma-Air", Euclid Chemical Co.
"Darex AEA" or "Daravair", W.R. Grace & Co.
"MB-VR" or "Micro-Air", Master Builders, Inc.
"Sealtight AEA", W.R. Meadows, Inc.
"Sika AER", Sika Corp.

2.03 RELATED MATERIALS

- A. Reglets: Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217 inch thick (26-gage) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. Waterstops: Provide flat, dumbbell-type or center bulb-type waterstops at construction joints and other joints as indicated size to suit joints.
- C. Rubber Waterstops: Corps of Engineers CRD-C 513.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

The Burke Co.
Progress Unlimited.
Williams Products, Inc.
- D. Polyvinyl Chloride Waterstops: Corps of Engineers CRD-C 572
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

The Burke Co.
Greenstreak Plastic Products Co.
W.R. Meadows, Inc.
Progress Unlimited
Schlegel Corp.
Vinylex Corp.
- E. Granular Base: Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.
- F. Sand Cushion: Clean, manufactured or natural sand.
- G. Vapor Retarder: Provide vapor retarder cover over prepared base material where indicated below slabs on grade. Use only materials that are resistant to deterioration when tested in accordance with ASTM E 154, as follows:
 - 1. Polyethylene sheet not less than 8 mils thick.

OR

Water-resistant barrier consisting of heavy Kraft papers laminated together with glass-fiber reinforcement and overcoated with black polyethylene on each side.
 - a. Product: "Moistop", Fortifiber Corp.
- H. Vapor Barrier: Premoulded membrane, seven-ply construction consisting of reinforced core

and carrier sheet with fortified bitumen layers, protective weathercoating, and plastic antistick sheet. Water vapor transmission rate of 0.00 grains/sq. ft./hr. when tested in accordance with ASTM E 96, Method B. Provide manufacturer's recommend mastics and gusset tape.

1. Product: "Sealtight Premoulded Membrane with Plasmatic Core", W.R. Meadows, Inc.
- I. Nonslip Aggregate Finish: Provide fused aluminum oxide granules or crushed emery as abrasive aggregate for nonslip finish graded fine 1/32 to 1/4 inch, with emery aggregate containing not less than 60-70% aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof, and nonglazing and is unaffected by freezing, moisture, and cleaning materials.
- J. Colored Wear-Resistant: Packaged, dry, combination of materials consisting of portland cement, graded quartz aggregate, coloring pigments, and plasticizing admixture. Use coloring pigments that are finely ground, nonfading mineral oxides, interground with cement. Color as selected by Design Professional from manufacturers' standards, unless otherwise indicated.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

"Conshake 600 Colortone", Conspec Marketing & Mfg. Co.
"Floorcron", Cormix.
"Surflez", Euclid Chemical Co.
- K. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.

OR
Moisture-Relating Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- L. Liquid Membrane-Forming Curing Compound: Liquid-type membrane forming curing compound complying with ASTM C 309, Type I, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

"A-H 3 Way Sealer", Anti-Hydro Co., Inc.
"Spartan-Cote", The Burke Co.
"Conspec #1", Conspec Marketing & Mfg. Co.
"Hardtop", Cormix.
- M. Water-Base Acrylic Membrane Curing Compound: ASTM C 309, Type I, Class B.
1. Available Products: Subject to compliance with requirements, products that may be

incorporated in the work include, but are not limited to, the following

"Highseal", Conspec Marketing & Mfg. Co.
"Safe Cure and Seal", Dayton Superior Corp.
"Aqua-Cure", Euclid Chemical Co.

- N. Evaporation Control: Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

"Aquafilm", Conspec Marketing and Mfg., Co.
"Eucobar", Euclid Chemical Co.
"E-Con", L & M Construction Chemicals, Inc.
"Confilmm", Master Builders, Inc.
- O. Underlayment Compound: Free-flowing, self-leveling, pumpable, cement-based compound for applications from one inch thick to feathered edges.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

"K-15", Ardex, Inc.
"Conflow", Conspec Marketing and Mfg., Co.
"LevelLayer II", Dayton Superior Corp.
"Flo-Top", Euclid Chemical Co.
- P. Bonding Compound: Polyvinyl acetate or acrylic base.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following

Polyvinyl Acetate (Interior Only):

"Superior Concrete Bonder", Dayton Superior Corp.
"Euco Weld", Euclid Chemical Co.
"Weld-Crete", Larsen Products Corp.
"Everweld", L & M Construction Chemicals, Inc.

Acrylic or Styrene Butadiene:

"Acrylic Bondcrete", The Burke Co.
"Stongbond", conspec Marketing and Mfg., Co.
"Day-Chem As Bond", Dayton Superior Corp.
"SBR Latex", Euclid Chemical Co.
- Q. Epoxy Adhesive: ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type", "Grade", and "Class" to suit project requirements

1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following
"Burke Epoxy M.V.", The Burke Co.
"Spec-Bond 100", Conspec Marketing and Mfg., Co.
"Euco Epoxy System #452 or #620", Euclid Chemical Co.
"Epoxtite Binder 2390", A.C. Horn, Inc.
- R. Floor Hardener: "Labidolith" by Sonneborn Building Products, Inc.; "Hornolith" by A.C. Horn Co.; "Samiseal 50" by Master Builders Co.
- S. Dovetail Anchor Slots: 20 gauge galvanized sheet metal, with filled face. Provide at all concrete walls, columns or beams which are faced with masonry. Slots to be spaced at maximum 24" on center.
- T. Grout: Non-metallic, nonshrink with a minimum 28 day compressive strength of 7000 psi and a minimum 7 day compressive strength of 4000 psi.

2.04 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Design Professional for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
 1. Limit use of fly ash to not exceed 25 percent of cement content by weight.
- B. Submit written reports to Design Professional of each proposed mix for each class concrete at least 15 days prior to start to work. Do not begin concrete production until proposed mix designs have been reviewed by Design Professional.
- C. Design mixes to provide normal weight concrete with the following properties:
 1. 4000-psi, 28-day compressive strength; W/C ratio, 0.44 maximum (non-air-entrained), 0.35 maximum (air-entrained).

The following shall be 4000 psi-air entrained: pavements, curbs, lighting poles (foundation).
 2. 3000-psi, 28-day compressive strength; W/C ratio, 0.58 maximum (non-air-entrained), 0.46 maximum (air-entrained).

The following services shall be 3000 psi non-air-entrained: foundation walls, retaining walls, slabs on grade, slabs, interior bearing walls, exterior bearing walls columns, joists, beams, girders, lintels, interior modular components, and equipment bases. The following shall be 3000 psi air-entrained concrete: fill, topping walks, pavements curbs, bollards, manholes, electrical ductbank encasement, electric service feeder encasement and electric conduit encasement.
- D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances

warrant, as accepted by Design Professional. Laboratory test data for revised mix design and strength results must be submitted to and accepted by Design Professional before using in work.

2.05 ADMIXTURES

- A. Use water-reducing admixtures or high-range water-reducing admixture (Superplasticizer) in concrete as required for placement and workability.
- B. Use nonchloride accelerating admixture in concrete slabs places at ambient temperatures below 50°F (10°C).
- C. Use high-range water-reducing admixture (HRWR) in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water/cement ratios below 0.50.
- D. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus or minus 1-1/2 percent within following limits:
 - 1. Concrete structures and slabs exposed to freezing and thawing, deicer chemicals, or hydraulic pressure:
 - 4.5 percent (moderate exposure); 5.5 percent (severe exposure) 1-1/2-inch max. aggregate.
 - 4.5 percent (moderate exposure); 6.0 percent (severe exposure) 1-inch max. aggregate.
 - 5.0 percent (moderate exposure); 6.0 percent (severe exposure) 3/4-inch max. aggregate.
 - 5.5 percent (moderate exposure); 7.0 percent (severe exposure) 1/2-inch max. aggregate.
 - 2. Other concrete (not exposed to freezing, thawing, or hydraulic pressure) or to receive a surface hardener: 2 percent to 4 percent air.
- E. Use admixtures for water reduction and set control in strict compliance with manufacturer's direction.
- F. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W/C) ratios as follows:
 - Subjected to freezing and thawing: W/C 0.45.
 - Subjected to deicers/watertight: W/C 0.40.

Subjected to brackish water, salt spray, or deicers: W/C 0.40.

- G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

Ramps, Slabs, and Sloping Surfaces: Not more than 3 inches.

Reinforced Foundation Systems: Between 4 and 6 inches.

Concrete Containing HRWR Admixture (Superplasticizer): Not more than 8 inches after addition of HRWR to site-verified 2-inch to 3-inch slump concrete.

2.06 CONCRETE MIXING

- A. Job-Site Mixing: Mix materials for concrete in appropriate drum-type batch machine mixer. For mixers of one cu. yd. or smaller capacity, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-1/2 minutes of mixing time by 15 seconds for each additional cu. yd. or fraction thereof.
- B. Provide batch ticket, to the Owner's Representative, for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.
- C. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as specified.
 - 1. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.01 GENERAL

- A. General: Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation, and position. Maintain formwork construction tolerances complying with ACI 347.

3.02 FORMS

- A. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- B. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- C. Provide temporary openings where interior area of framework is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate

- temporary openings in forms at inconspicuous locations.
- D. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
 - E. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
 - F. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.03 VAPOR RETARDER/BARRIER INSTALLATION

- A. General: Following leveling and tamping of granular base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal vapor barrier joints with manufacturer's recommended mastic and pressure-sensitive tape.
- C. After placement of vapor retarder/barrier, cover with sand cushion and compact to depth as shown on drawings.

3.04 PLACING REINFORCEMENT

- A. General: Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement and supports and as herein specified.
- B. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- D. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by Design Professional.
- E. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- F. Install welded wire fabric in as long lengths 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.

- G. Form accurately to dimensions indicated. Make bends and splices according to CRSI Standard Specifications. Injurious rebending or straightening not allowable. Use no bar with kinks or bends not shown. Heating not allowable unless approved by Design Professional.
- H. Do not splice reinforcement at points of maximum stress. At points where bars lap or splice, including distribution steel, provide sufficient lap to transfer stress between bars by bond and shear.

3.05 **JOINTS**

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to Design Professional.
- B. Provide keyways at least 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Accepted bulkheads designed for this purpose may be used for slabs.
- C. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements.
- D. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete.
- E. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions.
- F. Isolation Joints in Slabs-on-Ground: Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.
 - 1. Joint filler and sealant materials are specified in Division 7 Sections of these specifications.
- G. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/8 inch wide by 1/4 slab depth or inserts 1/4 inch wide by 1/4 of slab depth, unless otherwise indicated.
 - 1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface to strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 - 2. Contraction joints in unexposed floor slabs may be formed by saw cuts as soon as possible after slab finishing as may be safely done without dislodging aggregate.
 - 3. If joint pattern not shown, provide joints not exceeding 15 feet in either direction and

located to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

- H. Joint sealant material is specified in Division 7 Sections of these specifications.

3.06 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.
- B. Install reglets to receive top edge of foundation sheet waterproofing and to receive thru-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- C. Forms for Slabs: Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.07 PREPARATION OF FORM SURFACES

- A. General: Coat contact surfaces of forms with an approved, unresidual, low-VOC, form-coating compound before reinforcement is placed.
- B. Do not allow excess form-coating material to accumulate in forms or to come in contact in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
- C. Coat steel forms with a nonstaining, rust-preventative material. Rust-stained steel formwork is not acceptable.

3.08 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts to permit installation of their work; cooperated with other trades in setting such work.
- B. General: Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
- C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete to avoid segregation at its final location.
- D. Placing Concrete in Forms: Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- E. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Bring slab surfaces to correct level with straight edge and strike off. Use bull floats or derbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position during concrete placement.
- F. Cold-Weather Placing: Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
- When air temperature has fallen to or is expected to fall below 40°F (4°C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.
1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 2. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
- G. Hot-Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F (32°C). 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. Use of liquid nitrogen to cool concrete is Contractor's option.
 2. 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 embedment in concrete.

3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to Design Professional.

3.09 FINISH OF FORMED SURFACES

- A. Rough Form Finish: For formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.
- B. Smooth Form Finish: For formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or other similar systems. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.
- C. Smooth Rubbed Finish: Provide smooth rubbed finish to scheduled concrete surfaces, which have received smooth form finish treatment, not later than one day after form removal.
 1. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
- D. Grout-Cleaned Finish: Provide grout-cleaned finish to schedule concrete surfaces that have received smooth form finish treatment.
 1. Combine one part portland cement to 1-1/2 parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-base bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amount determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 2. Thoroughly Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before

power floating and troweling. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.

- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.
- C. Provide moisture curing by following methods.
 - 1. Keep concrete surface continuously wet covering with water.
 - a. Use continuous water-fog spray.
 - b. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
- D. Provide moisture-cover curing as follows:
 - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
- E. Provide curing and sealing compound to exposed interior slabs and to exterior slabs, walks, and curbs as follows:
 - 1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with 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.
 - 2. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
- F. Curing Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- G. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.

Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise directed by Engineers of record.

3.11 REMOVAL OF FORMS

- A. General: Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations, and provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beam soffits, joists, slabs, and other structural elements, may not be removed less than 14 days and until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.12 REUSE OF FORMS

- A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-facing compound as specified for new formwork. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use "patched" forms for exposed concrete surfaces except as acceptable to Design Professional.

3.13 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings, or as specified.

3.14 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Design Professional.
 - 1. Cut out honeycomb, rock pockets, voids over 1/4 inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding

- agent. Place patching mortar before bonding compound has dried.
2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Design Professional. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.
1. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- C. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified.

Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete. Proprietary underlayment compounds may be used when acceptable to Design Professional.
 4. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- D. Repair isolated random cracks and single holes not over 1 inch in diameter by dry-pack

method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack before bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

- E. Perform structural repairs with prior approval of Design Professional for method and procedure, using specified epoxy adhesive and mortar.
- F. Repair methods not specified above may be used, subject to acceptance of Design Professional.

3.15 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General: The Owner may employ and pay for a testing laboratory to perform tests and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Design Professional.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slum to comply with ASTM C 94.
 - 1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 - 2. Air Content: ASTM C 173; volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
 - 3. Concrete Temperature: Test hourly when air temperature is 40°F (4°C) and below, when 80°F (27°C) and above, and each time a set of compression test specimens is made.
 - 4. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory-cured test specimens except when field-cure test specimens are required.
 - 5. Compression Strength Test: ASTM C 39; one set of four cylinders for each 50 cu. yds. of each type of concrete for each days pour. One specimen tested at 7 days, three specimens tested at 28 days.
 - 6. When frequency of testing will provide fewer than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 - 7. When total quantity of a given class of concrete is less than 50 cu. yds., Design Professional may waive strength test if adequate evidence of satisfactory strength is provided.

8. 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.
 9. 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.
- D. Test results will be reported in writing to Design Professional, Ready-Mix Producer, and Contractor within 24 hours after test. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive breaking days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- E. 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.
- F. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have been attained in the structure, as directed by Design Professional. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

3.16 CLEAN UP

- A. Immediately prior to final inspection, preliminary to acceptance, wash and clean all exterior concrete wearing surfaces and interior uncovered wearing surfaces. Leave all concrete in clean acceptable condition.
- B. Upon the completion of the installation all debris created by the installation shall be removed from the premises of the Owner or disposed of as directed by the Owner.

END OF SECTION 033100

SECTION 260513 - MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 26 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. This Section includes cables and related splices, terminations, and accessories for medium voltage electrical distribution systems.
- B. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 26 Section 260529 "FASTNERS, ATTACHMENTS AND SUPPORTING DEVICES" for cable and termination supports.
 - 2. Division 26 Section 260553 "Electrical Identification" for identification for cables and cable markers.
 - 3. Division 26 Section 260544 - "Underground Electrical Work".
- C. Contractor shall refer to Section 011200 - "Summary of Work", Section 015000 - "Temporary Facilities and controls" and the "Temporary Power and Sequence of Connections" notes for each building on the Drawings for the sequencing required to accomplish the work.

1.03 SUBMITTALS

- A. General: Submit the following according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Shop Drawings: Submit shop drawings for the installation sequence, pulling tensions and sidewall pressure of all wire and cable pulls, including identification of manhole locations with splices and manholes which will be "pulled-through" without splicing.
- C. Product data for medium voltage cables and cable accessories, including splices and terminations, pulling devices, end seals and ground wire.
- D. Product certificate signed by manufacturer that its products comply with the specified requirements.
- E. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.
- F. Product Test Reports: Certified reports of manufacturers' design and production tests indicating compliance of cable and accessories with referenced standards.
- G. Field test reports indicating and interpreting test results relative to compliance with performance requirements specified. Include certified copies of field test records.

- H. Samples: 16-inch (400mm) lengths of each type of cable specified.
- I. Maintenance data for cables and accessories to be included in the "Operating and Maintenance Manual" specified in Division 1.
 - 1. Include description of requirements for periodic tests of cables.
 - 2. Include operation of fault indicators and separable insulated connectors and their accessories.
- J. Any splicing or terminating methods other than those required by this Section, for which the components are in accordance with the requirements of this Section, shall be submitted to the Engineer for approval.
- K. Manufacturer shall provide an independent agency test report demonstrating qualification of terminations and splices to the load cycling requirements of MV-105 specifications for 105C continuous operation and 140C emergency operation.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced and certified cable splicer to install, splice, and terminate medium-voltage cable.
- B. Manufacturer Qualifications: Firm with 20 years experience in manufacturing medium-voltage cable and accessories similar to those indicated for this Project, with a record of successful in-service performance. Wires and cables manufactured more than 1 year prior to installation shall not be used on the project. Manufacturer shall employ quality assurance system which conforms to the requirements of ISO 9000.
- C. Testing Firm Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control Services," an independent testing firm shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).
 - 1. Testing Firm's Field Supervisor Qualifications: A person currently certified by the NETA or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- D. Comply with NFPA 70 "National Electrical Code" for components and installation.
- E. Comply with HH-I-553 "Insulation Tape, Electrical (Rubber, Natural and Synthetic)" for identification.
- F. Comply with IEEE 48 "High Voltage AC Cable Terminators, Test Procedure and Requirements".
- G. Comply with IEEE 383 "Type Test of Class 1E Electric Cables, Field Splices and Connections for Nuclear Power Generating Stations".

- H. Comply with IEEE 404 "Standard for Type Test of Cable Joints for Use with Extruded Dielectric Cable Rated 5,000 through 46,000 Volts, and Cable Joints for Use with Laminated Dielectric Cable Rated 2,500 through 500,000 Volts.
- I. Comply with IEEE 837 "Standard for Qualifying Permanent Connections Used in Substation Grounding".
- J. Comply with UL 44 "Rubber-Insulated Wires and Cables".
- K. Comply with UL 467 "Grounding and Bonding Equipment".
- L. Comply with UL 510 "Insulating Tape" for cable identification.
- M. Comply with UL 1581 "Reference Standard for Electrical Wires, Cables, and Flexible Cords".
- N. Comply with IEEE C2 "National Electrical Safety Code" for components and installation.
- O. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed and Labeled": As defined in the "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- P. Single-Source Responsibility: All medium-voltage cable provided for this project shall be the product of a single manufacturer.
- Q. Certifications: Certifications shall be submitted including certification of the Qualifications of Medium-Voltage Cable Installers, Certified Factory and Field Test Reports, and certificates of compliance submitted in lieu of other proofs of compliance with these contract provisions.
- R. Certified Field Test Reports: Field tests shall be made and test reports shall be written and certified by the Contractor to the engineer. Field tests shall include cable, operational, and resistance-to-ground tests.
- S. Certification of the Qualifications of Medium-Voltage Cable Installers: A minimum of 30 days before splicing, the Contractor shall submit a certification, to and for the approval, that contains the names and the qualifications for persons recommended to perform the splicing and termination of medium-voltage cables approved for installation under this Contract. The certification shall indicate that persons recommended to perform actual splicing and terminations have been adequately trained in the proper techniques and have had at least 3 recent years of experience in splicing and terminating the same or similar types of cables approved for installation. In addition, persons recommended by the Contractor may be required to perform a dummy or practice splice and termination, in the presence of the owners Representative, before being approved as a qualified installer of medium-voltage cables. If that additional requirement is imposed, the Contractor shall provide short sections of the approved types of cables along with the approved type of splice and termination kits, and detailed manufacturer's instruction for the proper splicing and termination of the approved cable types.

- T. The following tests for wires and cables shall be performed and certified reports of these tests shall be submitted to the Engineer:
 - 1. Jacket tests in accordance with ICEA S-93-639.
 - 2. Cable tests in accordance with AEIC CS-8.
- U. The test results shall be certified for each reel/coil/box of wire or cable.
- V. Factory inspection and witnessing of tests by the Owners Representative shall be required for all wires and cables furnished under this Contract. The Owners Representative reserves the right to require additional testing, or to waive factory inspection or witnessing of tests. The Contractor shall notify the Engineer 14 days in advance of the scheduling of the scheduling of such factory tests.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver medium-voltage cable on factory reels conforming to NEMA WC 26.
- B. Store cables on reels on elevated platforms in a clean and dry location, protected from the weather.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cables:
 - a. The Kerite Company.
 - b. The Okonite Company.
 - c. South Wire.
 - d. General Cable
 - 2. Cable Splicing and Terminating Products and Accessories:
 - a. ElastiMold
 - b. 3M
 - c. MAC Products, Inc.
 - d. G & W
 - e. Raychem – Tyco Electronics
 - f. Engineer Approved Equal.

2.02 CABLES

- A. This specification section describes the requirements for ethylene-propylene rubber (EPR) or

kerite ethylene-propylene (EP) insulated, tape-shielded power cables, designed to operate at conductor temperatures of 105°C. normal, 140°C. emergency, and 250°C. short circuit conditions as defined by ICEA S-93-639 (NEMA WC-74) and Underwriters Laboratories (UL) Standard 1072. The cables shall be suitable for installation above or below grade, indoors or outdoors and in wet or dry locations. Qualifying cables shall be UL labeled as MV-105, 133% insulated, Sunlight Resistant and For Use (UL), in accordance with UL Standard 1072. The cable covered under this specification shall be manufactured and tested in accordance with AEIC CS8-00 and ICEA S-93-639.

- B. Conductors shall be compressed or compact, Class B stranded, copper in accordance with the requirements of ICEA S-93-639. Copper conductors shall consist of all bare strands or tin coated strands in the outer layer in accordance with ASTM B3, B8, B33, and B496.
- C. Conductor shield (stress control layer) shall be an extruded, black-colored, non-conducting or semiconducting thermoset material in accordance with Section 3.3.2 of ICEA S-93-639. The minimum point thickness shall be in accordance with AEIC CS-8-00.
- D. Insulation shall be a Type IV discharge resistant, EP based compound per Section 4.3.2 of ICEA S-93-639 and be listed by UL. The minimum average thickness of the insulation shall be in accordance with Table I.

TABLE 1

Rated Voltage	Conductor Size	Insulation Thickness	Jacket Thickness	AC Test Voltage*
kv	AWG/kcmil	(mils)	(mils)	
15	2-750	220	80	44 kv (5 min)

*Coordinate final test voltages and durations with manufacturer.

- E. Insulation shielding shall consist of a non-metallic conducting or semiconducting material extruded directly over the insulation and under a 5 mil bare copper tape. The non-metallic layer shall be black-colored with properties conforming to the requirements of Table 5.1 of ICEA S-93-639 and 15.2 of UL-1072 and thickness per Tables 15.3 of UL-1072. The layer shall be free stripping from the EP insulation. The 5 mil bare copper tape shall be helically applied with a 25% overlap directly over the non-metallic layer.
- F. Overall jacket shall be extruded black-colored polyvinyl chloride (PVC) material with physical properties per Table 7.1 of ICEA S-93-639 and in accordance with Table 7-3 of ICEA S-93-639 and shall be surface printed as required by UL 1072.
- G. Optional FR jacket shall be an extruded black-colored chlorinated polyethylene (CPE) based material specially formulated to resist electrical discharge, moisture, oil, heat and sunlight complying with the physical properties of Table 7.1 of ICEA S-93-639 and thickness in accordance with Table 7.3 of ICEA S-93-639 and shall be surface printed as required by UL Standard 1072.
- H. Production testing shall consist of the following:

1. Continuous DC spark testing of the non-conducting stress control layer prior to extrusion of the EP insulation.
2. Mooney Viscosity, Scorch Viscosity, and Specific Gravity of each batch of the EP insulation prior to extrusion. (From suppliers certificate of compliance)
3. AC voltage withstand test for a 5 minute duration of each finished cable at the values specified in Table 1 of this specification.
4. Volume resistivity of the non-metallic shield. (From suppliers certificate of compliance)
5. DC resistance of all insulated conductors and metallic shields.
6. Dimensional verification of all extruded layers.
7. Absence of water in conductors and interfaces confirmed.

I. Warranty

1. The manufacturer shall warrant solely to the purchaser that the medium voltage cable (cable) furnished by the manufacturer under this specification shall be free from defects in material and workmanship provided that the cable is utilized under the conditions contemplated and covered by the design specifications and further provided that the cable is installed, spliced, terminated, maintained, and operated in accordance with the manufacturer's recommended standards and procedures.
2. If the cable fails electrically while in service, the purchaser shall notify the manufacturer within five (5) days of the discovery of this failure and shall permit a representative of the manufacturer a reasonable opportunity to inspect the cable. If it is mutually determined by the purchaser and the manufacturer that the failure is the result of defective material or workmanship, the manufacturer's sole responsibility under this warranty shall be to repair or replace the defective cable, the choice of which will be at the manufacturer's option. If the manufacturer chooses to replace the cable, the new cable will be delivered free of charge to the delivery point called for in the original order.
3. The manufacturer will not be responsible for any damage or failure caused by the purchaser or any third party including, without limitation, acts of God.
4. The manufacturer will not be responsible for any defects or repairs to, or replacement of, adjacent or connected equipment to which the cable may supply electrical power or from which it may take electrical power, or with which it may, in any mannere, be associated. The manufacturer will not be responsible for any incidental or consequential damages whatsoever, either direct or indirect, resulting from a failure of the cable.
5. The above warranty shall be exclusive and in lieu of all other warranties whether written, oral, expressed or implied including, but not limited to, any warranty of merchantability or fitness for a particular purpose.

- J. All wires and cables shall be delivered with end seals at each end of each cable to prevent the entrance of moisture. The end seals shall be solder-wiped seal, cold shrinkable cap or heat shrinkable cap.
- K. The outer jacket of each cable shall be printed with the manufacturer's name, type of insulation, size of conductor, rated voltage, year of manufacture, insulation thickness and UL listing. Each reel shall carry a tag identifying manufacturer, cable type, size, voltage and length of cable on reel.
- L. Medium voltage cables shall be suitable for rated circuit voltage. Other parts of the cable system, such as joints and terminations, shall have ratings not less than the rating of the cables on which they are installed. Separable insulated connectors shall have nominal voltage ratings coordinated to associated apparatus ratings rather than cable ratings when used to connect cable to the apparatus. Cables shall be provided with 133 percent insulation level.
- M. Medium voltage cables and conductors in manholes shall be fireproofed for the entire length within a manhole on an individual cable basis. Fireproofing shall extend at least one (1) inch into any duct. Systems shall be listed in the FM Approval Guide as a fire protective coating for grouped electrical conductors and shall be suitable for application on the type of medium voltage cable provided under this specification. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewerage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.
 - 1. Preapplication: Plastic tape wrapping shall be applied before application of fireproofing tape over exposed metallic items such as the cable ground wire, metallic outer covering or armor to minimize the possibility of corrosion from the fireproofing materials or moisture. Plastic tape shall be pressure sensitive, 10 mil thick, conforming to Fed. Spec. HH-I-595. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty.
 - 2. Fireproofing Tape Application: A Flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spiraling in one-half laped wrapping or in two butt-jointed wrappings with the second wrapping covering the joints of the first.
- N. Cable Tags: Provide stainless steel metal tags, No. 28 gauge and ¾ inch wide, embossed with letters and numbers 5/16 inch high, fastened to the cable at both ends of tags with nominal 1/16 inch diameter monel metal wire or stainless steel cable ties. Provide at all points in the cable run where cable cannot be readily identified, including manhole, pull points, etc.

2.03 SPLICING, TERMINATING AND ARCPROOFING MATERIALS

- A. General
 - 1. All splicing, terminating and arcproofing materials shall be compatible so that no one material will adversely affect the physical or electrical properties of any other, or of the wire or cable itself.

2. All materials for making splices and terminations shall be specifically designed for use with the type of wire or cable, insulation and installation and operating conditions of the specific application.
3. Insulation shall be rubber-based, 125-mil elastic filler putty; 1-1/2 inches wide; Scotch (3M) Scotchfil, or approved equal.

2.04 SPLICE KITS

- A. Connectors: IEEE 404 and 592, compression type, as recommended by cable or splicing kit manufacturer for the application.
- B. Splices shall meet the full electrical and physical integrity of the wire and cable construction, including voltage rating, ampacity, BIL, and type of waterproofing.
- C. Splicing Products: As recommended in writing by the splicing kit manufacturer for the specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions. Approved methods include the following but splice types must be consistent.
 1. Premolded ethylene propylene diene monomer (EPDM) splicing body kit with cable joint sealed by interference fit of mating parts and cable.
 2. Utility Applications: Premolded ethylene propylene diene monomer (EPDM) splicing body kit with cable joint sealed by interference fit of mating parts and cable.
 - a. High voltage in-line splices shall be fully compatible with cables described in Section 2.02 and shall contain all necessary components to reinstate primary cable insulation, semi-con shielding, metallic shielding and grounding systems, and overall jacket to the equivalent of the cable itself. Splices shall be of a uniform cross-section and shall consist of heat-shrinkable radiation cross-linked material. The semi-conducting layer shall be bonded to the underlying insulating layer to ensure no air gaps between the layers. High voltage splices shall be Raychem HVS or engineer approved equal.
 - b. High voltage cable splices shall be qualified to IEEE-404 standards and shall be capable of properly splicing cables described in Section 260513.2.02. Splices shall be qualified to the water submersion tests described in ANSI-C119.2. Splices shall be tested by a third party agency to meet the performance requirements of the MV-105 standards with 105C continuous operating temperature/140C emergency operating temperature.
 - c. Hand-taped or pre-molded rubber splice are not allowed.
 - d. The splice shall be rejacketed with a heavy wall, heat-shrinkable, sealant-lined sleeve to provide a waterproof hot melt adhesive seal.
- D. See Section 260544 - "Underground Electrical Work" for additional requirements.
- E. Shields and ground straps shall be applied as required to continue the shielding system

through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint. Ground straps shall be flexible, tinned copper braid of equivalent gauge to wire shielding.

- F. Each splice shall be bonded to ground, using a flexible ground strap, 2 feet long, not less than #6 AWG or equivalent size.

2.05 SOLID TERMINATIONS

- A. Conductor Terminations: Comply with IEEE Standard 48, as indicated. Insulation class equivalent to that of the cable. Terminations for shielded cables shall include a shield grounding strap.
- B. The cable termination must have a voltage class rating equal to or greater than the cable being terminated. The rating shall be 5, 8.7, 15, 25/28 kV or 35 kV as an IEEE Standard 48-1990 Class 1 termination. It must have a maximum continuous operating temperature rating of 105° C, with an emergency overload rating of 104° C. The termination stress control shall be capacitive and constructed of Hi-K stress control compound and a Hi-K EPDM rubber tube. The installation procedure shall not require using silicone grease. The termination insulator shall be of a non-skirted tubular design, constructed of tracking resistant silicone rubber, dark gray in color. The termination must be of a pre-stretched Cold Shrink design, installed without the application of a heat source. The termination kit shall include a one-piece, non-skirted, silicone rubber termination with solderless mechanical ground assembly, and shall accommodate tape (ribbon), wire, or UniShield shielded cables.
- C. The Class 1 termination kits shall be used with listed copper or aluminum compression lugs.
- D. Solid termination kits shall be EM QT-III series, or approved equal.

2.06 SEPARABLE INSULATED CONNECTORS

- A. Dead-break Insulated Connectors System
 - 1. The 600 Amp separable insulated connector system shall be rated for continuous operation on single-conductor shielded power cables rated up to 25 kV. The system components shall be designed in accordance with the specifications listed in ANSI/IEEE Standard 386 for 600 Amp deadbreak interfaces. The system shall be made up of specific kits designed for splicing, tapping (adding-on), dead-ending and 600 Amp equipment (apparatus) connecting. Each kit shall contain all of the components necessary for its intended application, except for the connector, cable sizing adapter and shield adapter, which shall be contained in a separate adapter kit. The system shall be capable of making dead-end, 2-way, 3-way or multiple tap splices, and of making connections to ANSI/IEEE 386 specified 600 Amp apparatus bushings.
 - 2. Modular splicing system shall be 3M #4815 series, or approved equal.
 - 3. Protective Cap for Separable Conductors: Insulating, electrostatic-shielding,

water-sealing cap.

4. Standoff Insulator for Separable Conductors: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable elbow terminator.
5. Tool Set: Shotgun-type hot stick with energized terminal indicator, fault indicator test tool, and carrying case. (Provide one stick per piece of terminating equipment.)

B. Load Break Elbows

1. 200 Amp load break elbows shall be rated for continuous operation on single-conductor power cables rated up to 15kV. The system components shall be designed in accordance with the specifications listed in ANSI/IEEE Standard 386 for load break elbows. The system shall be made up of specific kits designed for terminating underground cable to transformers, switching cabinets and junctions equipped with load break bushings. Load break elbows should be molded using high quality peroxide-cured EPDM insulation. Standard features, shall include a coppertop connector, tin plated copper loadbreak probe with an ablative arc-follower tip, stainless steel pulling eye and capacitive test point.
2. 200 Amp load break elbows shall be 3M #5810 series, or approved equal

C. Protective Cap for Separable Conductors: Insulating, electrostatic-shielding, water-sealing cap.

D. Standoff Insulator for Separable Conductors: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable elbow terminator.

E. Tool Set: Shotgun-type hot stick with energized terminal indicator, fault indicator test tool, and carrying case. (Provide one stick per loop switch.)

2.07 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: 10-mil (250-micron) -thick, corrosion-protective, moisture-resistant PVC pipe-wrapping tape.

B. Arc-Proofing Tape: NRTL-listed fireproofing tape, flexible, conformable, and compatible with the cable jacket on which used.

C. Glass Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.08 CABLE FAULT INDICATORS

A. Indicators: Indicator shall be housed in a sealed, semi-conductive rubber boot which will enable it to be utilized in wet locations. The unit shall contain a closed core current transformer which shall be used both for current sensing of faults and providing power to

operating the FCI. The unit shall have a fish eye highly visible orange reflective target display which cannot be reset by mechanical vibration. Units shall be supplied with “arms” to concentrate the magnetic flux of the phase on which the indicator is applied, as well as shield the unit from the flux of adjacent phases. Units shall be designed for use on 200A or 600A separable load break elbows respectively.

2.09 SOURCE QUALITY CONTROL

- A. Test and inspect cables according to NEMA WC 8 before shipping. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig. (35 KPa).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine new and existing raceways to receive medium-voltage cables for compliance with installation tolerances and other conditions affecting performance of the cable. Prior to pulling wires and cables clean raceway systems of all foreign matter and perform all operations necessary so as not to cause damage to wires and cables while pulling. Prior to pulling wires and cables into underground conduit systems, place a feeding tube approved by the Engineer at the entrance end of such systems. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install medium-voltage cable in ducts, manholes and electric service rooms as indicated, according to manufacturer's written instructions and IEEE 576. Cable joints are only acceptable in manholes.
- B. Keep wires and cables dry at all times.
- C. Seal wire and cable ends with watertight end seals if splicing or terminating does not follow at once.
- D. Before splicing or terminating wires and cables, make a thorough inspection to determine that water has not entered the wires and cables or that the wires and cables have not been damaged.
- E. Pull conductors simultaneously where more than one cable is indicated in same raceway. Use NRTL-listed and manufacturer-approved pulling compound or lubricant. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- F. Use pulling means including, fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable. Basket grips may be used only for pulling tensions up to 1000 pounds per grip.
- G. Install exposed cable parallel and perpendicular to surfaces of exposed structural members

and follow surface contours where possible.

- H. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.
- I. Install splices at pull points and elsewhere as indicated using standard kit. Conform to kit manufacturer's written instructions. All medium voltage wires and cables shall be spliced in each manhole through which they pass, unless otherwise shown on the Contract Drawings, or unless the Contractor submits pulling tension and side wall pressure calculations and they are approved by the Engineer. Sufficient slack shall be provided for future splicing.
- J. Install terminations at ends of conductors with standard kits. Conform to manufacturer's written instructions. Comply with classes of terminations indicated.
- K. Install separable insulated connector components where indicated in accordance with manufacturer's written instructions.
 - 1. Quantities: Provide the following quantities of components as a minimum:
 - a. Protective Cap: Install at each terminal junction, 1 on each terminal to which no feeder is indicated to be connected.
 - b. Standoff Insulator: 3.
- L. Arc-Proofing: Arc-proof all medium-voltage cable at locations not protected by conduit, cable tray, or termination materials except where indicated. Apply as follows and as recommended by the manufacturer of the tape.
 - 1. Clean cable sheath.
 - 2. Wrap metallic cable components with 10-mil (250-micron) pipe wrapping tape.
 - 3. Smooth surface contours with electrical insulation putty.
 - 4. Apply arc-proofing tape in one half-lapped layer with the coated side toward the cable.
 - 5. Band the arc-proofing tape with 1-inch (25mm) -wide bands of half-lapped adhesive glass-cloth tape 2 inches (50 mm) on center.
 - 6. Wires and cables shall be grouped by circuit and arcproofing applied over the group of cables comprising one circuit. Splices shall be arcproofed individually and the taping shall join with and be overlapped by the group taping.
- M. All cables passing through fire rated elements shall be in conduit sleeves and firestopped.
- N. Fault Indicators: Install fault indicators on each phase at each manhole and at termination points.

3.03 MEGOHMETER TESTING OF INSULATION RESISTANCE (IR)

- A. Connected equipment (switches, relays, buswork, transformers, etc.) may have lower IR values than the cable, or may not be capable of withstanding the test voltage applied by the "Megger" and so should be disconnected, if possible, before any testing is done.
- B. Leakage current from conductor ends to "ground" flowing over wet or dirty wire and cable ends will act to make IR look low. Therefore, tests should be performed to the greatest extent possible when working areas is dry. Wire/cable ends should always be cleaned and dried by wiping them with a cloth or wiper which has been moistened with suitable solvent. Test should be performed as soon as cleaning/drying is completed.
- C. The IR of many insulations is affected by temperature. The higher the temperature, the lower the apparent IR and vice versa. The constants given below are for insulation systems at a uniform 60°F. If the total system, or parts of it, are at temperatures which are above or below 60°F, a correction factor may have to be applied to determine the "true" IR. However, if the measured IR of the system is equal to, or greater than, the calculated value, a correction to "true" value is probably not needed for practical purposes.
- D. If there are any questions on this point, contact cable manufacturer for specific information.
- E. The target value for the IR of a particular cable can be calculated using the formula:

$$IR = K \text{ Log } (D/d)$$

Where :

- IR = Insulation resistance in megohms 1000 feet at 60°F*
- K = Specific insulation resistance constant in megohms - 1000 feet at 60°F (see values below)
- D = Diameter over insulation, mils
- d = Diameter under insulation, mils

Values of K for Typical Insulations

Crosslinked	
Polyethylene:	
Low voltage cables (0)-2000 volts)	10,000
High voltage cables (>2000 volts)	20,000
Polyethylene	50,000
Polyethylene-	
PVC composite	30,000
PVC	2,000
Ethylene Propylene	
Rubber:	
Low voltage cables (0)-2000 volts)	10,000
High voltage cables (>2000 volts)	20,000

Synthetic Rubber 2,000
Ozone Resistant
Butyl Rubber 20,000

***Note: Measured IR is inversely proportional to cable length; i.e. a cable of 500 ft. will exhibit twice the IR of 1000 foot length, and 2000 foot length will have the IR of 1000 feet.**

F. High Voltage Direct (D-C) Test After Installation

D-C field testing is the most effective means of certifying medium voltage cable integrity, from splices and terminations to full circuit performance.

The following information lists the recommended field test voltages for 15 kv shielded cable with all 133% insulation level, pertinent comments on the performance of tests and step-by-step procedures when conducting such tests.

POST-INSTALLATION 15 MINUTE DC TEST VOLTAGE

Rated Voltage Phase to Phase kV	Conductor AWG or Kemil	Minimum Average Insulation Thickness mils		Field DC Test Voltage, kV	
		<u>A</u>	<u>B</u>	<u>Insulation Thickness A</u>	<u>Insulation Thickness B</u>
15	8 to 1000	175	220	55	65

G. Note that the test voltages are only recommended for cables which have not been put in service.

H. The following are requirements and recommendations applicable to D-C testing:

1. In order to obtain leakage current readings that are most representative of the cable system, and to insure against flashovers to other structures, it is best and often necessary to remove the bus ties or aerial jumpers from the terminals before performing such tests.
2. In addition, it is sometimes necessary to "smooth" any sharp edges or points of the hardware on the terminal top fittings using a soft, putty-like insulating compound. This helps reduce stress concentration and corona discharge off such sharp projections. Alternatively, or in addition, a clean, dry plastic bucket or trash can (with any metallic fittings removed) is placed over the top of the terminals to effectively lengthen the leakage path to a surrounding grounded structure. Note that the far-end terminals must be treated in the same manner.
3. All surfaces of the terminal insulators should be carefully wiped to remove any dust and left completely clean and dry for the test, since surface contamination or moisture will significantly increase leakage current flow over the surface of the terminals.

4. For the same reason, such testing is normally not performed in inclement weather (rain, snow, sleet, fog) when there are outdoor terminations involved. The most representative test results will be obtained when the tests are performed under cool, dry weather conditions.
 5. After each cable has been tested, its conductor should be grounded, using a properly terminated resistor, to drain off the electrical charge that has accumulated in the cable. To ensure that this charge has been completely drained, the conductor should be grounded for a period of time equal to or not less than 5 times the test period.
 6. If there is any doubt that this has been done, ground the cable with a grounding stick before starting any work after such testing has been performed.
- I. The following Leakage Current characteristics of significance in evaluating the condition of the cable are:
1. Linearity of the leakage current at a number of incremental voltages between zero and the prescribed test voltage.
 2. The behavior of the leakage current when the prescribed test voltage is reached and maintained for the duration of the test.
- J. With a reliable system, the current will drop rapidly from the value indicated when the test voltage is first reached, with the decrease gradually diminishing until the current becomes stable at a value well below the peak.
- K. Instability of the leakage current (provided that it is not caused by test set supply voltage fluctuations or corona discharge at terminals) may be an indication of incipient breakdown. In such cases, an extension of the test period may be appropriate to precipitate breakdown, thereby pinpointing the problem and making location possible.
- L. If the leakage current does not decrease, or begins increasing after an initial drop, it is a strong sign of trouble in the cable system. As noted above, one course of action in such cases is to extend the test so as to precipitate breakdown and make location of the defective section possible.
- M. In general, it is not considered meaningful to compare values of leakage current measured on the same cable at different times, or on different but like cable at the same time. The reason being, there are many factors (cable temperature, number and type of splices, type of terminals, cleanliness of terminal surfaces, length of cable circuit, air temperature and humidity, etc.) which can affect these measurements and which can make such direct comparisons less than meaningful.
- N. Step-by-Step Procedure for D-C Field Testing:
1. Ground all conductors, except the one to be tested.
 2. Connect cable shield to ground; ground any adjacent equipment.

3. Ensure adequate clearance of the conductor/terminals to be tested from ground to prevent flash over.
4. Carefully wipe terminals to remove any dust.
5. Corona-proof conductor/terminal ends of cable by taping sufficient level to prevent corona. If cable is terminated in potheads, cover pothead stub and cap with polyethylene bucket or bag.
6. Fence conductor/terminal ends for personnel safety.
7. Preliminary step "Megger" cable to be tested. Any cable which exhibits low "Megger" readings is questionable and should be cleared before the high voltage D-C test is performed.
8. Connect output of test set to conductor/terminal to be tested and connect ground terminal of test set to ground.
9. Bring D-C voltage up to prescribed test level in five equal steps. Raise the voltage at an even rate, so as to reach the required level in not less than 10 seconds. Hold the voltage at each step for 60 seconds. Read and record the leakage current at the end of each hold period.
10. Hold the full test voltage for not less than 10 minutes or more than 15 minutes. Read and record the leakage current at 15 second intervals for the first 2 minutes and then every minute for the duration of the test.
11. Bring the test voltage control quickly and smoothly to zero. Read and record the voltage remaining on the cable after 30 seconds and one minute.

Discharge the cable to ground using a properly terminated resistor stick. When the test set voltmeter indicates zero voltage on the cable, attach a solid ground to the terminal/cable, then disconnect the test set and resistor stick.
12. Test each conductor/cable in the circuit in the circuit in the same manner.
13. Record all data concerning the circuit and test results.

3.04 GROUNDING

- A. Ground the shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware according to manufacturer's written instructions. Unless otherwise shown on the Contract Drawings, grounding conductors shall be Class B stranded for sizes 600 volt rated, XHHW or RHW. Covering shall be a continuous green color and conform to ASTM B 33 and UL 44.

3.05 IDENTIFICATION

- A. Identify all cable using color coded tape under metallic scheduling and also in accordance with Division 26 Section 260553 "Electrical Identification."
- B. Each wire and cable shall be identified by its circuit in all cabinets, boxes, manholes, handholes, wire ways, and other enclosures, and at all terminal points.
- C. The circuit designations shall be as shown on the Contract Drawings. Tags shall be attached to wires and cables in such a manner as to be readily visible.
- D. The tag ties shall be wrapped around all conductors comprising the circuit or feeder to be identified.
- E. Wires and cables which are arcproofed shall be identified under arcproofing and outside the applied arcproofing.

3.06 FIELD QUALITY CONTROL

- A. Testing Firm: Provide the services of a qualified independent testing firm to perform specified field quality-control testing.
- B. Testing: Upon installation of medium-voltage cable and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA Standard ATS, Section 7.3.2. Certify compliance with test parameters.
- C. After installation and before the operating test or connection to the existing system, the medium-voltage cable system will be given a high potential test in accordance with AEIC CS6. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The method, voltage, length of time and other characteristics of the test shall be in accordance with NEMA WC 8, and shall not exceed the recommendations of IEEE No. 404 for cable joints and IEEE No. 48 for cable terminations unless the cable and accessory manufacturers indicated higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed.
- D. Correct malfunctioning cables and accessories at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest until entire installation is satisfactory to the Engineer.
- E. Ground wires and cables shall be tested to prove continuity and proper connections to equipment and ground rods. The Contractor shall certify all field testing and shall submit the test results to the Engineer for approval.

3.07 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Owner, to prevent entrance of moisture into the cable and ensure that medium-voltage cable is without damage or deterioration at Substantial Completion.

END OF SECTION 260513

SECTION 311110 - SITE CLEARING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this Section.

- B. Related Sections:
 - SECTION 017329 - MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK
 - SECTION 311316 - TREE AND SHRUB PROTECTION AND TRIMMING
 - SECTION 312316 - EARTHWORK FOR STRUCTURES AND UTILITIES
 - SECTION 321216 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321413 - REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321313 - REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330130 - REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330160 - REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 323113 - CHAIN LINK FENCES AND GATES
 - SECTION 329113 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT

- C. Contractor shall refer to Section 1010 - "Summary of Work", Section 1500 - "Temporary Facilities" and the "Temporary Power and Sequence of Connections" notes for each building as shown on drawings inclusive, for the sequencing required to accomplish the work.

1.02 SUMMARY

- A. This Section generally includes, but is not necessarily limited to, the following site clearing work:
 - 1. Protection of existing trees.
 - 2. Removal of trees and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Removing and restoration above-grade improvements.

5. Removing and restoration below-grade improvements.
6. Stripping topsoil.
7. Removal and restoration of existing sidewalks, roads and pavement.

1.03 PROJECT CONDITIONS

- A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, pavements and other adjacent occupied or used facilities. Do not close or obstruct streets, walks, pavements or other occupied or used facilities without permission from authorities having jurisdiction.
- B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements.
 1. Protect improvements adjoining the work site.
 2. Restore damaged improvements to their original condition, as acceptable to Design Professional.
- C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide 4' high snow fence to protect trees and vegetation to be left standing. Install fence at drip line of trees.
 1. Water trees and other vegetation to remain within limits of contract work as required to maintain their health during course of construction operations.
 2. Provide protection for roots over 1-1/2 inch diameter that are cut during construction operations. Cover exposed roots with earth as soon as possible.
 3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to Design Professional. Employ a qualified, per 02122 arborist to repair damages.
 4. Replace trees which cannot be repaired and restored to full-growth status, as determined by arborist.

PART 2 - PRODUCTS (Not applicable)

PART 3 - EXECUTION

3.01 SITE CLEARING

- A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. "Removal" includes digging out and off-site disposing of stumps and roots.

1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.
- B. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.
1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
 - a. Remove heavy growths of grass from areas before stripping.
 - b. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.
 2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.
 3. Dispose of unsuitable or excess topsoil, same as specified for disposal of waste material.
- C. Clearing and Grubbing: Where shown, clear site of trees, shrubs and other vegetation, which may interfere with the new construction indicated to be left standing.
1. Completely remove stumps, roots, and other debris protruding through ground surface.
 2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
 - a. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.
- D. Removal and Restoration of Improvements: Remove and restore existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
1. Abandonment or removal of certain underground pipe or conduits may be indicated on mechanical or electrical drawings, and is included under work of related Division 23 and 26 sections. Removal of abandoned underground piping or conduit interfering with construction is included under this Section.

3.02 DISPOSAL OF WASTE MATERIALS

- A. Burning on Owner's Property: Burning is not permitted on Owner's property.
- B. Removal from Owner's Property: Remove waste materials from Owner's property.
- C. Debris removal shall be performed by the close of the work date that debris was unearthed.

END OF SECTION 311100

SECTION 311316 - TREE AND SHRUBS PROTECTION AND TRIMMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this Section.
- B. Related Sections:
 - SECTION 017324 - MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK
 - SECTION 311110 - SITE CLEARING
 - SECTION 312316- EARTHWORK FOR STRUCTURES AND UTILITIES
 - SECTION 321216 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321413- REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321313 - REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330130 - REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330160 - REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 323113 - CHAIN LINK FENCES AND GATES
 - SECTION 329113 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT
- C. Contractor shall refer to Section 1010 - "Summary of Work", Section 1500 - "Temporary Facilities" and the "Temporary Power and Sequence of Connections" notes for each building as shown on drawings inclusive, for the sequencing required to accomplish the work.

1.02 SUMMARY

- A. This Section generally includes, but is not necessarily limited to, trimming and protection of trees that are indicated to remain but interfere with or are close to new construction, as herein specified.
 - 1. Trees which are to be removed are generally indicated on the drawings.

2. Trees which are to remain and must be protected are generally indicated on the drawings.
3. No tree is to be removed except within the footprint of the new above and underground construction.
4. Removal, storing and replanting of shrubs.

1.03 SUBMITTALS

- A. Certification: Submit written certification by qualified arborist that trees and shrub indicated to remain have been protected during the course of construction in accordance with recognized standards and that where damage did occur, trees and shrubs were promptly and properly treated. Indicate which damaged trees and shrubs (if any) are incapable of retaining full growth potential and are recommended to be replaced.

1.04 QUALITY ASSURANCE

- A. Arborist Qualifications: Engage a qualified arborist who has successfully completed tree and shrubs protection and trimming, to perform the following work:
 1. Remove branches from trees and trimming that are to remain, if required.
 2. Recommend procedures to compensate for loss of roots and perform initial pruning of branches and stimulation of root growth where removed to accommodate new construction.
 3. Recommend procedures for excavation and grading work juxtaposed to established plants.
 4. Perform tree repair work for damage incurred by new construction.

1.05 PROJECT CONDITIONS

- A. Temporary Protections: Provide temporary fencing, barricades, or other suitable guards located outside drip-line (outer perimeter of branches) to protect trees and other plants that are to remain from damage.
- B. Protect Root Systems: Do not store construction materials, debris, or excavated material within drip line of trees to remain.

Do not permit vehicles within drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems within drip line.

PART 2 - PRODUCTS

2.01 PRODUCTS

- A. See Section 02201 for requirements.

PART 3 - EXECUTION

3.01 GENERAL

- A. Protect tree root systems from damage due to noxious materials caused by run-off or spillage during mixing, placement, or storage of construction materials. Protect root systems from flooding, eroding, or excessive wetting resulting from dewatering operations.
- B. Do not allow fires under or adjacent to trees or other plants that are to remain.
- C. Remove branches from trees that are to remain, if required to clear new construction.
 - 1. Where directed by Design Professional, extend pruning operation to restore natural shape of entire tree.
 - 2. Cut branches and roots, if required, with sharp pruning instruments; do not break or chop.

3.02 EXCAVATION AROUND TREES

- A. Excavate within proximity of trees only where indicated. Do not machine excavate within drip-line.
- B. Where excavating for new construction is required within drip line of trees, hand excavate to minimize damage to root systems. Provide sheeting at excavations if required. Use narrow-tine spading forks and comb soil to expose roots.
 - 1. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of new construction and relocation is not practical, cut roots approximately 3 inches back from new construction.
- C. Do not allow exposed roots to dry out before permanent backfill is placed; provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.
- D. Where trenching for utilities is required within drip line, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots; cut only smaller roots that interfere with installation of new work. Cut roots with sharp pruning instruments; do not break or chop.
- E. Prune branches to balance loss to root system caused by damage or cutting of root system.

3.03 GRADING AND FILLING AROUND TREES AND SHRUBS

- A. Maintain and restore existing grade within drip-line of trees.

3.04 REPAIR AND REPLACEMENT OF TREES

- A. Repair trees damaged by construction operations. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.
- B. Remove and replace dead and damaged trees that arborist determines to be incapable of restoration to normal growth pattern.
 - 1. Provide new trees and shrubs of same size and species as those being replaced.
 - 2. If trees over 6 inches in caliper measurement (taken 12 inches above grade) are required to be replaced, provide new trees of 6-inch caliper size and of species selected by the Design Professional.

3.05 DISPOSAL

- A. Burning on Owner's property of removed trees and branches is not permitted on site.
- B. Removal from Owner's Property: Remove excess excavation, displaced trees, and trimmings and dispose of off Owner's property.

END OF SECTION 311316

SECTION 312316 - EARTHWORK FOR STRUCTURES AND UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

- B. Related Sections:
 - SECTION 330160- MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK
 - SECTION 311110 - SITE CLEARING
 - SECTION 321316 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 321414 - REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330130 - REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 330160 - REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 323113 - CHAIN LINK FENCES AND GATES
 - SECTION 019329 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT
 - SECTION 033000 - CAST-IN PLACE CONCRETE
 - SECTION 055000 - METAL FABRICATIONS

- C. Contractor shall refer to Section 1010 - "Summary of Work", Section 1500 - "Temporary Facilities" and the "Temporary Power and Sequence of Connections" notes for each building as shown on drawings inclusive, for the sequencing required to accomplish the work.

1.02 SUMMARY

- A. This Section includes: Earthwork related to furnishing and installing underground electric work, utilities, structures, conduits, or other related appurtenances, more specifically, requirements for trench excavation, refilling, bedding, backfill construction and restoration of existing pavements, turf and grades. It does not include specific material requirements or fabrication instructions for underground electrical conduit bank, structures, and appurtenances which are covered in other sections of the project specifications.

- B. This Section includes the following:

1. Preparing of subgrade for building slabs, areaways, walks, and pavements.
 2. Drainage fill course for support of building slabs and areaways are included as part of this work.
 3. Subbase course for walks, areaways and pavements.
 4. Subsurface drainage backfill for walls, areaways and trenches.
 5. Excavating and backfilling of trenches.
 6. Excavating and backfilling for underground mechanical and electrical utilities and buried mechanical and electrical appurtenances.
- C. This Section includes: Earthwork construction necessary for the restoration of existing earth work disturbed by the work of the contract serving existing: exterior storm drainage system exterior sanitary drainage system, exterior water distribution systems exterior steam and condensate system conduits and tunnels, existing telephone systems, existing communications systems, CCTV systems, site lighting systems, structures and appurtenances.
- D. Additional Requirements for Excavating and Backfilling for Underground/Electrical Work: Refer to Division 26 sections for additional requirements required in conjunction with underground electrical, conduit banks, utilities and buried electrical structures and appurtenances.
- E. Final grading, together with placement and preparation of topsoil for lawns and planting, is specified in Division 2, "Restoration Landscape Work."

1.03 DEFINITIONS

- A. Backfill: Material used in refilling a trench or other excavation.
- B. Base Course: The layer placed between the subbase and surface pavement in a paving system.
- C. Borrow: Soil material obtained off-site when sufficient approved soil material is not available from excavations.
- D. Cohesive Materials: Soils classified by ASTM D 2487 as GC, SC, ML, CL, MH, and CH. Materials classified as GM and SM will be identified as cohesive only when fines have a plasticity index greater than zero.
- E. Cohesionless Materials: Soils classified by ASTM D 2487 as GW, GP, SW, and SP. Materials classified as GM and SM will be identified as cohesionless only when the fines have a plasticity index of zero.
- F. Compaction: The method of mechanically stabilizing a material by increasing its density at a controlled moisture condition as set forth in the New York State D.O.T. Standard Specifications. "Degree of Compaction" is expressed as a percentage of the maximum density

obtained by the test procedure described in ASTM D 698 or D 1557 for general soil types or ASTM D 4253 or ASTM D 4254 for isolated cohesionless materials.

- G. Drainage Fill: Course of washed granular material supporting slab-on-grade placed to cut off upward capillary flow of pore water.
- H. Excavation consists of removal of material encountered to subgrade elevations specified, indicated, or required and subsequent disposal of materials removed.
 - 1. Unauthorized excavation consists of removal of materials beyond indicated specified or required subgrade elevations or dimensions without specific direction of Design Professional. Unauthorized excavation, as well as remedial work directed by Design Professional, shall be at Contractor's expense.
 - a. Under footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation. Lean concrete fill may be used to bring elevations to proper position, when acceptable to Design Professional.
 - b. In locations other than those above, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Design Professional.
 - 2. Additional Excavation: When excavation has reached required subgrade elevations, notify Design Professional, who will make an inspection of conditions. If Design Professional determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Design Professional.
- I. Granular Pipe Bedding: A dense, well-graded aggregate mixture of sand, gravel, or crushed stone (mixed individually, in combination with each other, or with suitable binder soil) placed on a subgrade to provide a suitable foundation for pipe.
- J. Lift: A layer or course of soil placed on top of unprepared subgrade or a previously prepared or placed soil in a fill or backfill.
- K. Subbase Course: The layer placed between the subgrade and base course in a paving system or the layer placed between the subgrade and surface of a pavement or walk.
- L. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular subbase, drainage fill, or topsoil materials.
- M. Structure: Buildings, foundations, manholes, handholes, drainage inlets, catch basins, drywells, leaching basins, culverts, spill ways, drainage structures, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.
- N. Topsoil: In natural or undisturbed soil formations, the fine-grained, weathered material on the surface or directly below any loose or partially decomposed organic matter. Topsoil may be a

dark-colored, fine, silty, or sandy material with a high content of well decomposed organic matter, often containing traces of the parent rock material. Gradation and material requirements specified herein apply to all topsoil references in this Contract. The material shall be representative of productive soils in the vicinity. (See USDA Soil Conservation reports for New York State).

- O. Unyielding Material: Rock or soil with cobbles in the trench bottom requiring a covering of finer grain material or special bedding to avoid bridging in the pipe or conduit.
- P. Satisfactory Materials: Satisfactory materials shall consist of any material classified by ASTM D 2487 as GW, GP, and SW.
- Q. Unsatisfactory Material: Soil or other material identified as having insufficient strength or stability to carry intended loads on trench backfills without excessive consolidation or loss of stability. Also backfill material which contains refuse, frozen material, large rocks, debris, and other material which could damage the pipe or cause the backfill not to compact. Materials classified as PT, OH, or OL by ASTM D 2487 are unsatisfactory.
- R. Unstable Material: Material in the trench bottom which lacks firmness to maintain alignment and prevent joints from separating in the pipe, conduit, or appurtenance structure during backfilling. This may be material otherwise identified as satisfactory which has been disturbed or saturated.

1.04 SUBMITTALS

- A. Test Report: Submit the following reports directly to Design Professional from the testing services, with copy to Contractor:
 - 1. Test reports on borrow material.
 - 2. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
 - 3. Field report; in-place soil density tests.
 - 4. One optimum moisture-maximum density curve for each type of soil encountered.
 - 5. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
- B. Certified Test Reports
 - 1. Underdrain backfill material.
 - 2. Concrete.
 - 3. Trench backfill material.
 - 4. Pipe bedding material.
 - 5. Topsoil.
 - 6. Submit test reports for all non-native materials and for native materials deemed by, the College's representative to be of questionable quality.

C. Manufacturers Certificates of Compliance

1. Filter fabric.
2. Warning and identification tape.
3. Kraft paper.
4. Conduit casing.
5. Casing end seals.
6. Wood preservative and treatment.

D. Contractor Provide Drawings, Shop Drawings, and Certifications

1. Shoring and Sheeting Plan: Describe materials of shoring system to be used. Indicate whether or not components will remain after filling or backfilling. Provide plans, sketches, or details along with calculations by a professional engineer registered in the state in which the project is located. Indicate sequence and method of installation and removal.
2. Dewatering Plan: Describe methods for removing collected water from open trenches and diverting surface water or piped flow away from work area. Describe equipment and procedures for installing and operating the dewatering system indicated. Describe the basic components of the dewatering system proposed for use and its planned method of operation. Record performance and effectiveness of method or system in use and submit weekly.
3. Temporary Continuation of Service Plans: Describe methods, procedures, equipment and services to provide continuous services of all utilities (electric, water, sanitary sewer, storm sewer, gas, telephone, communications, etc.). Describe the basic components and methods of operation.
4. Conduit casing fabrication drawings.
5. Proposed method of boring and jacking.
6. Certifications of each welder's qualifications prior to on-site welding.
7. Location of borrow materials.

E. Reports of Field Testing

1. Test for Moisture-Density Relation: Submit ten (10) days prior to commencing utility excavation.
2. Topsoil Tests: Submit topsoil tests verifying conformance to required parameters prior to commencing seeding and sodding, planting, operations.
3. Density and Moisture Tests: Submit within ten (10) days of test date.

Submit any field test data not listed above sufficiently in advance of construction so as not to

delay work.

- F. Soil materials shall be obtained from a New York State D.O.T. approved source.

1.05 QUALITY ASSURANCE

- A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.
- B. Testing and Inspection Service: Contractor shall employ a qualified independent geo-technical testing and inspection laboratory to perform soil testing and inspection service during earthwork operations. The costs of tests shall be paid for by the College.
- C. Testing Laboratory Qualifications: To qualify for acceptance, the geo-technical testing laboratory must demonstrate to Design Professional's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct required field and laboratory geo-technical testing without delaying the progress of the Work.
- D. Quality Control Testing
1. Testing Facilities: Tests shall be performed by an approved commercial testing laboratory. No work requiring testing will be permitted until the facilities have been inspected and approved by the Design Professional. Cost incurred for any subsequent inspection required because of failure of the first inspection will be charged to the Contractor.
 2. Testing of Backfill Materials: Characteristics of backfill materials shall be determined in accordance with particle size analysis of soils ASTM D 422 and moisture-density relations of soils ASTM 1557, method (D). A minimum of one particle size analysis and one moisture-density relation test shall be performed on each different type of material used for bedding and backfill. A mechanical tamper may be used provided the results are correlated with those obtained by the referenced hand tamper in ASTM D 1557, method D.
 3. Construction Quality Control: Quality control sampling and testing during construction shall be performed as hereinafter specified.
 4. Copies of all laboratory and field test reports shall be submitted to the Design Professional within 24 hours of the completion of the test.
- E. Codes
1. All State and Federal: Codes, rules, regulations and ordinances.
 2. O.S.H.A.
 3. New York State Uniform Code.
 4. New York State DEC.

- F. Applicable Publications: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The Publication in effect at the time of bidding shall be considered the basis of this specification. The Engineer will bring a copy of the applicable publication to the scheduled job meetings as directed by the College.
1. American Concrete Pipe Association (ACPA) Publication:

Concrete Pipe Installation Manual (for existing pipe earthwork disturbed by the work of the Contract).
 2. American National Standards Institute (ANSI) Publications:

B31.8 Gas Transmission and Distribution Piping Systems (for existing pipe earthwork disturbed by the work of the Contract).
 3. American Society for Testing and Materials (ASTM) Publications:

C 12 Installing Vitrified Clay Pipe Lines (for existing pipe earthwork disturbed by the work of the Contract).
C 14 Concrete Sewer, Storm Drain, and Culvert Pipe (for existing pipe earthwork disturbed by the work of the Contract).
C 33 Concrete Aggregates.
C 76 Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (for existing pipe earthwork disturbed by the work of the Contract).
D 422 Particle-Size Analysis of Soils
D 698 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (305-mm) Drop.
D 751 Coated Fabrics.
D 1140 Amount of Material in Soils Finer Than the No. 200 (75-micrometer) Sieve.
D 1556 Density of Soil in Place by the Sand Cone-Method.
D 1557 Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop.
D 1682 Breaking Load and Elongation of Textile Fabrics.
D 2316 Installing Bituminized Fiber Drain and Sewer Pipe (for existing pipe earthwork disturbed by the work of the Contract).
D 2487 Classification of Soils for Engineering Purposes.
D 2922 Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
D 4253 Maximum Index Density of Soils Using Vibratory Table.
D 4254 Minimum Index Density of Soils and Calculation of Relative Density.
D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 4. American Water Works Association (AWWA) Publications

C300 Reinforced Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids (for existing pipe earthwork disturbed by the work of the Contract).

- C600 Installation of Ductile-Iron Water Mains and Their Appurtenances (for existing pipe earthwork disturbed by the work of the Contract).
 - C603 Installation of Asbestos-Cement Pressure Pipe (for existing pipe earthwork disturbed by the work of the Contract).
 - M9 Concrete Pressure Pipe (for existing pipe earthwork disturbed by the work of the Contract).
 - M11 Steel Pipe Design and Installation (for existing pipe earthwork disturbed by the work of the Contract).
 - M23 PVC Pipe-Design and Installation (for existing pipe earthwork disturbed by the work of the Contract).
5. American Wood Preserver's Association (AWPA) Publications
- C2 Lumber, Timbers, Bridge Ties and Mine Ties-Preservative Treatment by Pressure Process.
 - P5 Water-Borne Preservatives.
6. American Welding Society (AWS) Publication
- D1.1 Structural Welding Code, Steel.
7. National Electrical Manufacturers Association (NEMA) Publications
- TC 6 PVC and ABS Plastic Utilities Duct for Underground Installation.
8. National Fire Protection Association (NFPA) Publications
- NFPA 30 Flammable and Combustible Liquids Code.
 - NFPA 70 The National Electrical Code Handbook.
9. United States Army Corps of Engineers (COE) Publications
- EM-385-1-1 Safety and Health Requirements Manual.
10. U.S. Department of Agriculture (USDA) Publication
- April 1972 Soil Survey Investigation Report No. 1, Soil Survey Laboratory and Procedures for Collecting Soil Samples, Soil Methods or latest Conservation Service Edition
11. State of New York, Department of Transportation (DOT).
- Standard Specifications for Construction and Materials January 2, 1990, or latest edition.
12. Manual of Uniform Traffic Control Devices
- Department of Transportation
 - Traffic and Safety Division

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1.06 DELIVERY AND STORAGE

- A. Deliver and store materials in a manner to prevent contamination, segregation, freezing, and other damage. Store synthetic fiber filter fabric to prevent exposure to direct sunlight.

1.07 PROTECTION OF EXISTING STRUCTURES AND NEW UTILITIES

- A. Become familiar with the existence of all utilities on the site belonging to the College, State, Local, Municipal and other public service corporations on/or adjoining the site of the work including but not limited to: Water, Gas, Electric, Telephone, TV, Communications, Steam, Condensate, Tunnels, etc.
- B. Do not perform any work which will subject the utilities or structures to damage.
- C. Do not remove or cause to be removed any structure or part of a structure owned by a public utility corporation Local Sub-Division, State, or other Agencies, and the College without the written approval of the Engineer.
- D. Cooperate with public utility corporations and the College whose structures (aerial, surface or sub-surface) are within the limits of or along the outside of the right-of-way to make it possible for them to maintain uninterrupted service.
- E. The term utility shall also apply to the site heat distribution systems, site gas, site water, site electrical and sewer systems, drainage, telephone and CCTV systems, etc.
- F. Excavations shall not be made around Local Sub-Division, and State monuments and bench marks until the said monuments of marks have been referenced and reset or otherwise disposed by the Chief Engineer of the Bureau of Highways and the Local Sub-Division. The necessary labor and materials required to remove, care for, and reset all such monuments and bench marks shall be furnished by the Contractor.
- G. Obtain site utility marking from site representatives of each Utility Co. and from the College.

1.08 STRUCTURAL SUPPORT OF STRUCTURES AND UTILITIES

- A. Shoring and Sheeting: Provide structural support, shoring, bracing, cribbing, trench boxes, underpinning and sheeting for all existing or new structures and utilities. Include provisions in the shoring and sheeting plan that will accomplish the following:
 - 1. Prevent undermining of areaways, structures, pavements and slabs, underground utilities such as steam tunnels, electric, gas, water, TV, tunnels, etc.
 - 2. Prevent slippage or movement in banks or slopes adjacent to the excavation.
 - 3. Allow for the abandonment of shoring and sheeting materials in place in critical areas

as the work is completed. In these areas, backfill the excavation to the required elevation and remove the remaining exposed portion of the shoring before completing the backfill.

B. Dewatering: Plan for and provide the structures, equipment, and construction for the collection and disposal of surface and subsurface water encountered in the course of construction.

1. Dewatering Plan: Base on site surface and subsurface conditions, available soil, and hydrological data. Remove water by pumping or other methods to prevent the softening of surfaces exposed by excavation, prevent hydrostatic uplift, and provide a stable trench condition for installation of the utility. Use screens and gravel packs or other filtering systems on the dewatering devices to prevent the removal of fines from the soil.
2. Operation and Performance: Operate the dewatering system continuously until construction work below existing water levels is complete. Measure and record the performance of the dewatering system at the same time each day with observation wells and piezometer installed in conjunction with the dewatering system.

C. Utilities: Movement of construction machinery and equipment over, electric conduits banks, conduits, pipes and utilities during construction shall be at the Contractor's risk. Perform all work adjacent to non-Owner utilities as indicated in accordance with procedures outlined by Con Edison. Excavation made with power-driven equipment is not permitted within ten (10) feet of any known utility or subsurface construction. For work immediately adjacent to or for excavations exposing a utility or other buried obstruction, use hand or light equipment excavation. Start hand or light equipment excavation on each side of the indicated obstruction and continue until the obstruction is uncovered or until clearance for the new grade is assured.

Support uncovered lines or other existing work affected by the Contract excavation until approval for backfill is granted by the College's Representative. Report damage to utility lines or subsurface construction immediately to the Engineer.

D. Structures and Surfaces: Protect newly backfilled areas and adjacent structures, slopes, or grades from traffic, erosion settlement, or any other damage. Repair and reestablish damaged or eroded grades and slopes and restore surface construction prior to acceptance. Protect existing streams, ditches, and storm drain inlets from water-borne soil by means of straw bale dike filter fabric dams as indicated on the contract drawings. All work shall be conducted in accordance with requirements of OSHA and NYSDEC.

1. Legally dispose of excavated material so that it will not obstruct the flow of streams, endanger a partly finished structure, impair the efficiency or appearance of any facilities, or be detrimental to the completed work.
2. Stockpile coarse rock from trench excavations in the location directed by the Design Professional.

E. Channels and Ditches: Construct rock protection (rip-rap) in areas indicated to the lines and

thicknesses specified indicated to dissipate stream energy and prevent channel erosion. Place rip-rap in bedding of granular material grout on a layer of filter fabric.

- F. Conduit Casing Under Pavement: Where permitted by Design Professional, the Contractor may provide new smooth wall steel pipeline casing under existing pavement in a trench by the boring and jacking method of installation. Provide each conduit casing to the lengths and dimensions required, complete and suitable for use with the new utility as approved by Design Professional.

1. Earthwork for Conduit Casings: Provide excavation, sheet piling, shoring, dewatering, and backfilling for casings under this section.

1.09 PROJECT CONDITIONS

- A. Site Information: The survey drawings bound within the documents show sub-surface utility lines used for the basis of the design shall be used for information only. Conditions are not intended as representations or warranties of accuracy of utility locations. The College will not be responsible for interpretations or conclusions drawn from this data by Contractor.

1. Test borings, non-intrusive tests for utilities and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.

- B. Existing Utilities: Locate existing underground utilities in areas of excavation work by hand excavation and by non-intrusive tests. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

1. Should uncharted, or incorrectly charted, conduit, piping or other utilities be encountered during excavation, consult the Engineer immediately for directions. Cooperate with College and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of the Engineer.

2. Do not interrupt existing utilities serving facilities occupied by College or others, during occupied hours, except when permitted in writing by the College and then only after acceptable temporary utility services have been provided.

- a. Provide minimum of five (5) working days' notice to the College or Con-Edison and receive written notice to proceed before interrupting any utility.

3. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with College and Engineer for shutoff of services if lines are active.

- C. Use of Explosives: Use of explosives is not permitted. Do not bring explosives onto site.

- D. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

1. Operate warning lights after sundown to sun up seven (7) days per week for the entire periods excavations are not backfilled and grades restored to their original condition

and as required by the College and authorities having jurisdiction.

2. Protect structures, utilities, sidewalks, areaways, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
3. Perform excavation by hand where new work is in close proximity to existing structures and existing utilities.
4. Perform excavation by hand within dripline of large trees to remain. Protect root systems from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with moistened burlap.
5. Install and maintain sediment and erosion control devices for the duration of construction in accordance with Erosion Control Plan and "The Manual of New York Guidelines for Urban Erosion and Sediment Control."

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Provide soil materials as described below free of debris, roots, wood, scrap materials, vegetable matter, refuse, soft unsound particles, ice, or other deleterious and objectionable materials.
- B. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP.
- C. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GC, SC, ML, MH, CL, CH, OL, OH, and PT.
- D. Sub-base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, and natural or crushed sand.
- E. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2 inch sieve and not more than 5 percent passing a No. 4 sieve.
- F. Drainage Fill: Washed, evenly graded mixture of 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 not more than 5 percent passing a No. 8 sieve.
- G. Backfill and Fill Materials: Materials New York State D.O.T. standard specifications complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension, debris, wastes, frozen materials, and vegetable and other deleterious matter.
 1. Backfill: Bring trenches to grade indicated on the drawings using material excavated on the site of this project. This material will be considered unclassified and no

testing other than for compaction will be required before use as backfill classified as GM, SM, SC, by ASTM D 2487 with a maximum particle size of 3 inches conforming to gradation of New York State, DOT Standard Specification..

2. Special Backfill for Roads and Paved Areas: Backfill trenches under roads and paved areas with material conforming to gradation of New York State, DOT Standard Specification. With material conforming to the requirements stated above except that the liquid limit of the material cannot exceed 35 percent when tested in accordance with ASTM D 4318, the plasticity index cannot exceed 12 percent when tested in accordance with ASTM D 4318, and not more than 25 percent by weight can be finer than the No. 200 sieve when tested in accordance with ASTM D 1140.
3. Sand: Clean, coarse-grained sand classified in accordance with the gradation set forth in the New York State DOT Standard Specification or SW or SP by ASTM D 2487 for bedding and backfill as indicated.
4. Gravel: Clean, coarsely graded natural gravel, crushed stone or a combination thereof gradation of New York State D.O.T. Standard Specification or having a classification of GW, GP in accordance with ASTM D 2487 for bedding and backfill as indicated. Maximum particle size shall not exceed 3 inches.
5. Backfill for Under Drainage Systems: Clean sand, crushed rock, or gravel meeting the following requirements:
 - a. Perforated or Slotted-Wall Pipe: Backfill meeting requirements of New York State D.O.T. Standard Specification.
 - b. Open Joint Pipe: Materials as described in New York State D.O.T. Standard Specification.
 - c. Blind or French Drains: Backfill meeting requirements of New York State D.O.T. Standard Specification.
 - d. Any Type Drain Used With Filter Fabric: Clean gravel or crushed stone or gravel conforming to New York State D.O.T. Standard Specification.
6. Topsoil: Salvaged topsoil from stockpile. Prior to spreading, test the topsoil, and add the necessary soil amendments to bring the material within the ranges described in New York State D.O.T. Specifications. Furnish additional topsoil from approved sources off the site meeting the requirements described in Table 2 if stockpiled material is insufficient to complete work indicated.

** OR **

Topsoil: Free of subsoil, stumps, rocks larger than one inch in diameter, brush, weeds, toxic substances, and other material or substance detrimental to plant growth. Topsoil shall be a natural, friable soil representative of productive soils in the vicinity. Modify the topsoil provided if necessary to meet the requirements described

in New York State D.O.T. Specification.

7. Borrow: Meeting requirement for general site fill backfill granular fill topsoil. Obtain borrow materials in excess of those furnished from excavations described herein from sources off the College's property. Borrow areas indicated.
8. Pipe Bedding: Provide material for pipe bedding where the existing pipe earth work is disturbed by the work of the Contract. See Part 3 of this Section of the project specification for material; material's reference and installations reference.

2.02 CONCRETE PIPE CRADLES OR ARCHES

- A. Existing concrete pipe cradles and arches disturbed by the work of the Contract shall be replaced with cradles and arches with concrete having a 28-day compressive strength of 3,000 psi.

2.03 FILTER FABRIC

- A. Provide a pervious sheet of polyester, nylon, glass or ultraviolet resistant, polypropylene filaments woven, spun bonded, fused, or otherwise manufactured into a nonraveling fabric with uniform thickness and strength. The fabric shall have the following manufacturer certified properties:
 1. Grab tensile strength (ASTM D 1682) min. 90 lbs
machine and transverse direction
 2. Grab elongation (ASTM D 1682) min. 15-70 percent
machine and transverse direction
 3. Puncture strength (ASTM D 751) min. 50 lbs
 4. Mullen burst strength (ASTM D 751) min. 100 psi
 5. Equivalent opening (CW02215) 70-100

2.04 BURIED WARNING AND IDENTIFICATION TAPE

- A. Provide metallic core, acid and alkali-resistant, polyethylene plastic warning tape manufactured specifically for warning and identification of buried utility lines. Provide tape on rolls, 3 inch-minimum width, color coded as stated below for the intended utility with warning and identification imprinted in bold black letters continuously over the entire tape length. Warning and identification to read, "CAUTION, BURIED (intended service) LINE BELOW" or similar wording. Color and printing is to be permanent, unaffected by moisture or soil. Provide warning tape for all new electric work and for all uncovered other existing utility and site services.

Warning Tape Color Codes

Red: Electric

Yellow: Gas, Oil, Dangerous Materials
Orange: Telephone and Other Communications
Blue: Water Systems
Green: Sewer Systems
White: Steam Systems

1. Warning Tape for Metallic Piping: Acid and alkali-resistant polyethylene plastic tape conforming to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.003 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise with a maximum 350 percent elongation.
2. Detectable Warning Tape for Electric Concrete Bank Enclosure and Non-Metallic Piping: Polyethylene plastic tape conforming to the width, color, and printing requirements indicated above. Minimum thickness of the tape shall be 0.004 inch. Tape shall have a minimum strength of 1500 psi lengthwise and 1250 psi crosswise. The tape shall be manufactured with integral wires, foil backing, or other means of enabling detection by a metal detector when the tape is buried up to 3 feet deep. Encase the metallic element of the tape in a protective jacket or provide with other means of corrosion protection.

2.05 MATERIAL FOR PIPE CASING

- A. Casing Pipe: ASTM A 139, Grade B, or ASTM A 252, Grade 2, smooth wall pipe. Casing size shall be of the outside diameter and wall thickness as indicated. Protective coating is not required on casing pipe.
- B. Wood Supports: Treated Yellow Pine or Douglas Fir, rough, structural grade. Provide wood with nonleaching water-borne pressure preservative (ACA or CCA) and treatment conforming to AWPA P5 and C2, respectively. Secure wood supports to carrier pipe with stainless steel or zinc-coated steel bands.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Protect subgrades and foundation soils against freezing temperatures or frost. Provide protective insulating materials as necessary.
- C. Provide erosion control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- D. Tree protection is specified in the Division 2 Section "Site Clearing."

3.02 EXCAVATION

- A. Excavation is unclassified and includes excavation to subgrade elevations required, regardless of character of materials and obstructions encountered.

3.03 SURFACE PREPARATION

- A. Stockpiling Topsoil: Strip suitable soil from the site where excavation or grading is required and stockpile separately from other excavated material. Material unsuitable for use as topsoil shall be stockpiled and used for backfilling. Locate topsoil so that the material can be used readily for the finished grading. Where sufficient existing topsoil conforming to the material requirements is not available on site, provide borrow materials suitable for use as topsoil. Protect topsoil and keep in segregated piles until needed.
- B. Cutting Pavement, Curbs, and Gutters: Saw cut with neat, parallel, straight lines one foot wider than trench width on each side of trenches and one foot beyond each edge of pits.

3.04 STABILITY OF EXCAVATIONS

- A. General: Comply with State, and Federal: Codes, ordinances, and requirements of all agencies having jurisdiction.
- B. Slope sides of excavations to comply with codes, ordinances, and requirements of agencies having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
- C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers, and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Extend shoring and bracing as excavation progresses.
 - 1. Provide permanent steel sheet piling or pressure-creosoted timber sheet piling wherever subsequent removal of sheet piling might permit lateral movement of soil under adjacent structures. Cut off tops a minimum of 2'-6" below final grade and leave permanently in place.

3.05 DEWATERING

- A. Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to stability of subgrades and foundations. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rain water and water removed from excavations to

collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.

3.06 STORAGE OF EXCAVATED MATERIALS

- A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust.
1. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.
 2. Dispose of excess excavated soil material and materials not acceptable for use as backfill or fill.
 3. Provide straw bales around the entire base of stockpiled materials to control sediment transport.

3.07 EXCAVATION FOR STRUCTURES

- A. Conform to elevations and dimensions required within a tolerance of plus or minus 0.10 foot, and extending a sufficient distance from footings and foundations to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection.
1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed. Trim bottoms to required lines and grades to leave solid base to receive other work.
 2. Excavation for Underground Tanks, Basins, Electrical and Mechanical Structures: Conform to elevations and dimensions required within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, and other construction and for inspection. Do not disturb bottom of excavations, intended for bearing surface.
 3. Erosion and sediment control devices shall be put in place prior to the start of any excavation and shall remain in place until the disturbed area(s) has/have been stabilized.

3.08 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Cut surface under walks and pavements to comply with cross-sections, elevations and grades as required to install new work.

3.09 COLD WEATHER PROTECTION

- A. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 °F.

3.10 BACKFILL AND FILL

- A. General: Place soil material in layers to required subgrade elevations, for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under grassed areas, use satisfactory excavated or borrow material.
 2. Under walks and pavements, use subbase material, satisfactory excavated or borrow material, or a combination.
 3. Under steps, use subbase material.
 4. Under building slabs, use drainage fill material.
 5. Under electric conduit banks, piping, and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation. Shape excavation bottom to fit bottom 90 degrees of cylinder.
 6. Backfill trenches with concrete where trench excavations pass within 18 inches of column or wall footings and that are carried below bottom of such footings or that pass under wall footings. Place concrete to level of bottom of adjacent footing.
 - a. Concrete is specified in Division 3.
 - b. Do not backfill trenches until tests and inspections have been made and backfilling is authorized by Design Professional. Use care in backfilling to avoid damage or displacement of pipe systems.
 7. Provide 4-inch-thick concrete base slab support for existing piping less than 2'-6" below surface of roadways. Provide minimum 4-inch-thick encasement (sides and top) of concrete prior to backfilling or placement of roadway subbase.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 2. Inspection, testing, approval, and recording locations of underground utilities have been performed and recorded.
 3. Removal of concrete formwork.
 4. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
 5. Removal of trash and debris from excavation.
 6. Permanent or temporary horizontal bracing is in place on horizontally supported walls.

3.11 PLACEMENT AND COMPACTION

- A. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow strip, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
 - 1. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.
- B. Place backfill and fill 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.
- C. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- D. Place backfill and fill materials evenly adjacent to structures, piping, and electric conduit bank to required elevations. Prevent wedging action of backfill against structures or displacement of piping bank or conduit bank by carrying material uniformly around structure, piping, and electric conduit bank to approximately same elevation in each lift.
- E. Control soil and fill compaction, providing minimum percentage of density specified for each area classification indicated below. Correct improperly compacted areas or lifts as directed by Design Professional if soil density tests indicate inadequate compaction.
 - 1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density, in accordance with ASTM D 1557:
 - a. Under structures, building slabs and steps, and pavements, compact top 12 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 - b. Under lawn or unpaved areas, compact top 6 inches of subgrade and each layer of backfill or fill material at 90 percent maximum density.
 - c. Under walkways, compact top 6 inches of subgrade and each layer of backfill or fill material at 95 percent maximum density.
 - 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade or layer of soil material.

Apply water in minimum quantity as necessary to prevent free water from appearing on surface during or subsequent to compaction operations.

- a. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
- b. Stockpile or spread soil material that has been removed because it is too wet to permit compaction. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory value.

3.12 GRADING

- A. General: All existing grades shall be restored to their original condition. Uniformly grade areas within limits of grading under this section, including adjacent transition areas. Smooth finished surface within specified tolerances, compact with uniform levels or slopes with elevations the same as the existing grades.
- B. Grading Outside Building Lines: All new grade elevations shall match existing. Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

1. Lawn or Unpaved Areas: Finish areas to receive topsoil to within not more than 0.10 foot above or below required subgrade elevations.
 2. Walks: Shape surface of areas under walks to line, grade, and cross-section, with finish surface not more than 0.10 foot above or below required subgrade elevation.
 3. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than 1/2 inch above or below required subgrade elevation.
- C. Grading Surface of Fill under Building Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2 inch when tested with a 10-foot straightedge.
- D. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.13 SUBBASE AND BASE COURSES

- A. General: Subbase course consists of placing subbase material, in layers of specified thickness, over subgrade surface to support a pavement base course.
1. Refer to other Division 2 sections for paving specifications.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Shoulders: Place shoulders along edges of subbase course to prevent lateral movement. Construct shoulders of acceptable soil materials, placed in such quantity to compact to thickness of each subbase course layer. Compact and roll at least a 12-inch width of shoulder simultaneous with the compaction and rolling of each layer of subbase course.
- D. Placing: Place subbase course material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placement operations.
1. When a compacted subbase course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.14 BUILDING SLAB DRAINAGE COURSE

- A. General: Drainage course consists of placement of drainage fill material, in layers of indicated thickness, over subgrade surface to support concrete building slabs.
- B. Placing: Place drainage fill material on prepared subgrade in layers of uniform thickness, conforming to indicated cross-section and thickness. Maintain optimum moisture content for compacting material during placement operations.

1. When a compacted drainage course is indicated to be 6 inches thick or less, place material in a single layer. When indicated to be more than 6 inches thick, place material in equal layers, except no single layer more than 6 inches or less than 3 inches in thickness when compacted.

3.15 SPECIAL EXCAVATION AND BACKFILLING FOR UTILITY LINES AND UTILITY LINE STRUCTURES

A. Trench excavation for utility lines and utility structures

1. Keep excavations free from water while construction is in progress. Notify the Design Professional immediately in writing if it becomes necessary to remove specified, unstable, or otherwise unsatisfactory material to a depth greater than specified. Make trench sides as nearly vertical as practicable except where sloping of sides is allowed. Sides of trenches shall not be sloped from the bottom of the trench up to the elevation of the top of the electric conduit bank, conduit, or pipe. Excavate ledge rock, boulders, and other unyielding material to an overdepth at least six (6) inches below the bottom of the electric conduit bank, or pipe and appurtenances unless otherwise indicated or specified. Blasting will not be permitted. Excavate soft, weak, or wet excavations as required. Use bedding material, gravel, sand, placed in 6-inch-maximum layers to refill overdepth to the proper grade. At the option of the Contractor, the excavations may be cut to an overdepth of not less than 4 inches and refilled to required grade as specified. Grade bottom of trenches accurately to provide uniform bearing and support for each section of electric conduit bank, or pipe structure on undisturbed soil, or bedding material as indicated or specified at every point along its entire length except for portions where it is necessary to excavate for bell holes and for making proper joints. Dig bell holes and depressions for joints after trench has been graded. Dimension of bell holes shall be only 1/2 inch greater than length, width, and depth of bell, as required for properly making the particular type of joint to ensure that the bell does not bear on the bottom of the excavation. Trench dimensions shall be indicated, specified, or as directed.
 - a. Shoring and Sheeting: Shore and sheet excavations as described in the approved plan submitted with various member sizes arranged to prevent injury to persons and damage to structures. Also arrange shoring and sheeting to preclude injurious caving during removal. Obtain approval from the Engineer prior to removing any shoring, sheeting, or bracing in excavations adjacent to on-grade slabs, foundations, or other structural elements.

B. Bedding For Utility Lines and Utility Structures

1. Shall be of the materials and depths as indicated, specified or as directed for utility lines and utility line structures. Place bedding in 6-inch-maximum loose lifts. Provide uniform and continuous support for each section of structure except at bell holes or depressions necessary for making proper joints.
 - a. Refill: Defined as material placed in excavation to correct overcut in depth.

- b. Concrete Cradles: Specified in lieu of other types of bedding for a particular type of pipe material shall be as indicated, specified, or as directed.
 - c. Concrete encasements shall be as indicated on the drawings.
- C. Buried Warning and Identification Tape for Utility Lines
- 1. Install tape in accordance with manufacturer's recommendations except as modified herein. Bury tape at the depth of 12 inches below finished grade; under pavements and slabs, bury tape 6 inches below top of subgrade.
- D. Backfilling for Utility Lines
- 1. Construct backfill in two operations (initial and final) as indicated and specified in this section. Place initial backfill in 6-inch-maximum loose lifts to one foot above electric conduit bank and pipe lines unless otherwise specified. Ensure that initially placed material is tamped firmly under pipe haunches. Bring up evenly on each side and along the full length of the structure. Ensure that no damage is done to structures or their protective coatings. Place the remainder of the backfill in 9-inch-maximum loose lifts unless otherwise specified. Compact each loose lift as specified in paragraph "General Compaction" before placing the next lift. Do not backfill in freezing weather or where the material in the trench is already frozen or is muddy, except as authorized. Provide a minimum cover from final grade of four feet for water mains, gas mains, storm drains, and for sewer mains except where permitted otherwise by Design Professional. Where settlements greater than the tolerance allowed herein for grading occur in trenches and pits due to improper compaction, excavate to the depth necessary to rectify the problem, then backfill and compact the excavation as specified herein and restore the surface to the required elevation. Coordinate backfilling with testing of utilities. Testing for the following shall be complete before final backfilling: electric distribution system, water distribution, storm drainage, sanitary sewer, gas distribution systems. Provide buried warning and identification tape installed in accordance with the manufacturer's recommendation.
- E. Compaction for Utility Lines
- 1. Use hand-operated, plate-type, vibratory, or other suitable hand tampers in areas not accessible to larger rollers or compactors. Avoid damaging pipes and protective pipe coatings. Compact material in accordance with the following unless otherwise specified. If necessary, alter, change, or modify selected equipment or compaction methods to meet specified compaction requirements.
 - a. Compaction of Material for Subcuts or Over Excavations: In soft, weak, or wet soils, tamp material to consolidate to density of adjacent material in trench wall. In stable soils, compact to 95 percent of ASTM D 1557 maximum, D 4254 relative density.
 - b. Compaction of Pipe and Conduit Bedding: In soil, compact to 95 percent of ASTM D 1557 maximum, D 4254 relative, density.

- c. **Compaction of Backfill:** Compact initial backfill material surrounding pipes, cables, electric banks, to 95 percent of ASTM D 698, 1557, 4254 maximum density except where bedding and backfill are the same material. Where bedding and backfill are the same material, compact initial backfill to the density of the bedding. Under areas to be seeded or sodded, compact succeeding layers of final backfill to 85 percent of ASTM D 698, 1557, 4254 maximum density. For utilities under roads, streets, building slabs or other areas to be paved compact succeeding layers of final backfill as specified under paragraph entitled "Special Earthwork Installation Requirements."

F. Erosion Control

- 1. Erosion and sediment control devices shall be put in place prior to the start of any excavation and shall remain in place until the disturbed area(s) has/have been stabilized.

3.16 SPECIAL EARTHWORK INSTALLATION REQUIREMENTS

- A. **Standard Specification References:** In addition to bedding and backfill construction requirements stated above, place material in overcuts, bed material, and provide special backfill construction in accordance with the installation references identified in the following Table for the pipe materials and utility systems listed.

TABLE 1

MATERIAL	SOIL MATERIALS REFERENCE	INSTALLATION REFERENCE
1. PVC Plastic Conduits Banks Encased in Concrete	NEMA TC 6 NFPA 30, NFPA 70	See Specification Section 16375 and Section 16110
2. Existing Earth Work Disturbed by the work of the contract serving existing Cast-Iron Soil, Ductile Iron and Ductile Iron Pressure Pipe	AWWA C600, except refill of overcut shall be gravel, bedding shall be GW, GP, SW, SP.	AWWA C600
3. Existing Earth Work Disturbed by the work of the contract serving existing Vitrified Clay Pipe	ASTM C12 except Class A, concrete cradle or concrete arch shall be as indicated, Class B, gravel bedding installed as indicated, Class C, GW, GP, SW, SP, as approved.	ASTM C 12

- | | | | |
|-----|---|---|---|
| 4. | Existing Earth Work Disturbed by the work of the contract serving existing Concrete, Gravity, Sewer | ASTM C 76 (Reinforced)
ASTM C 14(Nonreinforced)
Class A, B, or C,
bedding material | ACPA
Concrete Pipe
Installation
Manual |
| 5. | Existing Earth Work Disturbed by the work of the contract serving existing Concrete Pressure Pipe | AWWA C300, AWWA M9,
except shall be
Type 3, Compacted
Excavated Material,
Type 4, GW, GP,
SW, SP, Type 5,
Low Concrete Cradle. | AWWA M9 |
| 6. | Existing Earth Work Disturbed by the work of the contract serving existing Metallic Water Service Line Pipe (Steel, Copper Tube, Brass) | AWWA C600 | AWWA C600 |
| 7. | Existing Earth Work Disturbed by the work of the contract serving existing Steel Gas Piping | ANSI B31.8-2 | |
| 8. | Existing Earth Work Disturbed by the work of the contract serving existing Steel Water Main | AWWA M11 | AWWA M11 |
| 9. | Existing Earth Work Disturbed by the work of the contract serving existing Polyvinyl Chloride (PVC) Nonpressure Pipe | ASTM D 2321, except
bedding shall be
Class I, gravel,
Class II, GW, GP,
SW, SP, Class III,
GM, GC, SM, SC.
Haunching to springline
shall be Class I, gravel,
Class II, GW, GP, SW,
SP, Class III, GW, GP,
SW, SP. | ASTM D 2321
AWWA M23 |
| 10. | Existing Earth Work Disturbed by the work of the contract serving existing Polyvinyl Chloride (PVC) Pressure Pipe | ASTM D 2774, except
bedding shall be GW,
GP, SW, SP, and all
material surrounding pipe
shall have maximum particle
size of 1/2 inch. | ASTM D 2774 |

11. Existing Earth Work Disturbed by the work of the contract serving existing Underground Heat Distribution Systems (Pre-fabricated or Pre-Engineered Types) Provide bedding and backfill material in accordance with system manufacturer's recommendations as approved in SUBMITTALS. Section 15705
- B. Manholes and Other Appurtenances: Provide at least 12 inches clear from outer surfaces to the embankment or shoring. Remove unstable soil that is incapable of supporting the structure to an overdepth of one foot and refill with gravel or sand to the proper elevation. Stabilize soft, weak, or wet excavations as indicated. Refill overdepths with gravel, sand, or concrete to the required grade and compact as specified to 95 percent of ASTM D 698, ASTM D 1557, maximum density.
- C. Steel Cased Conduit: Install casing by dry boring and jacking method as follows:
1. Hole for Conduit Casing: Mechanically bore holes and case through the soil with a cutting head on a continuous auger mounted inside the casing pipe. Weld lengths of pipe together in accordance with AWS D1.1. Do not use water or other fluids in connection with the boring operation.
 2. Cleaning: Clean the inside of the casing of dirt, weld splatters, and other foreign matter which would interfere with insertion of the utilities by attaching a cleaning plug to the boring rig and passing it through the casing.
 3. Utilities: Provide the utilities in the casing using wood supports adjusted to obtained grades and elevations indicated.
 4. End Seals: After installation of piped utilities in the casing, provide watertight end seals at each end of the pipeline casing between the pipeline casing and the piping utilities. Provide watertight end seals as indicated. Segmented elastomeric end seals.
 5. Roads, Streets, Building Slabs, and Other Areas to be Paved: Place final backfill in 6-inch-maximum loose lifts. If a vibratory roller is used for compaction of final backfill, the lift thickness can be increased to 9 inches. Compact all backfill surrounding electric conduit banks pipes, and other structures to 95 percent of ASTM D 1557 maximum density except compact the top 12 inches of subgrade to 95 percent of ASTM D 1557 maximum density. Backfill to permit the rolling and compacting of the completed excavation with the adjoining material, providing the specified density necessary to enable paving of the area immediately after backfilling has been completed.

3.17 SPECIAL EARTHWORK REQUIREMENTS FOR SUBSURFACE DRAINS

- A. Excavate to the dimensions required. Provide a bedding surface of no more than one inch of sand, gravel, Type I subdrain backfill material and place on compacted native soil, impermeable material as indicated. Backfill blind or french drains, around and over the pipes

after pipe installation has been approved. Place special backfill in 6 inch lifts and compact with mechanical, vibrating plate tampers or rammers until no further consolidation can be achieved. Compact backfill overlying the special granular filter material as specified for adjacent or overlying work.

B. Granular Backfill Without Filter Fabric

1. Perforated or Slotted Wall Pipe: Place granular material as the pipe is laid and extend fit for a minimum of one pipe diameter on each side of and 18 inches above the top of the pipe. Place a layer of kraft paper, straw, 2 inches thick, on top of the granular filter before continuing with the backfill.
2. Open-Joint Pipe: Place both types of granular material specified as the pipe is laid forming an aggregate filter around the pipe. Use Type II material to envelope the pipe a minimum of one-half the pipe diameter or twice the maximum aggregate size, whichever is larger, on each side and on top of the pipe. Place Type I material next to and on top of the Type II material to provide a total fill extending at least one pipe diameter on each side of and 18-inches above the top of the pipe. Place a layer of kraft paper, straw, 2 inches thick, on top of the granular filter before continuing with the backfill.

C. Granular Backfill Using Filter Fabric

1. Perforated or Slotted Wall Pipes: Wrap one layer of filter fabric around pipe in such a manner that longitudinal overlaps are in unperforated or unslotted quadrants of the pipe. Overlap fabric a minimum of 2 inches. Secure the fabric to the pipe so that backfill material will not infiltrate through overlaps. Place granular material and extend it for a minimum of one pipe diameter on each side of and 18 inches above the top of the pipe. Place a layer of filter fabric on top of the granular filter before continuing with the backfill.
2. Open-Joint Pipe: Wrap one layer of filter fabric around pipe joints overlapping a minimum of 2 inches in the longitudinal direction and extending at least 6 inches on both sides of the joint. Secure the fabric to the pipe so that backfill material will not infiltrate through overlaps. Place granular material specified and extend it for a minimum of one pipe diameter on each side of and 18 inches above the top of the pipe. Place a layer of filter fabric on top of the granular filter before continuing with the backfill.
3. Blind or French Drains: Install filter cloth in trenches with smoothly graded sides and bottom, free of cavities or projecting rocks. Lay the cloth flat but not stretched and secure with anchor pins. Place the filter cloth so that drain water must pass through the cloth into the specified granular filter material. Overlap ends at least of 12 inches. Place backfill on the filter cloth in the direction of overlaps. Where fabric is damaged, place a new piece of filter cloth over the damaged area and overlap at least of 12 inches in every direction.

3.18 FINISH OPERATIONS FOR UTILITY LINES

- A. Grading: Finish to grades to match existing within one-tenth of a foot. Provide topsoil. Grade areas to drain water away from structures. Grade existing grades that are to remain but have been disturbed by the Contractor's operations.
- B. Spreading Topsoil: Clear areas to receive topsoil for the finished surface of materials that would interfere with planting and maintenance operations. Scarify subgrade to a depth of 2 inches. Do not place topsoil when the subgrade is frozen, extremely wet or dry, or in other conditions detrimental to seeding, planting, or grading. Comply with the requirements of New York State D.O.T. Standard Specifications.
- C. Borrow Area: Grade to drain properly. Maintain and restore borrow pits as specified in Section 01560, "Environmental Protection."
- D. Disposition of Surplus Material: Surplus or other soil material not required or suitable for filling, backfilling, or grading shall be become property of the Contractor and shall be removed from College property.
- E. Protection of Surfaces: Protect newly graded areas from traffic, erosion, and settlements that may occur and as required. Repair or reestablish damaged grades, elevations, or slopes.
- F. Pavement Repair and Restoration: Repair and restore pavement, curbs, and gutters. Do not repair pavement until trench or pit has been backfilled and compacted as herein specified. Provide a temporary road surface over the backfilled portion until permanent pavement is repaired. Remove and dispose of temporary road surface material when permanent pavement is placed. Maintain traffic on roads and streets crossed by trenches.

3.19 FIELD SAMPLING AND TESTING FOR UTILITY LINES

- A. Test sand, gravel, bedding, backfill, topsoil, for conformance to specified requirements. Test bedding and backfill for moisture-density relations in accordance with ASTM D 698, D 1557 and D 4253 as specified herein. Perform at least one of each of the required tests for each material used sufficiently in advance of construction so as not to delay work. Provide additional tests as specified above for each change of source. Perform final tests on topsoil to assure adjustment of parameters into the ranges specified. Perform density and moisture tests in randomly selected locations and in accordance with ASTM D 1556, D 2992 and D 3017 as follows:
 - 1. Bedding and Backfill in Trenches: One test per 100 linear feet in each lift.
 - 2. Appurtenance Structures: One test per 200 square feet or fraction thereof in each lift.

Where ASTM D 2922 and ASTM D 3017 are used to test field compaction densities, verify the results of the tests by performing at least one test per day using ASTM D 1556 at a location already tested in accordance with ASTM D 2922. Perform at least one additional test using ASTM D 1556 for every ten tests performed with a nuclear device, also at locations checked in accordance with ASTM D 2922.

3.20 FIELD QUALITY CONTROL GENERAL

- A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method) or ASTM D 2167 (rubber balloon method), as applicable.
 - a. Field density tests may also be performed by the nuclear method in accordance with ASTM D 2922, providing that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. In conjunction with each density calibration check, check the calibration curves furnished with the moisture gauges in accordance with ASTM D 3017.
 - b. If field tests are performed using nuclear methods, make calibration checks of both density and moisture gauges at beginning of work, on each different type of material encountered, and at intervals as directed by the Design Professional.
2. Footing Subgrade: For each strata of soil on which footings will be placed, perform at least one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata when acceptable to Design Professional.
3. Paved Areas and Building Slab Subgrade: Perform at least one field density test of subgrade for every 2,000 sq. ft. of paved area or building slab, but in no case fewer than three tests. In each compacted fill layer, perform one field density test for every 2,000 sq. ft. of overlaying building slab or paved area, but in no case fewer than three tests.
4. Foundation Wall Backfill: Perform at least two field density tests at locations and elevations as directed.
5. If in opinion of Design Professional, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained.

3.21 EROSION CONTROL

- A. Provide erosion control methods in accordance with the requirements contained in the SWPPP.

3.22 MAINTENANCE

- A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
- B. Repair, restore, and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact

to required density prior to further construction.

- D. Settling: Where settling is measurable or observable at excavated areas during general project warranty period, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.23 DISPOSAL OF EXCESS AND WASTE MATERIALS

- A. Removal from College Property: Remove waste materials, including unacceptable excavated material, trash, and debris, and dispose of it off College property in a legal manner.

END OF SECTION 312316

SECTION 312323 - FLOWABLE FILL

PART 1 – GENERAL

1.01 INTRODUCTION

- A. Flowable fill refers to a slurry-like material consisting of a mixture of Portland cement, fine aggregate or mineral filler, water and/or fly ash, which is used as a fill or backfill in lieu of compacted earth. This mixture is self-leveling, can be placed in one lift with minimal labor and no vibration or tamping, capable of filling all voids in irregular excavations and hard to reach places and reaches 95% or more compaction within a few hours. Flowable fill is sometimes referred to as controlled density fill (CDF), controlled low strength material (CLSM), lean concrete slurry, and unshrinkable fill.
- B. This section specifies the requirements for flowable fill used for trenches, support for pipe structures, culverts, utility cuts and other works where cavities exist and where firm support is needed. The materials and mix design for the flowable fill should be designed to produce the desired compressive strength to the surrounding soil after hardening, making excavation at a later time possible using conventional excavation.

1.02 DESCRIPTION

- A. Furnish and place flowable fill in a fluid condition that sets within the required time and, after curing, obtains the desired strength properties as evidenced by the recommendations of ACI 229, at locations shown on the plans or as directed by the Resident Engineer.

1.03 DEFINITIONS

- A. Flowable Fill: Ready-mix controlled low strength material used as an alternative to compacted soil, and is also known as controlled density fill, and several other names, some of which are trademark names of material suppliers. Flowable fill (controlled low strength material) differs from Portland cement concrete as it contains a low cementitious content to reduce strength development for possible future removal. For excavatable mixes, the flowable fill material should be proportioned to produce a 28-day compressive strength of 75 to 100 psi. For use as a permanent structural fill, flowable fill can be designed to achieve 28-day compressive strengths of as high as 1200 psi. Chemical admixtures may also be used in flowable fill to modify performance properties of strength, flow, set and permeability.

1.04 SUBMITTALS

- A. Submit samples and shop drawings.
- B. Flowable Fill Mix Design: Provide flowable fill mix design containing Portland cement, fine aggregate and water. At the Contractor's option, it may also contain fly ash, aggregate, or chemical admixtures in any proportions such that the final product meets the strength and flow consistency, and shrinkage requirements included in these Specifications.
 - 1. Test and Performance: Submit the following data:

- a. Flowable fill shall have a minimum strength of 100 psi according to ASTM C 39 at 28 days after placement.
 - b. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 1/8 inch per ft. of flowable fill depth (for mixes containing high fly ash content). Measurement of a final bleeding shall be as measured in Section 10 of ASTM C 940 “Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory”.
 - c. Flowable fill shall have a unit weight of 90 - 115 lbs/ft³ measured at the point of placement after a 60 minute ready-mix truck ride.
- C. Provide documentation that the admixture supplier has experience of at least one year, with the products being provided and any equipment required to obtain desired performance of the product.
- D. Manufacturer's Certificates: Provide Resident Engineer with a certification that the materials incorporated in the flowable fill, following achievement of the required strength, do not represent a threat to groundwater quality.

1.05 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this Specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
- | | |
|-------------------------------|--|
| D4832-02 | Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders. |
| C618-03 | Standard Specifications for Coal Fly Ash and Raw or Calcined Natural Pozzolan for use as Mineral Admixture in Concrete. (Use Fly Ash conforming to the chemical and physical requirements for mineral admixture, Class F listed, including Table 2 (except for Footnote A). Waive the loss on ignition requirement.) |
| C403/C403M-05 | Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance. |
| C150-99 Rev.A-04 | Standard Specification for Portland Cement |
| C33-03 | Standard Specification for Concrete Aggregates |
| C494/C494M-04
C940 RevA-98 | Standard Specification for Chemical Admixtures for Concrete
Standard Specification for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced – Aggregate Concrete in the Laboratory |

- C. American Concrete Institute (ACI):
SP-150-94 Controlled Low-Strength Materials

1.06 QUALITY ASSURANCE

- A. Manufacturer: Flowable fill shall be manufactured by a ready-mix concrete producer with a minimum of 1 year experience in the production of similar products.
- B. Materials: For each type of material required for the work of this Section, provide primary materials that are the products of one manufacturer. If not otherwise specified here, materials shall comply with recommendations of ACI 229, "Controlled Low Strength Materials."
- C. Pre-Approval Procedures: The use of flowable fill during any part of the project shall be restricted to those incidences where, due to field conditions, the Contractor has made the Resident Engineer aware of the conditions for which he recommends the use of the flowable fill, and the Resident Engineer has confirmed those conditions and approved the use of the flowable fill, in advance. During the submittal process, the Contractor shall prepare and submit various flowable fill mix designs corresponding to required conditions or if the Contractor desires to use flowable fill due to economics. Approval for the strength of the flowable fill shall be obtained from the Resident Engineer when the Contractor desires, or is required, to use flowable fill at specific location(s) within the project. Prior to commencement of field operations, the Contractor shall establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. The flowable fill shall be discharged directly from the mixer truck into the space to be filled. No compaction or vibration is required. The mix may be placed part depth or full depth as conditions dictate. Care is to be taken to prevent pipe from flowing. Formed walls or other bulkheads shall be constructed to withstand hydrostatic pressure exerted by the plastic flowable fill. All necessary means to confine the material within a designated space shall be provided. In addition, delivery and handling all products and equipment shall be in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.

1.08 PROJECT CONDITIONS

- A. No flowable fill shall be placed on frozen ground. Mixing and placing of the material is acceptable in freezing temperatures. At the time of placement the flowable fill shall have a temperature of at least 40°F. When flowable fill is placed in freezing temperatures, the material should be covered with blankets overnight. When paving over flowable fill in cold weather, any frozen material on the surface can be scraped off and removed prior to paving. Perform installation of flowable fill only when approved by the Resident Engineer, and when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide normal weight flowable fill containing cementitious materials, fine aggregate/mineral filler (2000-3000 lbs/yd³), fly ash (250-400 lbs/yd³), air content 0-70% and water (600 lbs/yd³). Cementitious materials shall be Portland cement (30-70 lbs/yd³), pozzolanic materials, or other self-cementing materials, or combinations thereof, at the Contractor's option and following approval by the Resident Engineer.
- B. Portland Cement: ASTM C150, Type I,II or III. Meeting New York State DOT standards.
- C. Mixing Water: Fresh, clean, and potable. Meeting New York State DOT standards, for use as mix-water for cast-in-place concrete.
- D. Air-entraining admixtures as per manufacturer's specifications.
- E. Chemical Admixtures: ASTM C494.
- F. Fine Aggregate/Mineral Filler: ASTM C33 or non-ASTM sands or mineral fillers with 100% passing 1/2" sieve may be considered which produce an acceptable flow and desired performance characteristic.

2.02 FLOWABLE FILL MIXTURE

- A. Mix design shall produce a consistency that will result in a flowable product at the time of placement which does not require manual means to move it into place.
- B. Flowable fill shall have a minimum strength of 100 psi according to ASTM C39 at 28 days after placement.
- C. Flowable fill shall have minimal subsidence and bleed water shrinkage. Evaporation of bleed water shall not result in shrinkage of more than 1/8 inch per foot of flowable fill depth (for mixes containing high fly ash content). Measurement of a final bleeding shall be as measured in Section 10 of ASTM C 940 "Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory".
- D. Flowable fill shall have a unit weight of 90 - 115 lbs/feet³ measured at the point of placement after a 60 minute ready-mix truck ride. In the absence of strength data, the cementitious content shall be a maximum of (150 lbs/cy).
- E. Flowable fill shall have an in-place yield of at least 98% of design yield for permanent type and a maximum of 110% of design yield for removable types at 1 year.
- F. Provide equipment as recommended by the manufacturer and comply with manufacturer's recommendations for the addition of additives, whether at the production plant or prior to placement at the site.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions of substrates and other conditions under which work is to be performed and notify Resident Engineer, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 APPLICATION OF FLOWABLE FILL

- A. Secure tanks, pipes and other members to be encased in flowable fill. Insure that there are no exposed metallic pipes, conduits, or other items that will be in contact with the flowable fill after placement. If so, replace with non-metallic materials or apply manufacturer's recommended coating to protect metallic objects before placing the flowable fill. Replacement or protection of metallic objects is subject to the approval of the Resident Engineer.

3.03 PROTECTION AND CURING

- A. Protect exposed surfaces of flowable fill from premature drying, wash by rain or running water, wind, mechanical injury, and excessively hot or cold temperature. Curing method shall be subject to approval by Resident Engineer.
- B. The flowable fill shall be left undisturbed until the material obtains sufficient strength. Sufficient strength for paving is achieved when the flowable fill can support the weight of foot traffic without apparent deformation. Sufficient strength for supporting vehicular traffic is 2.5tons per square foot as measured by a pocket penetrometer.

END OF SECTION 312323

**SECTION 321216 - REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE
PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections:
- | | |
|------------------|--|
| SECTION 330160 - | MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, TRANSFORMER VAULTS AND SITE WORK |
| SECTION 311110 - | SITE CLEARING |
| SECTION 311316 - | TREE PROTECTION AND TRIMMING |
| SECTION 312316 - | EARTHWORK FOR STRUCTURES AND UTILITIES |
| SECTION 321216 - | REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 321413 - | REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 321313 - | REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 330130 - | REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 330160 - | REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 323113 - | CHAIN LINK FENCES AND GATES |
| SECTION 329113 - | RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT |
- C. Contractor shall refer to Section 1010 - "Summary of Work", Section 1500 - "Temporary Facilities" and the "Temporary Power and Sequence of Connections" notes for each building as shown on drawings inclusive, for the sequencing required to accomplish the work.

1.02 SUMMARY

- A. This Section includes provisions for removal and restoration of existing asphalt concrete pavement disturbed by the work of the Contract.
- B. Saw-cutting of edges of existing pavement is specified on site work drawings.

- C. Subbase.
- D. Proof rolling of prepared subbase.

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Material Certificates signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.
- C. Pavement marking plan indicating lane separations and defined parking spaces. Note dedicated handicapped spaces with international graphics symbol.
- D. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
- E. Job Mix Formulas: Submit job mix formulas for asphalt paving indicating compliance with the requirements of each asphalt type specified including the name and location of the supplier.
- F. Quality Control Submittals
 - 1. Certificates: Submit one copy of all permits obtained from local regulatory agencies and the New York State Department of Transportation.
 - 2. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) including compliance with the requirements specified below in the "Quality Assurance" section of this Specification.
 - 3. Experience Listing: submit a list of completed projects using the products proposed for this project, including Owner's contact information and telephone number for each project, demonstrating compliance with applicable requirements specified in the "Quality Assurance" section of this Specification.

1.04 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.

- C. Grade Control: Establish and maintain required lines and elevations.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations and conform to New York State D.O.T. standard specifications dated May 2011.
- B. Herbicide Treatment: Commercial chemical for weed control, registered by Environmental Protection Agency. Provide granular, liquid, or wettable powder form.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
 - a. Ciba-Geigy Corp.
 - b. Dow Chemical U.S.A.
 - c. E.I. Du Pont de Nemours & Co., Inc.
 - d. FMC Corp.
 - e. Thompson-Hayward Chemical Co.
 - f. U.S. Borax and Chemical Corp.
- C. Wheel Stops: 2,500-psi compressive strength precast, air-entrained concrete, approximately 6 inches high, 9 inches wide, and 7 feet long. Provide chamfered corners and drainage slots on underside.
- D. Aggregate Base: Comply with the New York State Department of Transportation Standard Specification, Section 304, Paragraph 304-2.
 - 1. Base Course
 - a. Select RCA Granular Material: Where indicated supply stockpiled, sound, durable, recycled Portland cement concrete aggregate which is a product of mechanical crushing free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements modified below:

Sieve		Percent Passing
Sieve Size	Size Opening (mm)	
2 inch	50.8	100
1 inch	25.4	80 - 100
¼ inch	6.35	50 - 85
No. 40	0.425	15 - 40
No. 200	0.075	0 - 7

- b. Select Type 1 Granular Material: Where indicated supply stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with New York State Department of Transportation gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size Opening (mm)	
3 inch	76.2	100
2 inch	50.8	90 – 100
¼ inch	6.35	30 – 65
No. 40	0.425	5 – 40
No. 200	0.075	0 - 10

- c. Engineering Fabric: Fabric composed of high tenacity polypropylene yarns woven into a stable network. The fabric is to be inert to biological degradation and resistant to naturally encountered chemicals, alkalis and acids complying with the following mechanical and physical properties:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Wide Width Tensile Strength	ASTM D 4595	kN/mm ²	MD 17.6 (100)/CD 21.0 (120)
Grab Tensile Strength	ASTM D 4632	kN (lbs)	MD 0.9 (200)/CD 0.9 (200)
Grab Tensile Elongation	ASTM D 4632	%	MD 15/CD 10
Trapezoid Tear Strength	ASTM D 4533	kN (lbs)	MD 0.33 (75)/CD 0.33 (75)
Mullen Burst Strength	ASTM D 3786	kPa (psi)	2756 (400)
Puncture Strength	ASTM D 4833	kN (lbs)	0.4 (90)
Percent Open Area	COE-02215-86	%	1
Apparent Opening Size (AOS)	ASTM D 4751	mm (US Sieve)	0.300 (50)
Permittivity	ASTM D 4491	sec ⁻¹	0.05
Flow Rate	ASTM D 4491	1/min/m ² (gal/min/ft ²)	200 (5.0)
UV Resistance (at 500 Hours)	ASTM D 4355	% strength retained	70

Physical Properties	Test Method	Unit	Typical Value
Weight	ASTM D 5261	g/m ² (oz/ydm ²)	136 (4.0)
Thickness	ASTM D 5199	mm (mils)	0.51 (20)
Roll Dimensions (Width x Length)	-	m (ft)	3.8 x 132 or 5.3 x 94.2 (12.5 x 432) or (17.5 x 309)
Roll Area	-	m ² (yd ²)	502 (600)
Estimated Roll Weight	-	kg (lb)	95 (210)

- 1) **Manufacturer:** For convenience, details have been based on Mirafi 500X as manufactured by Ten Cate/Mirafi, Pendergrast, GA (Tel. #706-693-2226).

E. **Asphalt Pavement:** Paving materials shall comply with the New York State Department of Transportation Standard Specification, Section 400 for the materials indicated.

1. **Binder Course:** Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Sections 401 and 402 for Asphalt-Type 3 Binder.

Sieve		Percent Passing	
Sieve Size	Size Size (mm)	General Limits	Job Limit Tol. %
1½"	37.5	100	-
1"	25.0	95 – 100	-
½"	12.5	70 – 90	±6
¼"	6.3	48 – 74	±7
No. 6 Sieve	3.2	32 – 62	±7
No. 20 Sieve	.850	15 – 39	±7
No. 40 Sieve	.425	8 – 27	±7
No. 80 Sieve	.180	4 – 16	±4
No. 200 Sieve	.075	2 – 8	±2

- a. The PGB content shall be 4.5 – 6.5%, ±0.4%.
 - b. The mixing and placement temperature range shall be 120 – 165 degrees C.
2. **Shim Course:** Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Sections 401 and 403 for Asphalt – Type 5 Shim.

Sieve		Percent Passing	
Sieve Size	Size Size (mm)	General Limits	Job Limit Tol. %
¼"	6.3	100	-
No. 6 Sieve	3.2	80 - 100	±6
No. 20 Sieve	.850	32 - 72	±7
No. 40 Sieve	.425	18 - 52	±7
No. 80 Sieve	.180	7 - 26	±4
No. 200 Sieve	.075	2 - 12	±2

- a. The PGB content shall be 7.0 – 9.5%, ±0.4%.
 - b. The mixing and placement temperature range shall be 120 – 165 degrees C.
3. **Topcourse:** Hot plant mixed asphalt, complying with the New York State Department of Transportation Standard Specification, Sections 401 and 403 for Asphalt – Type 6F Topcourse.

Sieve		Percent Passing	
Sieve Size	Size Size (mm)	General Limits	Job Limit Tol. %
1"	25.0	100	-
½"	12.5	95 - 100	
¼"	6.3	65 – 85	±7
No. 6 Sieve	3.2	36 – 65	±7
No. 20 Sieve	.850	15 - 39	±7
No. 40 Sieve	.425	8 - 27	±7
No. 80 Sieve	.180	4 - 16	±4
No. 200 Sieve	.075	2 - 6	±2

- a. The PGB content shall be 5.4 – 7.0%.
 - b. The mixing and placement temperature range shall be 120 – 165 degrees C.
- F. Coatings: Comply with the New York State Department of Transportation Standard Specification, Section 702 for material designations indicated.
- 1. Tack Coat: Emulsified asphalt, slow setting type, New York State Department of Transportation designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
 - 2. Asphalt Cement Filler: New York State Department of Transportation Designation 702-05.
- G. Pavement Marking Paint: Utilize pavement marking paint complying with the New York State Department of Transportation Standard Specification, Paragraph 727-01, White Marking Paint – Type 1 or Paragraph 727-01, Yellow Marking Paint – Type 1.
- 1. Manufacturer: For convenience, specifications have been based on “Setfast Acrylic Latex Traffic Paint” by Sherwin Williams, Co., Cleveland, OH (Tel. # 216-566-2902).

2.02 ASPHALT-AGGREGATE MIXTURE

- A. Provide plant-mixed, hot-laid asphalt-aggregate mixture complying with ASTM D 3515 and as recommended by N.Y.S. D.O.T.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION

- A. Aggregate Base: Comply with the requirements of the New York State Department of Transportation Standard Specification, Section 304-3 for aggregate gradations specified, unless otherwise indicated.

1. Base Course: Completely fill voids with grits and roll with a _____, eliminating movement of the material ahead of the roller. After rolling, verify grading with a minimum ten foot long straight edge. Satisfactorily eliminate any depression over ¼” deep. Obtain approval of base prior to installing asphalt courses above.
 - a. Heavy Duty Pavement Thickness: Minimum 12” thickness (two 6” layers) unless otherwise noted.
 - b. Auto Duty Pavement Thickness: Minimum 12” thickness (two 6” layers) unless otherwise noted.
 - c. Recycled Asphalt Pavement: Refer to Project Manual Section 32 12 19 – Asphalt Pulverization for additional information.
- B. General: Remove loose material from compacted subbase surface immediately before applying herbicide treatment or prime coat.
- C. Proof-roll prepared subbase surface to check for unstable areas and areas requiring additional compaction.
- D. Do not begin paving work until deficient subbase areas have been corrected and are ready to receive paving.
- E. Herbicide Treatment: Apply chemical weed control agent in strict compliance with manufacturer's recommended dosages and application instructions. Apply to compacted, dry subbase prior to application of prime coat.
- F. Prime Coat: Apply at rate of 0.20 to 0.50 gal. per sq. yd., over compacted subgrade. Apply material to penetrate and seal, but not flood, surface. Cure and dry as long as necessary to attain penetration and evaporation of volatile.
- G. Tack Coat: Apply to contact surfaces of previously constructed asphalt or Portland cement concrete and surfaces abutting or projecting into hot-mixed asphalt pavement. Distribute at rate of 0.05 to 0.15 gal. per sq. yd. of surface.
- H. Allow to dry until at proper condition to receive paving.
- I. Exercise care in applying bituminous materials to avoid smearing of adjoining concrete surfaces. Remove and clean damaged surfaces.

3.02 PLACING MIX

- A. General: Place hot-mixed asphalt mixture on prepared surface, spread, and strike off. Spread mixture at minimum temperature of 225 deg F (107 deg C). Place areas inaccessible to equipment by hand. Place each course to required grade, cross-section, and compacted thickness.

- B. Asphalt Paving: Pave finished surface free from depressions that may collect water. The Contractor shall remove any depressions at their own expense over 1/8" deep when tested with a six foot straight edge without evidence of patching.
 - 1. Heavy Duty Paving: Pave over aggregate base in two courses, 1½" compacted depth topcourse over 3 ½" compacted depth binder course. Comply with the New York State Department of Transportation Standard Specification, Paragraph 401-3 and Paragraph 403-3 for asphalt types specified.
 - 2. Auto Duty Paving: Pave over aggregate base in two courses, 1½" compacted depth topcourse over 2" compacted depth binder course. Comply with the New York State Department of Transportation Standard Specification, Paragraph 401-3 and Paragraph 403-3 for asphalt types specified.
 - 3. Recycled Asphalt Paving: Pave over aggregate base in two courses, 1½" compacted depth topcourse over 1½" compacted depth binder course. Comply with the New York State Department of Transportation Standard Specification, Paragraph 401-3 and Paragraph 403-3 for asphalt types specified.
- C. Paver Placing: 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.
- D. Immediately correct surface irregularities in finish course behind paver. Remove excess material forming high spots with shovel or lute.
- E. 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.
- F. Curbs: Construct curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust.
- G. Place curb materials to cross-section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms as soon as material has cooled.

3.03 ROLLING

- A. General: Begin rolling when mixture will bear roller weight without excessive displacement.
- B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
- C. 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.

- D. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been evenly compacted.
- E. 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.
- F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot-mixed asphalt. Compact by rolling to specified surface density and smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.04 JOINING NEW ASPHALT PAVEMENT TO ADJACENT CONSTRUCTION

- A. Carefully construct joints between old and new pavements, or between successive days work to ensure continuous bond between adjoining paving. Construct joints with the same texture, density and smoothness as adjacent sections of asphalt courses. Clean sand, dirt and other deleterious material from contact surfaces and apply tack coat.
- B. Offset traverse joints a minimum of 24” between succeeding courses. Cut back pavement to the edge of previously placed courses to expose an even, vertical surface for the full course thickness.
- C. Offset longitudinal joints a minimum of 6” between succeeding courses. When edges of longitudinal joints are irregular, honeycombed or inadequately compacted, cut back all unsatisfactory sections to expose an even, vertical surface for the full course thickness.
- D. In horizontal joints between the binder and the topcourse, clean all contact surfaces and spray a tack coat prior to the installation of the topcourse if the binder has been in place for longer than seven days or if the pavement is determined to be excessively dirty by the Project Designer.
- E. Seal joints with the application of asphalt cement filler, a minimum of 2” to each side of the joint.

3.05 TRAFFIC AND LANE MARKINGS

- A. Cleaning: Sweep and clean surface to eliminate loose material and dust.
- B. Striping: Use chlorinated-rubber base traffic lane-marking paint, factory-mixed, quick-drying, and nonbleeding.

- C. Do not apply traffic and lane marking paint until layout and placement have been verified with Design Professional.
- D. 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.
- E. Traffic Marking: Apply pavement marking paint in accordance with the manufacturer's recommended procedures and in accordance with the New York State Department of Transportation Standard Specification, Paragraph 640-3.

3.06 WHEEL STOPS

- A. General: Secure wheel stops to hot-mixed asphalt surface with not less than two 3/4-inch-diameter galvanized steel dowels embedded in precast concrete at 1/3 points. Size length of dowel to penetrate at least 1/2 hot-mixed asphalt depth.

3.07 FIELD QUALITY CONTROL

- A. General: Testing in-place hot-mixed asphalt courses for compliance with requirements for thickness and surface smoothness may be done by Owner's testing laboratory. Repair or remove and replace unacceptable paving as directed by Design Professional.
- B. Thickness: In-place compacted thickness tested in accordance with ASTM D 3549 will not be acceptable if exceeding following allowable variations:
 - 1. Base Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus or minus 1/4 inch.
- C. 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:
 - 1. Base Course Surface: 1/4 inch.
 - 2. Wearing Course Surface: 3/16 inch.
 - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
- D. Check surface areas and in place densities at intervals as directed by Design Professional.
- E. Flood Tests: Perform a flood test in the presence of the Owner's Representative or the Project Designer utilizing a water tank truck. If a depression ponding water more than 1/8" in depth is found, provide corrective measures to provide proper drainage.

END OF SECTION 321216

SECTION 329113 - RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this Section.
- B. Related Sections:
- | | |
|------------------|--|
| SECTION 019329 - | MINOR DEMOLITION, REMOVALS, RESTORATIONS, ADDITIONS, ALTERATIONS, CUTTING AND PATCHING FOR WORK IN BUILDINGS, AREAWAYS, SERVICE ROOMS AND SITE WORK |
| SECTION 31110 - | SITE CLEARING |
| SECTION 311316 - | TREE AND SHRUBS PROTECTION AND TRIMMING |
| SECTION 312316 - | EARTHWORK FOR STRUCTURES AND UTILITIES |
| SECTION 321316 - | REMOVAL AND RESTORATION OF EXISTING ASPHALT CONCRETE PAVEMENT DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 321413 - | REMOVAL AND RESTORATION OF UNIT PAVERS DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 321313 - | REMOVAL AND RESTORATION OF PORTLAND CEMENT CONCRETE PAVING DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 330130 - | REPLACEMENT AND RESTORATION OF EXISTING UNDERGROUND SANITARY AND STORM DRAINAGE SYSTEMS DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 330160 - | REPLACEMENT AND RESTORATION OF UNDERGROUND HEAT DISTRIBUTION SYSTEM AND DOMESTIC HOT WATER SYSTEM AIR TESTED CONDUIT DISTURBED BY THE WORK OF THE CONTRACT |
| SECTION 323113 - | CHAIN LINK FENCES AND GATES |
| SECTION 329113 - | RESTORATION OF LANDSCAPE WORK DISTURBED BY THE WORK OF THE CONTRACT |
- C. Contractor shall refer to Section 011200 - "Contract Summary of Work", Section 015000 - "Temporary Facilities" and the "Temporary Power and Sequence of Connections" notes for each building as shown on drawings, for the sequencing required to accomplish the work.

1.02 SUMMARY

- A. Related Documents: Comply with all of the Contract Documents.
- B. Work Included: This Section generally includes, but is not necessarily limited to, the following landscape work: Disturbed by the work of the Contract trees, shrubs, plants,

ground cover, lawns topsoil replacement seeding and renovation of adjacent turf areas. This work also includes soil amendments and maintenance of landscape materials.

1.03 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Planting Soil: Existing, in-place surface soil, and imported topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for turf growth.
- D. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- E. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- F. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 1. Certification of each turfgrass seed mixture. Include identification of source and name and telephone number of supplier.
- C. Qualification Data: For qualified landscape Installer.
- D. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- E. Material Test Reports:
 - 1. Existing in-place surface soil
 - 2. Imported topsoil.
- F. Topsoil Amendment Schedule: Provide schedule of amendments for each type of topsoil used.
 - 1. Amendment Schedule shall include, but is not limited to:

- a. Ratio of Loose Compost to Topsoil by Volume
 - b. Revise first subparagraph below if a specific type of liming material (ground dolomitic limestone, calcitic limestone, mollusk shells, or other type) is required; coordinate with "Inorganic Soil Amendments" Article.
 - c. Weight of Lime per 1000 Sq. Ft.
 - d. Weight of Aluminum Sulfate per 1000 Sq. Ft.
 - e. Weight of Agricultural Gypsum per 1000 Sq. Ft.
 - f. Volume of Sand Plus 10 Percent Diatomaceous Earth or Zeolites per 1000 Sq. Ft.
 - g. Weight of Bonemeal per 1000 Sq. Ft.
 - h. Weight of Superphosphate per 1000 Sq. Ft.
 - i. Weight of Commercial Fertilizer per 1000 Sq. Ft.
 - j. Weight of Slow-Release Fertilizer per 1000 Sq. Ft.
- G. Maintenance Instructions: Recommended procedures to be implemented by Owner to maintain restored turf after Acceptance of Contract. Submit before scheduled final inspection.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer with not less than five (5) years' experience in successful installation and establishment of recreational baseball field turf in addition to requirements in Division 01 Section "Quality Requirements."
- B. Retain applicable subparagraphs below; revise to suit Project.
 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 3. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.

4. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
- C. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- D. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 3. Report suitability of tested soil for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
 - b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
- E. Preinstallation Conference: Conduct conference at Project site.

1.04 REGULATIONS AND STANDARDS

- A. The Contractor shall comply with all rules, regulations, laws and ordinances of all authorities having jurisdiction. All labor, materials, equipment and services necessary to make the work comply with such requirements shall be provided without additional cost to the Owner.
- B. Nomenclature: Plant names shall agree with the nomenclature of "Standardized Plant Names" as adopted by the American Joint Committee on Horticultural Nomenclature standards, Latest Edition. Names of varieties not listed therein shall conform generally with names accepted in the nursery trade. Clonal types must be true. No substitution shall be permitted.

1.05 APPLICABLE SPECIFICATIONS AND STANDARDS

- A. The following specifications and standards listed below, but referred to thereafter by basic designation only, form a part of this specification to the extent indicated by the references thereto:
- B. American Joint Committee on Horticultural Nomenclature:
 - 1. Standard Plant Names (Current Edition).
 - 2. American Association of Nurserymen.
 - 3. Horticultural Standards (Current Edition).

1.06 MEASUREMENTS

- A. Measurements of plants; trees, shrubs, and other plants shall be measured in units of caliper, height or spread to match existing although the Contractor may, at his option and with the approval of the Design Professional, supply oversize plants provided that this does not affect the Contract Price. Reduction of sizes specified will not be accepted.
- B. The caliper, height or spread, and quality shall be measured in accordance with standards specified in the current American Association of Nurserymen, Inc., American Standard for Nursery Stock, unless otherwise specified.
- C. A plant shall be dimensioned as it stands in its natural position.
- D. Deciduous trees shall be measured in units of average height in feet or of average caliper at a point six (6) inches (152mm) above the ground line for trees up to four (4) inches (102mm) in diameter, and twelve (12) inches (305mm) above the ground line for trees over four (4) inches (102mm) in caliper.
- E. Evergreen trees, deciduous shrubs, and evergreen shrubs of an upright type shall be measured in units of average height in feet.
- F. Evergreen shrubs of spreading type shall be measured in units of average spread in feet.
- G. Vines shall be measured by units of average spread of a typical plant or by units of plants of a specified age and root pot size.
- H. Ground cover plants shall be measured by units of plants of a specified age and root pot size.
- I. The minimum sizes of root balls, ball depth and diameters shall be in accordance with Recommended Balling and Burlapping Specifications, as set forth in the current edition of American Standards of Nursery Stock, sponsored by the American Association of Nurserymen, Inc.
- J. Analysis and testing of materials required under these Specifications shall be in accordance with the current methods of the Association of Official Agricultural Chemists and A.S.T.M.

1.07 VERIFYING CONDITIONS

- A. The Contractor, by careful examination, shall inform itself as to the nature and location of the work, the conformation of the ground, the nature of the soil and subsoil conditions, the character of the equipment and facilities needed preliminary to and during the execution of the work, the general and local conditions, climate, and all other matters which can in any way affect the work.
- B. The Contractor shall be held to have visited the site before submitting his proposal and to have familiarized himself with the aforesaid conditions and those of adjoining properties and utilities.
- C. The Contractor shall investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation and ingress and egress to the site. The Contractor shall conform to all governmental regulations in regard to the transportation of materials to and from and at the job site and shall secure in advance such permits as may be necessary.
- D. Should the Contractor, in the course of the work, find any discrepancies between the Drawings and the physical conditions of the locality, it will be his duty to immediately inform the Design Professional in writing and the Owner's Representative shall promptly clarify same. Any work done after such discovery unless authorized by the Owners Representative shall be done at the Contractor's risk.

1.08 ENVIRONMENTAL CONDITIONS

- A. Seeding, sodding, and ground cover planting shall be done only between August 15 and October 1 in the autumn and between April 1 and June 1 in the spring, unless otherwise authorized or directed by the Design Professional in writing.
- B. Trees and shrubs shall be planted between April 1 and June 1 or between September 1 and November 15.
- C. Conduct planting under favorable weather conditions during each season specified. Do not plant when ground is frozen. The Contractor may, at his option and under his full responsibility, conduct planting operations under unseasonable conditions without additional compensation.

1.09 PROTECTION

- A. The Contractor shall protect all utilities, structures, and vegetation during work.
- B. Paving and other work installed by others shall be kept clean and free of soil, straw, mulch, and other materials incidental to this work.
- C. Immediately before moving plant material from its sources, the Contractor shall spray all deciduous and evergreen plants with an antidessicant, applying an adequate film over trucks, branches, twigs, and/or foliage as directed by the Design Professional. Plant material shall be

resprayed after planting.

- D. Roots and balls of all plants shall be adequately protected at all times from freezing, sun, and/or drying winds. Balled and burlapped plants that cannot be planted immediately upon delivery shall be set on the ground and well protected with soil, wet peat or other acceptable material. All plants shall be watered as necessary until planted.
- E. Staking: Trees shall be staked immediately upon planting as indicated on Drawings. Plants shall stand plumb after guying and staking.
- F. Wrapping shall be done promptly after planting. The trunk of all deciduous trees shall be wrapped spirally from the ground line to the height of the second branches. Wrapping shall be neat and snug and the material held in place with twine every two feet.
- G. Spraying shall be done to control insects, fungus and other diseases.
- H. The Contractor shall provide, at his own expense, such barricades, temporary fencing, signs or policing as may be necessary for the protection of all planted and lawn areas until they are accepted.

1.10 MAINTENANCE

- A. Lawn Areas: The Contractor shall restore and produce dense, vigorous well-established lawns and shall maintain lawn areas until final acceptance of the work by the Owner. Maintenance shall include, but not be limited to, the preparation and reseedling of any bare areas, proper watering, refilling of rain-washed gullies and rutted areas, refertilizing and mowing. At the time of the first cutting, mower blades shall be set 2 ½ inches (63.5mm) high. At least three (3) mowings shall be completed before the work will be accepted, unless otherwise directed by the Design Professional. Any areas which fail to show uniform stand of grass shall be reworked as specified.
 - 1. The Contractor shall refertilize all lawn areas after the first two grass cuttings have been made, or as otherwise directed by the Design Professional, with commercial fertilizer, 10-6-4, at a rate of 20 pounds per 1,000 square feet (9 kgs/92.9 sq. m).
- B. Planting: Maintenance shall begin immediately after each plant is planted and continue to the termination of the guarantee period. Maintenance shall consist of pruning, refertilization, watering, weeding, mulching, tightening and repairing of guys and stakes, resetting plants to proper grades or upright position, restoration of the planting saucers, and spraying.
 - 1. Pruning shall be done periodically as necessary to remove dead or damaged branches.
 - 2. Refertilization is to be Rapid-Gro or approved equal at the rate of one pound (0.453 kgs) of fertilizer to 30 gallons (113 liters) of water per tree 3" (76.2mm) caliper and larger. All smaller trees at the rate of one-third pound (0.15 kgs) fertilizer to 10 gallons of water per tree applied every three (3) weeks between May 15 and July 1. Fertilizer is to be completely water-soluble and containing not less than 23 percent nitrogen, 21 percent phosphorous, and 17 percent potassium.

3. Weeding shall consist of the complete removal of weeds within the mulched area surrounding each plant.
4. It shall remain the responsibility of the Contractor to water as necessary to keep the plant materials in their best condition. Water all plants once each week during the growing season or at a longer interval if directed by the Design Professional. Water shall be applied slowly so as to penetrate the entire root zone.
5. Mulch and plant saucers shall be restored as necessary to preserve their appearance and to control weed growth. At the end of the maintenance period, mulched areas shall be top dressed with ½ inch (12.7mm) of topsoil and seeded. Seed mix shall be as specified elsewhere in these specifications.
6. Tighten and repair or replace stakes, guys, and wrappings as necessary. Remove at end of maintenance period unless otherwise directed by the Design Professional. If any plant settles from its proper elevation, it shall be raised to the proper level and not merely filled in with additional material.
7. Spraying shall be done to control insects, fungus, and other diseases.
8. A maintenance inspection by the Design Professional will be held approximately six (6) months after the beginning of the Guarantee Period. The Contractor shall accompany the Design Professional on the inspection and shall perform all required maintenance work immediately thereafter.

1.10 INSPECTION AND ACCEPTANCE

- A. Obtain all certificates of inspection of plant materials (except certificates of analysis of top soil samples) that may be required by federal, state or other authorities to accompany each shipment of plants, and on arrival the certificate shall be filed with the Design Professional.
- B. Topsoiling: Notice shall be given in written form to the Design Professional prior to beginning topsoiling operations so that inspection might be made and the areas to be topsoiled approved.
- C. Lawn Areas: The Contractor may request inspection for acceptance sixty (60) days after completing all work and after at least three mowings as specified.
 1. Inspection for Acceptance of Lawn Work: The Design Professional shall inspect all work for acceptance upon written request of the Contractor. The request shall be received at least two (2) weeks before the anticipated day.
 2. Any lawn areas which fail to show a uniform stand of grass shall be reworked, and resodded at the Contractor's expense with the same material as originally used thereon, and such work shall be repeated until all required areas are covered with a satisfactory stand of grass. Eroded areas shall be repaired and restored to finished grade.

3. Upon completion of all repairs or renewals, the Design Professional shall certify in writing to the Owner as to the acceptance of the work. The Design Professional shall be the sole judge of the acceptability of the work.
- D. Plant Material Inspection and Acceptance Prior to Installation: The Contractor shall request, in writing, the inspection of plant materials by the Design Professional. The Contractor shall furnish complete information as to the location of all plants which he proposes to supply.
1. Plants shall be subject to inspection and approval at place of growth for conformity to specification requirements as to quality, size and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work for size and condition of balls and root systems, diseases, insects and latent defects or injuries. No plants will be accepted if the ball is cracked or broken before or during planting operations. Rejected plants shall be removed from the site immediately. The Contractor shall furnish certificates of inspection of plant materials as may be required for Federal, State or other authorities to accompany shipments.
 2. No plants shall be dug or delivered to the site, or transplanted until the required inspections have been made and the plants approved by the Design Professional.
 3. Make a formal request in advance for any inspections at the various nurseries and collecting ground. This request shall state the location of the nursery or collecting grounds and shall list the particular plants which are to be inspected, as well as the size of such plants.
 4. Pay the entire cost of inspection (outside of 25 mile radius from City's limits), travel and maintenance of the Design Professional's inspector.
 5. All costs relating to nursery inspections, including a \$500/diem fee to the Design Professional, shall be paid by the Contractor.
 6. The Contractor or his authorized representative shall be present during inspections.
- E. Inspection of Plant Material for Beginning of Guarantee Period: Inspection of the work to determine its completion for beginning of the guarantee period will be made by the Design Professional upon request for such inspection submitted by the Contractor at least two (2) weeks prior to the anticipated date. All planting must be alive, healthy and installed as specified to be considered acceptable and complete.
1. After inspection the Contractor will be notified by the Design Professional of the date of the beginning of the guarantee period, or if any deficiencies are found, of the requirements and corrections which must be met prior to the beginning of the guarantee period.

1.11 RECEIPT OF MATERIALS

- A. Furnish a receipt for all bulk deliveries of topsoil and humus, brought to job each day prior to unloading.
- B. Bagged items delivered to job shall have tags on all bags identifying same and weight.
- C. Material not complying with above requirements will not be accepted.

1.12 GUARANTEE

- A. Planing, seeding and sodding is subject to the one year Guarantee requirements set forth in the Contract for the entire work of this Contract, provided that landscaping has been completed and accepted at the start when same has been completed and accepted.
- B. At the end of this period all planted material, trees, shrubs, plating, seeding and sodding that is dead or in a dying condition shall be replaced.
- C. It shall be the responsibility of this Contractor to inspect the plant material during the one year guarantee period, in order to satisfy himself that the material is receiving the proper care by the Owner.
- D. If the Contractor is of the opinion that the care and watering given plants and grass, by authorities, is insufficient or may cause them to die, prematurely, he shall immediately, and in sufficient time to permit the condition to be satisfactorily rectified, notify the Design Professional in writing, otherwise no consideration will be given such claims.

1.13 SHIPMENT DELIVERY

- A. Promptly notify the Owners representative, in advance, when the plant material is to be delivered and the manner of shipment; and furnish therewith an itemized list in duplicate of the actual quality of plant material in each delivery, and to expedite the required inspection at the point of delivery.
- B. The itemized list in duplicate of the plant material for each delivery shall include the pertinent data in the form as specified in the list of plants to be furnished.
- C. This list and the necessary inspection certificates to accompany each plant and shipment shall be delivered to the Owners representative prior to acceptance and plating of the material.
- D. When shipment is made by truck, all plant material shall be packed to provide adequate protection against climatic, seasonal and breakage injuries during transit, loading and unloading.
- E. The tops shall be securely covered with tarpaulin or canvas to minimize wind whipping and drying.
- F. A suitable method of handling shall be employed to insure the careful, workmanlike delivery of heavy balled plants to preclude cracked or "mushroomed" plant balls at the point of delivery.

- G. Necessary pruning of roots shall be performed prior to delivery of plant material to the site.
- H. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.
- I. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plantings.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers, lime, and soil amendments with appropriate certificates.

1.14 PREPARATION OF PLANTS

- A. Care shall be exercised in digging and preparing plants for shipment and transplanting. Workmanship that fails to meet the highest standards will be rejected and replaced with acceptable material at no additional cost. Balled plants shall be dug with sufficient roots and shall have a solid ball or earth securely held in place by burlap and stout rope. No manufactured balls will be accepted. Bare root plants shall be "puddled" immediately before shipment, or after digging.

1.15 SEPARATE PAYMENT

- A. If, because of the restrictions contained herein limiting the permissible planting periods, planting or seeding or sodding is not completed before all other general construction contract work is completed, the final payment when due will be made subject to the deductions for the value of such incomplete planting, seeding or sodding, which sums will be released upon completion and acceptance of such work.

PART 2 - PRODUCTS

2.01 TOPSOIL

- A. Topsoil: Topsoil shall be fertile, friable, natural soil. It shall be without a mixture of subsoil and shall be free of stones, lumps, plants or their roots, sticks, and other extraneous matter. Topsoil shall consist of natural topsoil without a mixture of subsoil, and shall be of good, rich uniform quality, free from poison ivy roots and undesirable material harmful to plant growth. Topsoil shall contain not less than 5% nor more than 20% organic matter determined by loss on ignition on moisture free sample dried at 100°C., in accordance with the current method of the Association of Official Agricultural Chemists.

- B. All topsoil for general planting and lawn work shall be new obtained from off-site stockpiles. At Contractor's expense, the topsoil shall be analyzed, and must be amended as necessary to meet the requirements herein specified.
- C. Topsoil must contain at least 5% organic matter determined by the wet combustion method (chromic acid reduction) as described in Circular No. 757 by the U.S. Department of Agriculture. The acidity range shall be pH 5.9 to pH 7.0 inclusive. The mechanical analysis of the soil shall be as follows:

<u>Passing</u>	<u>Retained On</u>	<u>Percentage</u>
1" (25.4mm) Screen		100%
1" (25.4mm) Screen	¼" (6.35mm) screen (gravel not more than)	3%
¼" (6.35mm) Screen	#100 USS Sieve (coarse, medium, and fine sand)	40-60%
#100 USS Sieve	(very fine sand, silt, and clay).	40-60%

- D. The Design Professional reserves the right to reject topsoil in which more than 60% of the material passing the U.S.S. No. 100 sieve consists of clay as determined by the Buoyocous hydrometer, by the decantation method. All percentages are to be based on weights of the sample dried at 100°C. Analysis shall be made in accordance with the current method of Association of Official Agricultural Chemists.
- E. Contractor shall furnish prepared soil analysis for organic content, mechanical analysis and pH of two (2) samples representative of topsoil to Design Professional for approval. Contractor to pay all costs. Analysis shall indicate required amendments, if any, and shall be performed by a reputable testing laboratory and shall be submitted together with the bid for the work of this Section. All additional costs of further topsoil analysis required, due to failure of original samples to meet the requirements of the specifications, shall be paid for by the Contractor.
- F. The entire quantity of topsoil shall be delivered to the job and a composite sample for analysis shall be made by the Design Professional. Make any and all amendments required for this topsoil to remedy any deficiency shown by the topsoil test. Topsoil which does not meet specified criteria shall be amended with additives as indicated by the analysis.

2.02 BONE MEAL

- A. Commercial raw bone meal shall be finely ground and have a minimum analysis of 4% nitrogen and 20% phosphoric acid. It shall be delivered in standard size bags showing weight, analysis and name of manufacturer. It shall be kept in a weatherproof storage place on the job. Application shall be as described in the specification.

2.03 COMMERCIAL FERTILIZER

- A. Fertilizer shall be uniform in composition, free-flowing, and suitable for application with

approved equipment. The fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, conforming to the applicable state fertilizer laws, and bearing the name, trade name or trademark, and warranty of the producer. Fertilizer for lawn work shall be a granular 5-10-5, and for general planting shall be slow release 10-10-10.

2.04 GROUND LIMESTONE

- A. Limestone: Agricultural-grade limestone ground to pass an 8-mesh sieve with 25 percent passing a 100-mesh sieve shall be furnished. In addition, calcareous limestone shall contain not less than 50 percent calcium oxide, and dolomitic limestone shall contain not less than 40 percent magnesium oxide. Coarser materials will be acceptable provided the specified rates of application are increased proportionately, on the basis of quantities passing the 8- and 100-mesh sieves, but no additional payment will be made for the increased quantity.
- B. The ground limestone shall be delivered in standard size bags of the manufacturer showing weight, analysis and name of the manufacturer. It shall be stored in a manner to insure preservation of its qualities and fitness for the work, and shall be placed undercover if the Design Professional directs.

2.05 CHLORDANE

- A. Chlordane shall be commercially produced in dry powdered form and of recent manufacture, which will meet the following analysis:
 - 1. Technical Chlordane 10%
 - 2. Inert Ingredients 90%
 - 3. Chlordane shall be furnished in packages appropriately labeled.
- B. Do not bring chlordane to the job until ready to apply, and take all precautions in handling and keeping from children.

2.06 HUMUS

- A. Humus shall consist of reed peat or sedge peat of such physical condition that it can be passed through a 1" screen and can be readily incorporated with the topsoil. It shall be free from sticks, stones, woody roots and other objectionable materials. Humus shall be taken from a previously well drained fresh water site, and shall be conditioned after excavation by storage in stockpiles for a 4 to 6 month period, which includes at least one freezing and thawing period. Organic matter, on a dry weight basis, shall test not less than 80% in test made in accordance with current methods of the Association of Official Agricultural Chemists. Acidity range shall be 5 pH to 7.5 pH. Moisture content by weight shall be 60% to 70%. Water-absorbing ability shall not less than 300%. Iron and sulphur content shall be low.
- B. Furnish a certified report of an approved analytical chemist showing the mechanical and chemical analysis of representative samples of the humus which he proposes to use. No humus shall be delivered until the approval of samples by the Design Professional, but such approval does not constitute a final acceptance. The Design Professional reserves the right to reject on or after delivery any material which does not in his opinion meet these

specifications. When humus is stored on the job, it shall be done as directed by the Design Professional.

2.07 SOD

- A. Sod: The turf shall be cultivated and grown in an established sod farm for commercial application from certified seed under good turf management and cultural practices for at least eighteen (18) months before lifting.
- B. The sod shall be a mixture of merion bluegrass and fescue creeping grass, with at least 50% merion present. It shall be square cut for uniform laying, and one inch minimum depth of soil around the roots. Sod that is dried out or overheated shall not be used.
- C. The blend/mix of grass in sod shall be one of those listed below and shall be harvested from one field to insure a uniform color and texture. Percentages of each grass type are to be within the given range for that type.
 - 1. 70-90% Tall Fescue: One or more of the following varieties: Apache, Arid, Bonanza, Falcon, Jaguar, Mustang, Rebel II.
 - 2. 10-20% Bluegrass: One or more of the following varieties: Benson (A-34), Bristol, Eclipse, P-104, Touchdown.
 - 3. 0-10% Perennial Ryegrass: One or more of the following varieties: All Star, Palmer, Pennant, Prelude, Premier, Yorktown II.
- D. Sod shall be machine cut to uniform soil thickness of five-eighths inch (5/8"), plus or minus one-quarter inch (1/4") at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut eighteen inches (18") wide by sixty inches (60") long (7½ sq. ft.) or rolls four feet (4') wide by fifty feet (50') long (200 sq. ft.). Standard sections of sod shall be strong enough to support their own weight and retain their size and shape when suspended vertically. Sod shall not be harvested or transplanted when the moisture content may adversely affect its survival.
- E. Sod shall be harvested, delivered, and transplanted within a period of thirty-six (36) hours. Before cutting, sod shall be mowed uniformly at a height of one and one-half inches (1½"). The Landscape Architect may inspect the sod before it is harvested but reserves the right to reject, on or after delivery, any sod which, in their opinion, does not meet with the specifications.

2.08 GRASS SEED

- A. Seed: Seed labeled in accordance with U.S. Department of Agriculture Rule and Regulations under the Federal Seed Act shall be furnished. Seed shall be furnished in sealed, standard containers, unless written exception is granted, indicating vendor name, showing the weight and analysis. Seed that is wet or moldy or that has been otherwise damaged in transit or storage will not be acceptable.
- B. All grass seed shall be fresh, re-cleaned grass seed of the latest crop mixed in the following

proportions by weight and meeting the following standards of pure live seed (P.L.S) content, purity and germination.

<u>Seed Kind</u>	<u>Percentage by weight of each seed kind in mixture</u>	<u>Percentage by weight of pure live seed of each kind</u>	<u>Percentage by weight of pure live seed in mixture</u>
Baron Kentucky Bluegrass	30	90	27
Fylking Kentucky Bluegrass	30	90	27
Chewings Red Fescue	20	90	18
Yorktown II Perennial Rye	20	88	17.6
Total pure live seed in mixture			89.6%
Maximum weed seed content			.9%
Other than weed and pure live seed			9.5%
Total			100.0%

- C. Seeds containing prohibited or restricted noxious weeds will not be accepted.
- D. Meadow grass seed shall be a mixture of wildflower and sheep fescue as indicated on the Drawings.
- E. The following noxious weeds are prohibited: Bindweed, Canada Thistle, quackgrass, hedge kind weed, horse nettle, wild garlic, bermuda grass, cheat, wild onion, corn cockle, dodder and wild onion, Johnson grass, perennial sweet sudan grass, sorghum alum, and other perennial sorghum hybrids.
- F. Present a certificate of P.L.S. tests of the grass seed intended for use. The certificate shall be obtained from a well-recognized seed test laboratory that is not engaged in the business of selling seeds. This certificate must state the true quality of the seeds which the Contractor proposes to furnish.
- G. Samples of the seed taken from the stock proposed to be supplied may be subjected to tests for purity, viability and seed content and acceptance of rejection will be made on the basis of such tests.
- H. Grass seed shall met the tolerance for germination and purity according to the standards tabulated on pages 22 and 23 of U.S. Department of Agriculture, Service and Regulatory Announcements No. 156.

- I. Peat Moss and Organic Matter: Baled sphagnum moss, brown, acid reaction about 4.5 pH, low in content of woody material, free of mineral matter harmful to plant life, and water absorbing capacity 1100 to 2000 percent by weight, or suitable alternate as approved by Design Professional. Organic matter shall be well-rotted, unleashed horse or cattle manure; free from harmful chemicals or other injurious substances; at least 3 months old, but not more than 2 years old; and with not more than 25% straw, leaves, etc.
- J. Water: Clean, fresh, and free from harmful materials, as available from hose bibbs and hydrants.
- K. Mulch: Material used for mulching hydroseeded areas shall be natural wood cellulose mulch, capable of dispensing readily in water and shall have no toxic effect when combined with seed or other materials. Mulch shall be dyed green by a dye non-injurious to plant growth and shall be packaged in new, labeled containers in an air dry condition.
- L. Mulch: For planting, tree saucers shall be pine bark chip, ¼" -½" size, free of extraneous matter, as approved by the Design Professional.
- M. Antidessicant: "Wiltproof," as manufactured by Nursery Specialty Product Incorporated, Stabbins Road, Croton Falls, New York.

2.09 RESTORATION OF EXISTING PLANT MATERIALS

- A. Verify the existing plant types and locations prior to submitting bid proposal, including sizes, quantities, and other requirements not shown on the drawings. Restore and/or replace plants and plans materials disturbed by the work of the Contract.
- B. All plants shall be nursery grown, unless otherwise specifically permitted in each instance, and shall have been growing under similar climatic conditions as the location of this project for at least two (2) years prior to award date of this Contract. They shall have straight trunks with the leader intact, undamaged and uncut, unless in the case of certain multi-stemmed specimens directly specified otherwise by the Design Professional.
- C. Plants shall be freshly dug, no heeled in or cold storage plants will be accepted. Plants shall be typical of their species or variety and shall have normal habits of growth. They shall be sound, healthy and vigorous, well-branched and densely foliated when in leaf. They shall be free from disease, insect pests, eggs or larvae, and shall have healthy well-developed fibrous root systems, free from defects, decay, disfiguring roots, sun-scald injuries, and abrasions of the bark.
- D. Plant names shall agree with nomenclature of "Standardized Plant Names" as adopted by the American Joint Committee on Horticultural Nomenclature, and size and grading standards shall conform to those of the American Association of Nurserymen, unless otherwise specified. No substitution will be permitted.
- E. All plants shall conform to the measurements specified in the Plant List except that plants larger than specified may be used if approved by the Design Professional. Use of such plants shall not increase the contract price. If larger plants are approved, the ball of earth shall be

increased in proportion of the size of the plants.

- F. Plants shall not be pruned prior to delivery.
- G. All plant materials shall be true to species or variety, shall be sound, healthy, vigorous, acclimated plants free abrasions of the bark, plant diseases, insect eggs, borers and all other forms of infestations. They shall have normal, well-developed branch systems and vigorous, fibrous root systems. All materials shall be freshly dug, nursery grown stock, and shall have been grown for a period of at least two years prior to the calling for bids, under the same climatic conditions as at the location of the site.
- H. A plant shall be dimensioned so it stands in its natural position. Trees under 6 inches in caliper shall be calipered at a point 1 foot above the ground. Trees over 6 inches shall be calipered at a point 2 feet above the ground. The stock furnished shall be a fair average of the minimum and maximum size specified.
- I. All trees must have straight trunks with single leader intact. There shall be no abrasion of the bark and no fresh cuts of limbs over 1-1/4 inches which have not completely call used over.
- J. The Contractor shall have investigated the sources of supply and satisfied himself that he can supply all of the plants mentioned in the Plant List in the size, variety, and quality noted and specified before submitting his bid. Failure to take this precaution will not relieve the Contractor from his responsibility to furnish and install all the plant material in strict accordance with the Contract requirements and without additional expense to the Owner. Substitutions will not be permitted.
- K. All plant stock shall be dug and handled with reasonable care and skill to prevent injuries to the trunk, branches, and root and shall be packed in an approved manner to insure arrival at the Project site in good condition.

2.10 STAKING AND GUYING

- A. Stakes: Stakes for the support, bracking, and deadmen shall be rough cypress, cedar, locust or other wood, free from unsound and loose knots, rot, cross grain, or other defects that may impair strength of stake. Stakes shall be minimum diameter of 2 inches (51mm) for trees up to 4 inches (102mm) in caliper, and minimum of 4 inches (102mm) diameter for trees over 4 inches (102mm) in caliper.
- B. Trees: Stakes shall be 8 feet long, of white cedar with bark attached and with a maximum allowable deflection of 10% (deflection shall be outward at top of stake). Stakes shall have a diameter at the middle of not less than 2 inches, not more than 2-3/4 inches, and a diameter of not less than 1-3/4 inches at the tip nor more than inches at the butt. Stakes shall be driven 30 inches into the ground and fastened to the trees with double No. 12 gauge annealed galvanized steel wire run through a suitable length of new black rubber hose. Stakes shall be placed about 1 foot away from the trunk, taking care to clear the roots.
- C. Guy Wire: Wire shall be new, soft, annealed galvanized steel wire, free from bends and kinks. No. 10 wire shall be used in guying and No. 12 wire for staking.

- D. Hose: Shall be new 3/4" (19mm) I.D. black corded rubber hose.

2.11 WRAPPING

- A. Wrapping Material: Wrapping for trees shall be waterproof paper 30-30-30, 4 inches (102mm) wide, in rolls, such as Krinkle Kraft Tree Wrapping paper, or approved equal.
- B. Trees of 2" caliper and up shall be wrapped with a 6" burlap bandage or suitable substitute securely tied at the top and bottom and at 2 foot intervals along the trunk. The bandage shall cover the entire surface of the trunk to the height of the first branches. Burlap shall be maintained until first winter has elapsed.
- C. Twine: Wrapping shall be tied with approved quality jute twine. Two-ply twine shall be used for trees 3 inches (76.2mm) and less in diameter, and 3 ply for trees over 3 inches (76.2mm) in diameter.

2.12 TREE GUARDS

- A. Restore existing tree guards.
- B. All metal work shall be hot dipped galvanized, after fabrication.

2.13 HERBICIDES AND PESTICIDES

- A. Herbicides and Pesticides: Approved for type and rate of application by local and state agencies with jurisdiction before use.

2.14 GRANULAR DRAINAGE BED AND FILTERS

- A. Granular drainage bed for tree pits, as required, shall be clean, dry crushed, rock or river run gravel up to one (1) inch (25.4mm) in diameter.
- B. Soil separator/filter for tree pits shall be soil-check filter media as manufactured by Brighton By-Products Co., Inc., New Brighton, PA.

PART 3 - EXECUTION

3.01 PLANTING TIME

- A. Trees-Shrubs
 - 1. Spring Planting.
 - 2. Fall Planting.
 - a. Deciduous March 1 - May 1 Oct. 15 - Dec. 1
 - b. Evergreen April 1 - May 15 Sept. 1 - Oct. 1

- c. Ground Cover April 15 - June 15
- B. Grass:
 - 1. Seed March 15- May 1....Aug. 15- Oct. 1
 - 2. Sod May be laid at any time except during the months of June and July, provided that the ground is not frozen. (Sodding for athletic fields - March 15 - Oct. 15)

3.02 PLANTING OPERATIONS

- A. In general planting and transplanting shall be done only in period specified in Par. 27, unless otherwise directed by the Owner's Representative. Balled plants may be planted at such times as the Owner's Representative may direct.
- B. Immediately following delivery and inspection at the job, all plants with exposed roots shall be heeled-in moist soil, in a manner satisfactory to the Owner's Representative. All plants heeled-in shall be properly maintained by the Contractor until planted.
- C. The roots of balled and burlapped (B. & B.) plants shall, if not immediately planted after digging and inspection, be adequately protected by topsoil until planted in their final location. Balled plants shall be handled so that the ball will not be loosened. After the soil has been thoroughly firmed under and around the ball, the burlap shall be cut away from the upper half of the ball and the remaining burlap adjusted to prevent the formation of air pockets; or when directed by the Owner's Representative, the burlap shall be entirely removed. Soil shall be firmed at six to eight inch intervals and thoroughly settled with water.
- D. In loading, unloading, or handling plants, exercise utmost care to prevent injuries to the branches or to the roots of the plants. The solidity of the ball or balled and platformed plants shall be carefully preserved. Trees with tops broken in transit shall be replaced by a satisfactory substitute.
- E. While plants with exposed roots are being transported to and from heeled-in beds, or being distributed in planting beds, or are awaiting planting after distribution, protect the roots from drying out by means of wet canvas, burlap, straw, or by "puddling". The means employed shall be satisfactory to the Owner's Representative and shall depend on weather conditions, and the length of time the roots must remain out of the ground. Plants with exposed roots shall be placed in the proper position and loose, friable topsoil shall be worked around the roots and thoroughly settled with water. Care shall be taken to avoid bruising or breaking the roots when tamping or firming the soil about them. Any large roots or fleshy roots which are bruised or broken shall be pruned with a clean cut at the time of planting.
- F. No planting shall be done except in the presence of the Owner's Representative. In general, all plant shall stand, after settlement, at the same level at which they have grown. Care shall be exercised in setting the plants plumb. Ropes, stones, etc. shall be removed from the hole before backfilling and all soil for backfilling shall be loose and friable and not frozen.

3.03 FINE GRADING AND SPREADING OF RESTORED TOPSOIL

- A. All areas within the Contract Limit Line, not occupied by buildings, pavements, structures, washed gravel mulch, or other hard surface, shall receive six (6) inches of restored topsoil.
- B. The sub-soil upon which topsoil is to be placed shall be cleared of all stones, woody roots, rubbish or other objectionable matter, removed from the premises, the surface thoroughly scarified and loosened to at least a depth of 4 inches, to the satisfaction of the Design Professional, the topsoil spread to a smooth even surface and to the depth required, then raked or otherwise manipulated to form smooth drainage grades to the levels shown on drawings.
- C. Topsoil shall be deposited and spread to a minimum depth of 8 inches over earth where seeded and sodded areas are indicated, 18 inches over rock where seeded, sodded or ground cover areas are indicated, and to a minimum depth of 18 inches over earth, and 36 inches over rock where planted, garden or shrubbery areas are indicated on drawings.
- D. Topsoil shall be spread, raked, compacted, and otherwise manipulated to form, after settlement, smooth draining final grades. Spread topsoil to six (6) inches depth, after compaction, creating smooth even surfaces, providing proper run off of surface water without ponding.
- E. Topsoil shall be cleaned of all hard clods, stiff clay, sods, stones, roots, sticks, and any other debris over 1 ½" which will interfere with the formation of the seed bed.
- F. To the topsoil used in backfilling major and minor tree pits, there shall be thoroughly incorporated bone meal as follows:
 - 1. 5 lbs. trees 2-1/2"-3" cal., 1 lb. minor trees 3'-4' high 7 lbs. trees 2"-3" cal., 1-1/2 lb. minor trees 4'-5' high 10 lbs. trees 4"-5" cal., 2 lb. minor trees 5'-6' high 12 lbs. trees 5"-6" cal. 3 lb. minor trees 6'-8' high 15 lbs. trees 6"-8" cal., 5 lb. minor trees 8'-10' high 20 lbs. trees 8"-10" cal. 7 lb. minor trees 10'-12' high.
- G. Where a bed or hedge of shrubs is shown, excavate all fill between shrubs of this bed or hedge before backfilling with topsoil.
- H. Topsoil which must be transported across any finished walks and roads shall be handled in such a manner that no damage will be done to the walks or roads. The Contractor shall be responsible for the repair of such damage at no additional cost to the Owner.
- I. Do not spread topsoil when in a muddy or frozen condition.
- J. Spreading of topsoil shall be coordinated with the seeding and sodding operations to insure these operations take place as soon as topsoiling has been completed and approved by the Design Professional.

3.04 PREPARATION OF LAWN BED

- A. Ground limestone and organic matter shall be applied in the stated proportions in addition to

the requirements, if any, stated in the mechanical and chemical analysis of topsoil.

- B. Ground limestone shall be distributed evenly by spreader over all areas to be seeded/sodded. It shall be worked lightly into the top three (3) inches (76.2mm) of the topsoil at least five (5) days before hydroseeding and sodding. The rate of application shall be 50 lbs. (22.5kgs) per 1000 square feet (93 sq. m).
- C. Organic matter shall be distributed evenly by spreader over all areas to be seeded or sodded. It shall be worked lightly into the top three (3) inches of the topsoil at least five (5) days before hydroseeding and sodding. The rate of application shall be 100 lbs. (45kgs.) per 1000 square feet (93. sq. m).
- D. Immediately before seeding or sodding, the topsoil shall be loosened to a depth of three inches (3") (76.2mm) and smoothed. Each area shall then be rolled in two directions perpendicular to each other with a light roller and then finely raked. Raking shall be done by hand adjacent to structures, paving, and trees.
- E. The finished surface shall be friable, smooth, finely textured, and shall conform to the lines and grades as indicated on the Drawings and/or as directed by the Design Professional. All bumps, depressions, or other irregularities shall be corrected prior to seeding and sodding operations begin.

3.05 SEEDING

- A. After topsoil has been placed, all areas indicated on drawings or specified to be seeded shall be raked to true lines, free from all unsightly variations, bumps, ridges or depressions. All sticks, stones, roots, or other objectionable material which might interfere with the affimation of a finely pulverized seed-bed shall be removed from the soil.
- B. The prepared lawn area shall be thoroughly rolled with an approved lawn roller and all low spots leveled up.
- C. Ground limestone shall be applied at the rate of 46 pounds per thousand square feet and shall be evenly distributed and worked lightly into the top of the soil to a depth of 3" either hand or machine at least five (5) days before applying commercial fertilizer.
- D. Chlordane shall be broadcast at the rate of 5 pounds per thousand sq. ft. and raked into the top 2" of topsoil.
- E. Acceptable commercial fertilizer shall be applied at a rate of 25 pounds per thousand square feet and worked lightly into the top 3" of topsoil.
- F. The rate of seeding shall be 5 pounds per thousand square feet. The grass seed shall be sown by approved machine in such a manner that a uniform stand shall result. After seeding, the surface shall be evenly raked as directed by the Design Professional with a fine-toothed rake and rolled with approved roller weighing at least 200 pounds.
- G. Grass seed shall only be sown in periods indicated under the "Planting Time" schedule or at

such other times as are approved by the Design Professional. All seeding is to be done in dry or moderately dry soil and at times when the wind does not exceed a velocity of 5 miles per hour.

- H. Seed mulch and fertilizer shall be mixed in the needed amount of water to produce a slurry and then applied under pressure at the rate specified. Mulch shall be added to the slurry mix after seed and fertilizer have been thoroughly mixed.
- I. Care shall be taken to prevent footprints or other disturbances to the finished surface.

3.06 DIGGING AND HANDLING PLANT MATERIAL

- A. No plant shall be dug or delivered to the site until the required inspections have been made and the plants approved by the Design Professional.
- B. Immediately before moving plant material from its source, the Contractor shall spray all deciduous and evergreen plants with antidessicant, applying an adequate film over trunks, branches, twigs, and/or foliage as directed by the Design Professional. Respray the plant material after planting.
- C. Dig balled and burlapped (B & B) plants with firm, natural balls of earth as specified above. No plants will be accepted if the ball is cracked or broken before or during planting operations.
- D. No plant shall be bound with wire or rope at any time so as to damage the bark, break branches, or destroy its natural shape.

3.07 LAYOUT

- A. Start the work of planting when other divisions of the work, including placing of topsoil, have progressed sufficiently to permit the work of planting.
- B. Stake out new planting where shown on plans except where obstructions below ground or overhead or where changes have been made in the construction. Necessary adjustments shall be approved by the Design Professional. Do not excavate any planting pits or beds until stake locations have been inspected and approved. Adjust stake locations as directed by the Design Professional.
- C. Prior to the excavation of all planting areas or plant pits, or placing tree stakes, the Contractor shall ascertain the location of below-grade structural slabs, all electric cables, all conduits, and all utility lines, so that proper precautions may be taken not to disturb or damage any subsurface improvements.

In the event any are uncovered, the Contractor shall promptly notify the Design Professional who will arrange to relocate the plant material. Failure to follow this procedure places upon the Contractor the responsibility of making, at his own expense, all the required repairs to damaged utilities and improvements.

3.08 PREPARATION OF PLANTING PITS

- A. Circular pits with vertical sides with a diameter at least one (1) foot greater than the spread of the ball or roots shall be excavated to a depth below finish grade required to accommodate beneath the ball or roots a bed of topsoil not less than six (6) inches in depth, as shown on the Drawings. The ball or roots shall rest on this bed when the plant is properly set to finished grade.
- B. Do not put plants in pits and beds until the pits and beds have been inspected and approved by the Design Professional.
- C. Remove all excavated subsoil.

3.09 HOLES FOR TREES AND SHRUBS

- A. The size of holes for all trees and shrubs with a ball of earth less than 4 feet in diameter and for all bare root trees shall be 2 times as wide as the diameter of the ball of earth or spread of roots and 6 inches deeper than the depth of the ball or roots. In no case shall the distance from the ball to the side of the hole be less than 12 inches.
- B. Holes for trees with a ball of earth 4 to 5 feet in diameter shall be 1-3/4 times as wide as the diameter of the ball of earth and 9 inches deeper than the depth of the ball.
- C. Holes for trees with a ball of earth over 5-feet in diameter shall be 1-1/2 times as wide as the diameter of the ball and 12 inches deeper than the depth of the ball.
- D. In no case shall holes for shrubs and vines be less than 12 inches deep and 12 inches in diameter.
- E. When the excavation for the tree pits occurs in an area filled with brickbats, ashes, stones, broken concrete or other foreign matter, the holes shall be dug 1/2 wider in diameter and 1/2 deeper than normally required, and the bottom and sides of pits shall be backfilled with fertilizer topsoil, thoroughly worked in place.

3.10 PLANTING SOIL MIXTURES

- A. General Planting Soil Mixtures: Planting soil shall be prepared on the site by mixing topsoil, peat, sand, and fertilizer so that the resulting soil is of the following consistency: 75% topsoil, 20% peat, and 5% sand. Fertilizer shall be added to the planting soil in strict accordance with the manufacturer's specifications.
- B. On-site mixtures of planting soils shall be approved by Design Professional prior to installation.

3.11 PLANTING

- A. Unless otherwise shown or specified, all plants shall be planted in pits, centered, and set on compacted planting soil to such depth that the finished grade level of the plant after settlement will be the same as that at which the plant was grown.

Plants shall be planted upright and, if necessary, faced to give the best appearance or relationship to adjacent plants and structures. No burlap shall be pulled out from under balls. Platforms, wire, and surplus binding from top and sides shall be removed. All broken or frayed roots shall be cut off cleanly. Planting soil shall be placed and compacted carefully to avoid injury to roots and to fill all voids. Tamp backfill firm to prevent settlement. When the hole is nearly filled, water as necessary and allow it to soak away. Balled and burlapped plants shall have the burlap cut away or folded back from the top of the ball before applying water. If backfill settles after watering, add more backfill to bring to required level. Construct saucer around entire area of plant pits as shown on the Drawings.

- B. Ground cover beds shall be cultivated 6" (152mm) deep and graded smooth immediately before planting ground cover plants. Before planting, spread commercial fertilizer per manufacturer's specifications and mix peat and sand into topsoil to a 6" (152mm) depth to produce planting soil as previously specified. Plant ground cover to within one foot of tree.

3.12 GROUND LIMESTONE

- A. The ground limestone shall be distributed evenly over all lawn, hedge, and ground-cover areas (except over Ericaceous plant areas), by machine, at least five (5) days before applying Commercial Fertilizer. The ground limestone shall be incorporated with the soil as specified under "SEEDING".

3.13 COMMERCIAL FERTILIZER

- A. Add to all shrub, round cover and garden areas at the rate of 25 lb. per thousand square feet and worked lightly into top 3-inches of topsoil.

3.14 HUMUS

- A. Humus shall be evenly spread over all seeded and sodded areas at the rate of 3 cu. yds. per 1000 sq. ft. and thoroughly incorporated with the top 3-inches of the top soil for tree pits, garden and planted areas at the rate of 1 cu. yd. of humus to 7 cu. yds. of topsoil. Soil containing 10% or more of organic matter as determined by the test described in Par. 13 shall have lesser amounts of humus added to give a maximum of approximately 15% organic content present. Substitution with peat moss instead of humus is prohibited.

3.15 STAKING AND GUYING

- A. Trees shall be supported immediately after planting. All evergreen trees shall be guyed as indicated on Drawings. Deciduous trees shall be staked as indicated on Drawings. Wires shall be encased in hose to prevent direct contact with the bark of the tree and shall be placed around the trunk in a single loop. Wires shall be tightened and kept taut by twisting the strands together, or with turnbuckles. Trees over 4" cal. shall have turnbuckles. Plants shall stand plumb after staking and guying. Guys, wires and stakes are to be maintained until final payment.
- B. Guying shall be done with three guys spaced equally about each tree. Each guy shall consist

of two strands of wire attached to the tree trunk at an angle of about 60 degrees at about two-fifths of the height of the tree, and anchored at the ground to notched stakes which have been driven into the ground at an angle away from the tree so that the tops of the anchor stakes are below finished grade. Care shall be taken when driving stakes if subgrade utilities are within four feet of the surface. Lines must be taut.

- C. Staking: Stakes shall be equally spaced about each tree and shall be driven vertically into the ground to a depth of 2 ½ to 3 feet (622mm to 914mm) in such a manner as not to injure the ball or roots. Trees shall be fastened to each stake at a height of about five feet by means of two strands of wire and hose. Stakes shall be uniform in height and placed according to the caliper of the tree as follows:
- D. Major trees over 6 feet high and less than 3" in caliper shall be supported with two 8' high stakes.
- E. Major trees 3 to 6 inches in caliper inclusive, as well as minor trees such as Cratagus, Malus, Magnolia, Halesia, Prunus, etc., shall be firmly guyed immediately after planting by 3 galvanized No. 12 gauge annealed steel wires attached to 2"x4" anchor posts 30 inches long, notched to receive the wires and driven into the ground with their tops below the finished grade. The wires shall be put through sections of new, black rubber hose of sufficient length to prevent injury to the trees and the free ends of the wire secured to anchor stakes below the ground surface. All staking and guying shall be done immediately after planting and transplanting. All trees shall stand plumb after staking and guying.
- F. All trees larger than 6" in caliper shall be firmly anchored after planting by 4 guys secure to anchors (dead men) placed at least 3' below finished grade. Each guy shall be made up of at least 4 strands of No. 10 gauge galvanized iron wire and shall be provided with an approved weldless turnbuckle, hood and eye type. Dead men shall be oak or locust posts 8" in diameter and 4' long placed immediately after planting. All trees shall stand plumb after anchoring.

3.16 WRAPPING

- A. Wrapping shall be done promptly after planting. The trunks of all deciduous trees shall be wrapped spirally from the ground line to the height of the second branches. The paper shall overlap 1 ½" minimum. Wrapping shall be neat and snug and the material held in place with the twine every two feet.

3.17 PRUNING

- A. Neatly prune and/or clip all plants to preserve their natural character, and in a manner appropriate to the particular requirements of each plant, and at the time designated by and to the satisfaction of the Design Professional. Do not prune or clip plants prior to delivery. Remove broken or badly bruised branches with a clean cut. Perform pruning with clean, sharp tools.
- B. Each plant shall be pruned to preserve its natural character in a manner appropriate to its particular requirements. In general, at least one-third of the wood shall be removed by thinning, or shortening branches, but no leaders shall be cut. Street trees shall be pruned to a

height of 7'-0" above sidewalk grade.

- C. Pruning cuts shall be painted over with an approved paint such as R.I.W. Tree Surgery Paint, manufactured by Toch Bros., N.Y.C.; Sherwin Williams Pruning Compound or approved equal.

3.18 MULCHING

- A. Mulching shall be done within two (2) days of planting. All shrub beds and tree saucers shall be covered with a two-inch layer of mulch as shown on the Drawings.
- B. Mulch and plant saucers shall be restored as necessary to preserve their appearance and to control weed growth.

3.19 WATERING

- A. At the time of planting, the soil around each plant shall be thoroughly saturated with water and as many times later as seasonable conditions require, until acceptance of the work.
- B. Water all plants once each week during the growing season or at a longer interval as required and approved by the Design Professional.

3.20 WEED AND PEST SPRAYING

- A. If an infestation of weeds or undesirable plants develop prior to acceptance of the lawn, the Contractor shall treat the infestation by hand weeding or chemical control. The chemical control shall be furnished and applied by the Contractor as recommended by the manufacturer and approved by the Design Professional. At least two weeks shall elapse after chemical control is applied before a request of inspection for acceptance is made to the Design Professional.

3.21 INSPECTION

- A. Inspect all plant materials at least once a month to locate any disease or insect pest infestation, identify, or have identified, the nature of the infestation, and submit the proposed method of control to the Design Professional for approval prior to application of control measures.

3.22 CLEANUP

- A. At all times during the progress of the work, the Contractor shall maintain the site in an orderly condition. Excess and waste materials shall be continuously and promptly removed; lawn areas, walks and roads shall be kept clear. Materials and equipment shall be stored where directed and shall be limited to the quantity required for the work. Rejected materials shall be immediately removed from the property.
- B. Upon completion and acceptance of the work, the Contractor shall promptly remove all equipment, surplus material, and all debris and trash resulting from operations under this Contract. The site shall be left in a neat, orderly condition and shall be "broom clean".

3.23 COOPERATION

- A. Cooperation with all others whose work affects or is affected by the work of this Section. Advise them of conditions necessary for proper performance under this Section.
- B. Resolve in writing any condition which may or will interfere with the proper performance of work of this Section. Otherwise, proceeding with the work of this Section shall be construed as complete acceptance of conditions for work of this Section.

3.24 MAINTENANCE OF TREES AND SHRUBS

- A. Maintain, at Contractor's expense, all planted and replanted areas to the satisfaction of the Design Professional until final acceptance of the work. Maintenance shall include watering, cultivating, spraying, pruning edging, tightening guys and other horticultural operations necessary for the proper growth of all plants or for keeping the whole area neat in appearance.

3.25 MAINTENANCE OF SEEDING AND SODDING

- A. Maintain all seeded and sodded areas until final acceptance of the Contract and any regrading, refertilizing, reseeding or resodding as directed by the Design Professional, shall be done at the Contractor's own expense. After the grass is started, any parts or areas which fail to show a uniform stand, for any reason whatsoever, shall be reseeded with the same mixture as originally used herein, and such reseeding shall be repeated until all required areas are covered with grass. Reseeding may only be carried on during the seeding periods.
- B. Establish and maintain a neat edge where planted areas meet grass areas, as directed by the Design Professional. Edging shall be done in workmanlike manner with spade or edging tool. Particular care shall be exercised in edging, to establish good flowing curves, as shown on the plans or as directed by the Design Professional. Edging shall not be done before grass is fully established.
- C. Properly water, mow and otherwise maintain all seeded and sodded areas throughout the life of the Contract, and until all Contract work is accepted. The grass shall be maintained at a maximum height of 2-1/2 inches.

3.26 ACCEPTANCE OF THE WORK

- A. Maintain all landscaping installed until acceptance is granted upon total completion of planting. Maintenance includes cutting of grass and all other plant operations.
- B. Acceptance shall be granted upon a healthy growth and satisfactory foliage condition of all plants and a complete stand of grass in all lawn areas.

END OF SECTION 329113