

SECTION 02 41 19

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Demolition and removal of selected site elements.
- 2. Salvage of existing items to be reused or recycled.

B. Related Requirements:

- 1. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
- 2. Section 015639 "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
- 3. Section 017300 "Execution" for cutting and patching procedures.
- 4. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements.

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. These items are to be protected during construction. If damaged, these items are to be replaced in kind by the contractor at no expense or additional cost to the owner.

1.4 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.
- B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
  - 1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 FIELD CONDITIONS

- A. Owner will occupy building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Landscape Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. Hazardous materials will be removed by Owner before start of the Work.
  - 2. If suspected hazardous materials are encountered, do not disturb; immediately notify Landscape Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
  - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  - 3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- F. Storage or sale of removed items or materials on-site is not permitted.
- G. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  - 1. Maintain fire-protection facilities in service during selective demolition operations.

1.6 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:
- B. Notify warrantor on completion of selective demolition and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Landscape Architect.
- E. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs.
  - 1. Comply with requirements specified in Section 013233 "Photographic Documentation."
  - 2. Inventory and record the condition of items to be removed and salvaged. Provide photographs of conditions that might be misconstrued as damage caused by salvage operations.

3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
  1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.
  1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
  2. Arrange to shut off indicated utilities with utility companies.
  3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.

### 3.3 PREPARATION

- A. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."
- B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  3. Cover and protect furniture, furnishings, and equipment that have not been removed.
  4. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."
- C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

### 3.4 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
7. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
8. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
9. Dispose of demolished items and materials promptly. Comply with requirements in Section 017419 "Construction Waste Management and Disposal."

B. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area.
4. Protect items from damage during transport and storage.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Landscape Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

### 3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

- B. Burning: Do not burn demolished materials.
- C. Disposal: Transport demolished materials and dispose of at designated spoil areas on Owner's property.
- D. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

### 3.7 CLEANING

- A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Form-facing material for cast-in-place concrete.
- 2. Form liners.
- 3. Shoring, bracing, and anchoring.

B. Related Requirements:

- 1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.

1.3 DEFINITIONS

- A. Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.
- B. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following:

- 1. Exposed surface form-facing material.
- 2. Form ties.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

- 1. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.
  - a. Location of construction/contraction joints is subject to approval of the Architect.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing and inspection agency.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Form Liners: Store form liners under cover to protect from sunlight.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.
  - 1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
  - 2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

- A. As-Cast Surface Form-Facing Material:
  - 1. Provide continuous, true, and smooth concrete surfaces.
  - 2. Furnish in largest practicable sizes to minimize number of joints.
  - 3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:
    - a. Plywood, metal, or other approved panel materials.
    - b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
      - 1) APA HDO (high-density overlay).
      - 2) APA MDO (medium-density overlay); mill-release agent treated and edge sealed.
      - 3) APA Structural 1 Plyform, B-B or better; mill oiled and edge sealed.
      - 4) APA Plyform Class I, B-B or better; mill oiled and edge sealed.



- B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.
  - 1. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Form Liners:
  - 1. Size: See landscape architecture plans.
  - 2. Face Pattern: See landscape architecture plans.

D.

## 2.3 RELATED MATERIALS

- A. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- B. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- C. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
  - 2. Form release agent for form liners shall be acceptable to form liner manufacturer.
- D. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF FORMWORK

- A. Comply with ACI 301.
- B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete" for as-cast finishes.
- C. Limit concrete surface irregularities as follows:
  - 1. Surface Finish-1.0: ACI 117 Class D, 1 inch.

2. Surface Finish-3.0: ACI 117 Class A, 1/8 inch
- D. Construct forms tight enough to prevent loss of concrete mortar.
1. Minimize joints.
  2. Exposed Concrete: Symmetrically align joints in forms.
- E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.
1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
  2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  3. Install keyways, reglets, recesses, and other accessories, for easy removal.
- F. Do not use rust-stained, steel, form-facing material.
- G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.
1. Provide and secure units to support screed strips
  2. Use strike-off templates or compacting-type screeds.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Construction and Movement Joints:
1. Construct joints true to line with faces perpendicular to surface plane of concrete.
  2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  3. Place joints perpendicular to main reinforcement.
  4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.
    - a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  5. Space vertical joints in walls as indicated on Drawings.
    - a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.
  - 1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
  - 3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  - 4. Clean embedded items immediately prior to concrete placement.

### 3.3 REMOVING AND REUSING FORMS

- A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
  - 1. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work.
  - 1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
  - 2. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.
  - 1. Align and secure joints to avoid offsets.
  - 2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  - 1. Inspect formwork for shape, location, and dimensions of the concrete member being formed.
  - 2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

END OF SECTION 03 10 00

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SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Steel reinforcement bars.
  - 2. Welded-wire reinforcement.

1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Each type of steel reinforcement.
- B. Shop Drawings: Comply with ACI SP-066:
  - 1. Include placing drawings that detail fabrication, bending, and placement.
  - 2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.
- C. Construction Joint Layout: Indicate proposed construction joints required to build the structure.
  - 1. Location of construction joints is subject to approval of Architect.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Statements: For testing and inspection agency.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1. Store reinforcement to avoid contact with earth.

## PART 2 - PRODUCTS

### 2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60, deformed bars, assembled with clips.
- C. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

### 2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.
  1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    - a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
- C. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.
  1. Finish: Plain.

### 2.3 FABRICATING REINFORCEMENT

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

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protection of In-Place Conditions:

- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

### 3.2 INSTALLATION OF STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.
- B. Accurately position, support, and secure reinforcement against displacement.
  - 1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
  - 2. Do not tack weld crossing reinforcing bars.
- C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.
- D. Provide concrete coverage in accordance with ACI 318.
- E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- F. Splices: Lap splices as indicated on Drawings.
  - 1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
  - 2. Stagger splices in accordance with ACI 318.
- G. Install welded-wire reinforcement in longest practicable lengths.
  - 1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."
    - a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.
  - 2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
  - 3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
  - 4. Lace overlaps with wire.

### 3.3 JOINTS

- A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement.
  - 2. Continue reinforcement across construction joints unless otherwise indicated.
  - 3. Do not continue reinforcement through sides of strip placements of floors and slabs.

### 3.4 INSTALLATION TOLERANCES

- A. Comply with ACI 117.



3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  - 1. Steel-reinforcement placement.

END OF SECTION 03 20 00

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

B. Related Requirements:

- 1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and water stops.
- 2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
- 3. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

- B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

- 1. Portland cement.
- 2. Aggregates.
- 3. Admixtures:

- a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.

4. Vapor retarders.
5. Curing materials.
  - a. Include documentation from color pigment manufacturer, indicating that proposed methods of curing are recommended by color pigment manufacturer.
6. Joint fillers.
7. Repair materials.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Slump limit.
6. Air content.
7. Nominal maximum aggregate size.
8. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
9. Intended placement method.
10. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Concrete Schedule: For each location of each Class of concrete indicated in "Concrete Mixtures" Article, including the following:

1. Concrete Class designation.
2. Location within Project.
3. Exposure Class designation.
4. Formed Surface Finish designation and final finish.
5. Final finish for floors.
6. Curing process.
7. Floor treatment if any.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - a. Location of construction joints is subject to approval of the Architect.

## 1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.
2. Ready-mixed concrete manufacturer.
3. Testing agency: Include copies of applicable ACI certificates.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Bonding agents.
5. Adhesives.
6. Vapor retarders.
7. Semirigid joint filler.
8. Joint-filler strips.
9. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Portland cement.
2. Aggregates.
3. Admixtures:

D. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

E. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated and employing an ACI-certified Concrete Quality Control Technical Manager.

1. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.

D. Field Quality Control Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as an ACI Concrete Field-Testing Technician, Grade 1, in accordance with ACI CPP 610.1 or an equivalent certification program.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with ASTM C94/C94M and ACI 301.

1.8 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
2. Fog-spray forms, steel reinforcement, and sub-grade just before placing concrete. Keep sub-grade uniformly moist without standing water, soft spots, or dry areas.

1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to furnish replacement sheet vapor retarder/termite barrier material and accessories for sheet vapor retarder/ termite barrier and accessories that do not comply with requirements or that fail to resist penetration by termites within specified warranty period.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

- A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.

2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
3. Obtain aggregate from single source.
4. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I/II,
2. Fly Ash: ASTM C618, Class C or F.
3. Slag Cement: ASTM C989/C989M, Grade 100 or 120

C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.

1. Alkali-Silica Reaction: Comply with one of the following:
  - a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
  - b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
  - c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.
2. Maximum Coarse-Aggregate Size: 3/4-inch nominal.
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Air-Entraining Admixture: ASTM C260/C260M.

E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride in steel-reinforced concrete.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

F. Water and Water Used to Make Ice: ASTM C94/C94M, potable.

## 2.3 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

- C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.
  - 1. Color:
    - a. Ambient Temperature Below 50 deg F: Black.
    - b. Ambient Temperature between 50 deg F and 85 deg F: Any color.
    - c. Ambient Temperature Above 85 deg F: White.
- D. Curing Paper: Eight-foot-wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.
- E. Water: Potable or complying with ASTM C1602/C1602M.
- F. Clear, Waterborne, Membrane-Forming, Dissipating Curing Compound: ASTM C309, Type 1, Class B.

## 2.4 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade and class to suit requirements.

## 2.5 CONCRETE MIXTURES, GENERAL

- 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, in accordance with ACI 301.
  - 1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash or Other Pozzolans: 25 percent by mass.
  - 2. Slag Cement: 50 percent by mass.
  - 3. Silica Fume: 10 percent by mass.
  - 4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
  - 5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
- C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

2.6 CONCRETE MIXTURES (see General Notes on Plans)

- A. Class A: Normal-weight concrete used for footings and foundation walls.
  - 1. Exposure Class: ACI 318 F1 S0 W0 C1.
  - 2. Minimum Compressive Strength: 4000 psi at 28 days.
  - 3. Maximum w/cm: 0.50.
  - 4. Air Content:
    - a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
  - 5. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish batch ticket information.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions:
  - 1. Before placing concrete, verify that installation of concrete forms, accessories, and reinforcement, and embedded items is complete and that required inspections have been performed.
  - 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:
  - 1. Daily access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
  - 4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.



1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.
3. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

### 3.4 JOINTS

- A. Construct joints true to line, with faces perpendicular to surface plane of concrete.
- B. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-fourth of concrete thickness as follows:
  1. Grooved Joints: Form control joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of control joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  2. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

### 3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items is complete and that required inspections are completed.
- B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.
- C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect in writing, but not to exceed the amount indicated on the concrete delivery ticket.
  1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
  1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
  1. If a section cannot be placed continuously, provide construction joints as indicated.
  2. Deposit concrete to avoid segregation.
  3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.

4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
  - a. Do not use vibrators to transport concrete inside forms.
  - b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
  - c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
  - d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
  
- F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  1. Do not place concrete floors and slabs in a checkerboard sequence.
  2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  3. Maintain reinforcement in position on chairs during concrete placement.
  4. Screed slab surfaces with a straightedge and strike off to correct elevations.
  5. Level concrete, cut high areas, and fill low areas.
  6. Slope surfaces uniformly to drains where required.
  7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
  8. Do not further disturb slab surfaces before starting finishing operations.

### 3.6 FINISHING FORMED SURFACES

#### A. As-Cast Surface Finishes:

1. ACI 301 Surface Finish SF-1.0: As-cast concrete texture imparted by form-facing material.
  - a. Patch voids larger than 1-1/2 inches wide or 1/2 inch deep.
  - b. Remove projections larger than 1 inch.
  - c. Tie holes do not require patching.
  - d. Surface Tolerance: ACI 117 Class D.
  - e. Apply to concrete surfaces not exposed to public view.
  
2. ACI 301 Surface Finish SF-3.0:
  - a. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
  - b. Remove projections larger than 1/8 inch
  - c. Patch tie holes.
  - d. Surface Tolerance: ACI 117 Class A.
  - e. Locations: Apply to concrete surfaces see landscape architecture plans

### 3.7 FINISHING FLOORS AND SLABS

- #### A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish:

1. While still plastic, texture concrete surface that has been screeded and bull-floated or darbied.
2. Use stiff brushes, brooms, or rakes to produce a profile depth of 1/4 inch in one direction.
3. Apply scratch finish to surfaces to receive concrete floor toppings or [o receive mortar setting beds for bonded cementitious floor finishes.

C. Float Finish:

1. When bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operation of specific float apparatus, consolidate concrete surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats.
2. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture and complies with ACI 117tolerances for conventional concrete.
3. Apply float finish to surfaces to receive trowel finish.
  - a. Finish and measure surface so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.-long straightedge resting on two high spots and placed anywhere on the surface does not exceed 3/16 inch.

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.
2. Coordinate required final finish with Architect before application.

### 3.8 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

### 3.9 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.

2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period, as follows:
  - a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
  - b. Continuous Sprinkling: Maintain concrete surface continuously wet.
  - c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
  - d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
  - e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
    - 1) Recoat areas subject to heavy rainfall within three hours after initial application.
    - 2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1as follows:

1. Begin curing immediately after finishing concrete.
2. Interior Concrete Slabs:
  - a. Floors to Receive Curing Compound:
    - 1) Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.
    - 2) Recoat areas subjected to heavy rainfall within three hours after initial application.
    - 3) Maintain continuity of coating, and repair damage during curing period.
    - 4) Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.

3.10 TOLERANCES

- A. Conform to ACI 117

3.11 JOINT FILLING

- A. Prepare, clean, and install joint filler in accordance with manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [one] [six] month(s).
2. Do not fill joints until construction traffic has permanently ceased.

- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.
- D. Overfill joint, and trim joint filler flush with top of joint after hardening.

### 3.12 CONCRETE SURFACE REPAIRS

#### A. Defective Concrete:

- 1. Repair and patch defective areas when approved by Architect.
- 2. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

#### B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

#### C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

- 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.
  - a. Limit cut depth to 3/4 inch.
  - b. Make edges of cuts perpendicular to concrete surface.
  - c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
  - d. Fill and compact with patching mortar before bonding agent has dried.
  - e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
- 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.
  - a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
  - b. Compact mortar in place and strike off slightly higher than surrounding surface.
- 3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance as determined by Architect.

#### D. Repairing Unformed Surfaces:

- 1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.
  - a. Correct low and high areas.
  - b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
- 2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inchwide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
- 3. After concrete has cured at least 14 days, correct high areas by grinding.

4. Correct localized low areas during, or immediately after, completing surface-finishing operations by cutting out low areas and replacing with patching mortar.
    - a. Finish repaired areas to blend into adjacent concrete.
  5. Correct other low areas scheduled to receive floor coverings with a repair underlayment.
    - a. Prepare, mix, and apply repair underlayment and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
    - b. Feather edges to match adjacent floor elevations.
  6. Correct other low areas scheduled to remain exposed with repair topping.
    - a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.
    - b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  7. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.
    - a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    - b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    - c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    - d. Place, compact, and finish to blend with adjacent finished concrete.
    - e. Cure in same manner as adjacent concrete.
  8. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.
    - a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    - b. Dampen cleaned concrete surfaces and apply bonding agent.
    - c. Place patching mortar before bonding agent has dried.
    - d. Compact patching mortar and finish to match adjacent concrete.
    - e. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.13 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.
- B. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency shall be responsible for providing curing container for composite samples on Site and verifying that field-cured composite samples are cured in accordance with ASTM C31/C31M.
  2. Testing agency shall immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
  3. Testing agency shall report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.
    - a. Test reports shall include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:
      - 1) Project name.
      - 2) Name of testing agency.
      - 3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
      - 4) Name of concrete manufacturer.
      - 5) Date and time of inspection, sampling, and field testing.
      - 6) Date and time of concrete placement.
      - 7) Location in Work of concrete represented by samples.
      - 8) Date and time sample was obtained.
      - 9) Truck and batch ticket numbers.
      - 10) Design compressive strength at 28 days.
      - 11) Concrete mixture designation, proportions, and materials.
      - 12) Field test results.
      - 13) Information on storage and curing of samples before testing, including curing method and maximum and minimum temperatures during initial curing period.
      - 14) Type of fracture and compressive break strengths at seven days and 28 days.
- C. Batch Tickets: For each load delivered, submit three copies of batch delivery ticket to testing agency, indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, design slump at time of batching, and amount of water that can be added at Project site.
- D. Inspections:
1. Headed bolts.
  2. Verification of use of required design mixture.
  3. Concrete placement, including conveying and depositing.
  4. Curing procedures and maintenance of curing temperature.
  5. Verification of concrete strength before removal of shores and forms from beams and slabs.
  6. Batch Plant Inspections: On a random basis, as determined by Architect.
- E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M shall be performed in accordance with the following requirements:
1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.

- a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C143/C143M:
  - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - b. Perform additional tests when concrete consistency appears to change.
3. Slump Flow: ASTM C1611/C1611M:
  - a. One test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - b. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete.
  - a. One test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C1064/C1064M:
  - a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
6. Compression Test Specimens: ASTM C31/C31M:
  - a. Cast and laboratory cure two sets of three 6-inch by 12-inch or 4-inch by 8-inch cylinder specimens for each composite sample.
7. Compressive-Strength Tests: ASTM C39/C39M.
  - a. Test one set of three laboratory-cured specimens at seven days and one set of two specimens at 28 days.
  - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
9. 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 if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.
10. 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.
11. Additional Tests:



- a. Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
  - b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
    - 1) Acceptance criteria for concrete strength shall be in accordance with ACI 301 section 1.6.6.3.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

### 3.14 PROTECTION

- A. Protect concrete surfaces as follows:
1. Protect from petroleum stains.
  2. Diaper hydraulic equipment used over concrete surfaces.
  3. Prohibit vehicles from interior concrete slabs.
  4. Prohibit use of pipe-cutting machinery over concrete surfaces.
  5. Prohibit placement of steel items on concrete surfaces.
  6. Prohibit use of acids or acidic detergents over concrete surfaces.
  7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03 30 00

SECTION 03 30 53

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - 1. Walls.
  - 2. Footings.
  - 3. Slabs-on-grade.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 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. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
  - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.

- C. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Curing compounds.
  - 6. Bonding agents.
  - 7. Adhesives.
  - 8. Joint-filler strips.
  - 9. Repair materials.
  
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
  - 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
  
- E. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
  
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
  
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
  - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
  
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
  
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
  
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.

2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: The Contractor shall engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

### PART 2 - PRODUCTS

#### 2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
  - a. High-density overlay, Class 1 or better.
  - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
  - c. Structural 1, B-B or better; mill oiled and edge sealed.
  - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

- I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive damp-proofing or waterproofing.

## 2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- D. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars, ASTM A 767/A 767M, Class I zinc coated after fabrication and bending.
- E. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars, assembled with clips.
- F. Plain-Steel Wire: ASTM A 82/A 82M, galvanized.
- G. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
- H. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

## 2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
- C. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
- D. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

## 2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
  1. Portland Cement: ASTM C 150, Type II gray.
- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
  1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94/C 94M and potable.

## 2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. 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. Retarding Admixture: ASTM C 494/C 494M, Type B.
  3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
    - b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
    - c. Grace Construction Products, W. R. Grace & Co.; DCI.
    - d. Sika Corporation; Sika CNI.
    - e. Or approved equal.

- D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
    - b. Grace Construction Products, W. R. Grace & Co.; DCI-S.
    - c. Sika Corporation; FerroGard 901.
    - d. Or approved equal.
- E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ChemMasters.
    - b. Davis Colors.
    - c. Dayton Superior Corporation.
    - d. Hoover Color Corporation.
    - e. Lambert Corporation.
    - f. QC Construction Products.
    - g. Rockwood Pigments NA, Inc.
    - h. Scofield, L. M. Company.
    - i. Solomon Colors, Inc.
    - j. Or approved equal.
  2. Color: As selected by Architect from manufacturer's full range.
- F. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- G. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch sieve, 10 to 30 percent passing a No. 100 sieve, and at least 5 percent passing No. 200 sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

## 2.6 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
    - b. BASF Construction Chemicals - Building Systems; Confilm.
    - c. ChemMasters; SprayFilm.
    - d. Conspec by Dayton Superior; Aquafilm.
    - e. Dayton Superior Corporation; Sure Film (J-74).
    - f. Edoco by Dayton Superior; BurkeFilm.
    - g. Euclid Chemical Company (The), an RPM company; Eucobar.
    - h. Kaufman Products, Inc.; Vapor-Aid.
    - i. Lambert Corporation; LAMBCO Skin.
    - j. L&M Construction Chemicals, Inc.; E-CON.
    - k. Meadows, W. R., Inc.; EVAPRE.
    - l. Metalcrete Industries; Waterhold.
    - m. Nox-Crete Products Group; MONOFILM.
    - n. Sika Corporation; SikaFilm.
    - o. SpecChem, LLC; Spec Film.
    - p. Symons by Dayton Superior; Finishing Aid.
    - q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
    - r. Unitex; PRO-FILM.
    - s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.
    - t. Or approved equal.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.



- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
    - b. BASF Construction Chemicals - Building Systems; Kure 200.
    - c. ChemMasters; Safe-Cure Clear.
    - d. Conspec by Dayton Superior; W.B. Resin Cure.
    - e. Dayton Superior Corporation; Day-Chem Rez Cure (J-11-W).
    - f. Edoco by Dayton Superior; Res X Cure WB.
    - g. Euclid Chemical Company (The), an RPM company; Kurez W VOX; TAMMSCURE WB 30C.
    - h. Kaufman Products, Inc.; Thinfilm 420.
    - i. Lambert Corporation; AQUA KURE - CLEAR.
    - j. L&M Construction Chemicals, Inc.; L&M Cure R.
    - k. Meadows, W. R., Inc.; 1100-CLEAR.
    - l. Nox-Crete Products Group; Resin Cure E.
    - m. Right Pointe; Clear Water Resin.
    - n. SpecChem, LLC; Spec Rez Clear.
    - o. Symons by Dayton Superior; Resi-Chem Clear.
    - p. TK Products, Division of Sierra Corporation; TK-2519 DC WB.
    - q. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.
    - r. Or approved equal.
- F. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. BASF Construction Chemicals - Building Systems; Kure-N-Seal 25 LV.
    - b. ChemMasters; Spray-Cure & Seal Plus.
    - c. Conspec by Dayton Superior; Sealcure 1315.
    - d. Dayton Superior Corporation; Day-Chem Cure and Seal (J-22UV).
    - e. Edoco by Dayton Superior; Cureseal 1315.
    - f. Euclid Chemical Company (The), an RPM company; Super Diamond Clear; LusterSeal 300.
    - g. Kaufman Products, Inc.; Sure Cure 25.
    - h. Lambert Corporation; UV Super Seal.
    - i. L&M Construction Chemicals, Inc.; Lumiseal Plus.
    - j. Meadows, W. R., Inc.; CS-309/30.
    - k. Metalcrete Industries; Seal N Kure 30.
    - l. Right Pointe; Right Sheen 30.
    - m. Vexcon Chemicals, Inc.; Certi-Vex AC 1315.
    - n. Or approved equal.
  2. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.7 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1752, cork or self-expanding cork.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  - 1. Types I and II, non-load bearing and Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Reglets: Fabricate reglets of not less than 0.022-inch thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- E. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

## 2.8 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  - 4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, Portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
  - 4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

## 2.9 CONCRETE MIXTURES, GENERAL

- 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.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
  - 1. Fly Ash: 25 percent.
  - 2. Combined Fly Ash and Pozzolan: 25 percent.
  - 3. Ground Granulated Blast-Furnace Slag: 50 percent.
  - 4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent Portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
  - 5. Silica Fume: 10 percent.
  - 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
  - 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use admixture in concrete, as required, for placement and workability.
  - 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
  - 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

## 2.10 CONCRETE MIXTURES FOR SITE ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:
  - 1. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
  - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
  - 3. Slump Limit: 5 inches (125 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
  - 4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
  - 5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

- B. Slabs-on-Grade, Pavement at Sprayground, Curbs and Edge Restraints: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
  2. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m).
  3. Slump Limit: 4 inches, plus or minus 1 inch (25 mm).
  4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
  5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.
  6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

## 2.11 FABRICATING REINFORCEMENT

- A. See 1.4 ACTION SUBMITTALS of this document for Shop Drawings.

## 2.12 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, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes. The Contractor shall notify the Project Administrator of any concrete delivery on site at least 24 hours in advance.
- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For mixer capacity of 1 cu. yd. or smaller, 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.
  2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
  3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads. All material used for formwork shall be new.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated on drawings, within tolerance limits of ACI 117.
- C. Construct forms tight enough to prevent loss of concrete mortar.

- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
  - 1. Install keyways, reglets, recesses, and the like, for easy removal.
  - 2. Do not use rust-stained steel form-facing material.
- E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. Chamfer exterior corners and edges of permanently exposed concrete as indicated on the Drawings.
- H. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- I. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- J. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- K. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  - 2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  - 3. Install dovetail anchor slots in concrete structures as indicated.

### 3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 degrees F (10 degrees C) for 48 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
  - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
  - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 SHORES AND RESHORES

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
  - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### 3.5 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Granular Course: Cover vapor retarder with granular fill, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch or minus 3/4 inch.
  - 1. Place and compact a 1/2-inch thick layer of fine-graded granular material over granular fill.

### 3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

### 3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Control Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct control joints for a depth equal to at least one-third of concrete thickness as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

### 3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed and locations approved by Architect.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations 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 lose plasticity. At each insertion, limit duration of vibration to time necessary to

consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- E. Deposit and consolidate concrete for sidewalks and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
  
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
  
- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
  - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### 3.9 FINISHING SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
  
- B. Broom Finish: Apply a broom finish to exterior concrete pavement, ramps, and elsewhere as indicated.
  - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

### 3.10 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.



- B. Curbs and Edge Restraints: Light-brown finish.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

### 3.11 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

### 3.12 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  - 1. Defer joint filling until concrete has aged at least one month. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

### 3.13 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's and Owner's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part Portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form work removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  2. Repair defects on surfaces exposed to view by blending white Portland cement and standard Portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.14 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- B. Inspections:
  - 1. Steel reinforcement placement.
  - 2. Steel reinforcement welding.
  - 3. Headed bolts and studs.
  - 4. Verification of use of required design mixture.
  - 5. Concrete placement, including conveying and depositing.
  - 6. Curing procedures and maintenance of curing temperature.
  - 7. Verification of concrete strength before removal of shores and forms from walls and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 4. Compression Test Specimens: ASTM C 31/C 31M.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
  - 5. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  - 6. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  - 7. 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.
  - 8. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and

inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

9. 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.
10. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

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SECTION 04 21 13.13

BRICK VENEER MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Extent of work is shown on Drawings and includes but is limited to:

1. Repair of existing brick-clad retaining walls.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated including, but not limited to:

1. Cementitious materials. Include brand, type, and name of manufacturer.
2. Setting bed mortar mixes. Include description of type and proportions of ingredients.
3. Grout mixes. Include description of type and proportions of ingredients.
4. Joint sealants and backer rods.
5. Shims and setting buttons; plastic or nylon.

- B. Samples for Initial Selection:

1. For pigmented sealant and mortar and other items involving color selection. Include sample of manufacturers full range of colors. Selected product may be a standard color or a custom blended color.

- C. Samples for Verification:

1. Brick units:
  - a. Submit (3) units for each type of product specified, if using new brick.

- D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs experienced brickmasons and brick fitters.
- B. Source Limitations for Brick: Obtain each variety of brick, regardless of finish, from one quarry with resources to provide materials of consistent quality in appearance and physical properties.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS

- A. Protection of Brick Masonry: Cover partially completed brick masonry when construction is not in progress to protect from inclement weather.
- B. Stain Prevention: Immediately remove mortar to prevent staining the exposed surfaces of brick masonry and all adjacent surfaces.
- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace brick masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1.7 COORDINATION

- A. Verify field measurements prior to fabrication. Notify Landscape Architect of any discrepancies prior to fabrication.

1.8 WARRANTY

- A. Unless stated otherwise in these Specifications, warranty shall state that all work is in accord with drawings and Specifications, as amended by any changes thereto authorized by the Landscape Architect, free from defects in materials and workmanship for a period of five (5) years from date of acceptance of the work by the Owner or failure of system to meet performance requirements. Contractor shall agree to repair or replace defective materials and workmanship during the guarantee period at no additional cost to the Owner.
  - 1. Defective materials and workmanship are hereby defined to include evidence of abnormal deterioration, aging, structural failure of components resulting from exposure to normal load and forces, failure of operating parts to function normally, sealant failures, deterioration or discoloration of finishes in excess of normal aging, and failure to fulfill other specified performance.

PART 2 - PRODUCTS

2.1 BRICK

- 1. To match existing wall brick.

2.2 MORTAR MATERIALS

- A. Regional Materials: When possible, provide aggregate for mortar and grout, cement, and lime that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.
- B. Mortar Materials:
  - 1. Aggregate: complying with ASTM C 144.
  - 2. Water: Clean, non-alkaline and potable.
  - 3. Mortar Cement: complying with ASTM C 1329.
    - a. Type N
- C. Mortar Mixes:
  - 1. General: Do not add mixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.
  - 2. Mixing: Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with ASTM C 270 proportion specification and manufacturer's instructions for mixing time and water content, unless otherwise indicated.



2.3 MISCELLANEOUS MASONRY ACCESSORIES

- A. Backer Rod for Sealant Joints: Flexible, closed cell, polyethylene, rope-like joint backing material of appropriate diameter for specified joint size as indicated on the Drawings to resist pressure during sealant tooling. Backer rod shall not stain or adhere to sealant materials and shall be fully compatible with sealant compounds.
- B. Joint Sealant: Sanded silicone with integral color to match brick. Conforms to the following properties under ASTM C-920: Type S, Grade NS, Class 25, Use NT, Use I, Use M, Use G. Conforms to ASTM C-794 Adhesion Properties.
- C. Geotextile filter fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured according to test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
  - 3. Permittivity: 0.5 per second, minimum; ASTM D 4491.
  - 4. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive brick masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into brick masonry are correctly installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean dirty or stained brick surfaces by removing soil, stains, and foreign materials before setting. Clean brick by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING OF BRICK MASONRY, GENERAL

- A. Perform necessary field cutting and trimming as brick is set. Do not trim exposed ends or faces. Cuts shall be made at joints or hidden surfaces.

- B. Sort brick before it is placed to remove brick that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange bricks to match existing wall pattern.
- D. Set brick to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure brick masonry in place. Set brick accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
- E. Maintain uniform joint widths except for variations due to different brick sizes and where minor variations are required to maintain bond alignment if any.

### 3.4 CONSTRUCTION TOLERANCES

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet or more.
- B. Variation from Level: For joints and lines of coping, horizontal grooves, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or more.
- C. Measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each brick from level, plumb, or dimensioned plane.
- D. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- E. Variation in Plane between Adjacent Rough Bricks: Do not exceed one-half of tolerance specified for thickness of brick.

### 3.5 JOINTING

- F. Prepare joint surfaces for sealant by removing mortar from joint before it sets and brush clean dust and mortar particles from joint prior to application of sealant.
- G. Tape-off brick-joint to protect the adjacent surface from contact with the sealant and to create a crisp line. Tool joints, with a smooth jointing tool to produce a concave joint profile set just below the face of brick.

### 3.6 ADJUSTING AND CLEANING

- H. Remove and replace brick masonry of the following description:
  - 1. Broken, chipped, stained, or otherwise damaged brick. Brick may be repaired if methods and results are approved by Architect.
  - 2. Defective joints.
  - 3. Brick masonry not matching approved samples and mockups.
  - 4. Brick masonry not complying with other requirements indicated.

I. Replace in a manner that results in brick masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

J. Final Cleaning: After mortar is thoroughly set and cured, clean brick masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning brick masonry.

END OF SECTION 04 21 13.13

SECTION 04 43 00

STONE MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This project will be submitted for Leadership in Energy and Environmental Design (LEED) Certification by the US Green Building Council. Refer to Division 01 Section "Sustainable Design Requirements" for LEED requirements applicable to the work of this section.

1.3 SECTION INCLUDES

- A. Boulder.

1.4 RELATED REQUIREMENTS

- A. Division 01 Section "Construction Waste Management".

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated including, but not limited to:
- B. Samples for Initial Selection
  - 1. Boulder:
    - a. Submit photos with dimensions of proposed boulders.

1.6 QUALITY ASSURANCE

- A. Source Limitations for Stone: Obtain each variety of stone, from one quarry with resources to provide materials of consistent quality in appearance and physical properties.

1.7 PROJECT CONDITIONS

- A. Protection of Stone Masonry: Cover partially completed stone masonry when construction is not in progress to protect from inclement weather.

1.8 COORDINATION

- A. Verify field measurements prior to installation. Notify Landscape Architect of any discrepancies prior to installation.

1.9 WARRANTY

- A. Unless stated otherwise in these Specifications, warranty shall state that all work is in accord with drawings and Specifications, as amended by any changes thereto authorized by the Landscape Architect, free from defects in materials and workmanship for a period of five (5) years from date of acceptance of the work by the Owner or failure of system to meet performance requirements. Contractor shall agree to repair or replace defective materials and workmanship during the guarantee period at no additional cost to the Owner.
  - 1. Defective materials and workmanship are hereby defined to include evidence of abnormal deterioration, aging, structural failure of components resulting from exposure to normal load and forces, failure of operating parts to function normally, sealant failures, deterioration or discoloration of finishes in excess of normal aging, and failure to fulfill other specified performance.

PART 2 - PRODUCTS

2.1 BOULDER

- A. Mixture of Quarry Boulders. Irregular shape, various sizes, max. 5'1 x 2'6 x 2'h, min. 3'1 x 18" w x 18" h. Can be obtained from Johnson Quarries, or locally sourced. Color range to include gray and tan.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected

3.2 PREPARATION

- A. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

3.3 SETTING OF STONE MASONRY, GENERAL

- A. Sort stone before it is placed to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- B. Set stone to comply with requirements indicated on Drawings. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

3.4 ADJUSTING AND CLEANING

- A. Remove and replace stone masonry of the following description:
  - 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Landscape Architect.
- B. Replace in a manner that results in stone masonry matching approved samples complying with other requirements, and showing no evidence of replacement

END OF SECTION 04 43 00

SECTION 05 52 15

EXTERIOR HANDRAILS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Painted steel tube handrails.
- B. This Section includes requirements for detailing and engineering of railing systems to fulfill performance requirements and conform to design intent indicated on Drawings.

1.2 RELATED SECTIONS

- A. Section 033000 Cast-in-Place Concrete

1.3 PERFORMANCE STANDARDS

- A. Delegated-Design: Install handrails and guardrails to resist the simultaneous application of a lateral force of 50lbs./LF and a vertical load of 100 lbs./LF, both applied to the top of the railing. The rail shall resist a total lateral force and total vertical load of at least 200 lbs. each.
- B. Submit calculations and drawings signed and sealed by a Professional Engineer licensed in the Pennsylvania indicating that the railings can meet these performance criteria. Railings shall be fully coordinated with field measured conditions including but not limited to expansion joint locations.
- C. Control of corrosion: prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

- A. Product Data: for each type of product indicated, including finishing materials and color chart for selection.
- B. Shop Drawings: Indicate profiles, sizes, anchorage, and accessories. Indicate materials of each item. Provide plans, elevations, and details as required to clearly illustrate the full scope of work. Include material information, finishes, and types of joinery, fasteners, anchorages, and accessory items.
  - 1. Include structural analysis data, signed and sealed by a qualified professional engineer responsible for analysis preparation.
  - 2. Verify actual conditions by field measurements before fabrication and indicate measurements on shop drawings.
- C. Samples
  - 1. Submit one handrail sample, 12 inches long including a typical weld, indicating material and finish.

1.5 QUALITY ASSURANCE

- A. Contractor shall have had experience with at least two (2) other projects of similar scope and complexity and shall perform work with personnel totally familiar with furnishings installation and construction techniques under the supervision of an experienced foreperson.
- B. Manufacturer: Company specializing in the manufacture of products specified in this Section with a minimum of three (3) years of experience.

1.6 DELIVERY STORAGE AND HANDLING

- A. Deliver, store, handle and protect all materials from damage.

1.7 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard 3-year limited warranty.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

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

2.2 TUBE RAILING MATERIALS

- A. Steel Pipe: ASTM A53, Type S, Grade A, standard weight (Schedule 40), unless another grade and weight are required by structural loads.
- B. Steel tubing: ASTM A500, Grade A, standard weight (Schedule 40), unless another grade and weight are required by structural loads.
- C. Plates, Shapes and Bars: ASTM A36/A36M.
- D. Welding materials: AWS D1.1, type required for materials being welded.

2.3 FASTENERS

- A. Unless otherwise indicated, provide Type 304 stainless steel fasteners.
- B. Provide concealed fasteners for interconnecting components and for attaching rails to other work, unless otherwise indicated.
- C. Anchors: provide chemical or torque-controlled expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.



2.4 PAINTED FINISHES

- A. Shop Painted Finish: Provide a uniform smooth finish on all railing surfaces using the following products, or approved equal. Fully prepare surfaces in accordance with the manufacturer's recommendations.
1. Primer: Rust-Oleum Commercial C740 System DTM Alkyd Enamel Primer.
  2. Finish Coat: Rust-Oleum Commercial C740 System 400 VOC DTM Alkyd Enamel.
  3. Color: Black.

2.5 ACCESSORIES

- A. Grout: CE CRD-C621; Non-shrink type, premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 5,000 psi at 7 days.
1. Five Star Products, Inc.; Five Star Grout.
  2. L&M Construction Chemicals, Inc.; Duragrout.
  3. Euclid Chemical Company; NS Grout.
- B. Cover Flange: Item # 637, Steel Flat Base Flange For 1-1/2" Pipe (1.90" Diameter) With No Mounting Holes and Set Screw, Unfinished, Kit as manufactured by R&B Wagner, Inc., Milwaukee, WI 53224, (888) 243-6914, or approved equal.

2.6 FABRICATION

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finishes and anchorage, but not less than that required to support structural loads.
- B. Fabricate connections that will be exposed to weather in a manner to exclude water; provide weep holes where water may accumulate and slip joints in handrails that span structure.
- C. Cut, reinforce, drill and tap as indicated to receive finish hardware, screws and similar items.
- D. Welded connections: finish exposed surfaces smooth and blended so not roughness shows after finishing and welded surface matches contours of adjoining materials.
- E. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- F. Close exposed ends of hollow railing members with prefabricated end fittings.
- G. Provide inserts and other anchorage devices for connecting railings to concrete.
- H. For railing posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.
- I. Assemble railings in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly

mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

- J. Nonwelded connections: connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work. Notify Landscape Architect in writing of deviations from the manufacturer's recommended installation tolerances and conditions.
- B. Commencement of installation constitutes acceptance of conditions.

### 3.2 PREPARATION

- A. Supply items required to be cast into concrete.

### 3.3 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Install expansion joints as required to accommodate thermal movement. Provide slip joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side and locate joint within 6 inches of post.
- C. Use metal sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout mixed and placed to comply with anchoring material manufacturer's written instructions.
- D. Cover anchorage joint with flange of same metal as post either welded to post after placing anchoring material or attached to post with set screws.
- E. Set railing in sleeves where indicated. Grout annular space between sleeves and railing posts.
- F. Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.
- G. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.
- H. Assemble with spigots and sleeves to accommodate tight, hairline joints and secure installation.
- I. Provide anchorage devices and fittings to secure to in-place construction to adjacent construction. Separate dissimilar materials with bushings, grommets or washers to prevent electrolytic corrosion.
- J. Secure mounting brackets to building structure in a positive manner using manufacturer recommended reinforcement and anchorage methods for substrate conditions. Locate brackets

and hardware at spacing required to support structural loads.

- K. Installation of railing system shall be rigid and secure, installed by mechanics experienced in erection of architectural metal. Mounting hardware shall be drawn up tightly. Rails shall be set plumb and aligned.

#### 3.4 ADJUSTING AND CLEANING AND PROTECTION

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting. Apply by brush or spray to provide a minimum of 2.0-mil dry film thickness.
- B. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

#### 3.5 ERECTION TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch in 10 feet, non-cumulative.
- B. Maximum Offset from True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 05 52 15

SECTION 10 06 10

EXTERIOR SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Philadelphia Parks and Recreation Signage Standards Manual, latest version.

1.2 REQUIRED QUALIFICATIONS SUBMITTALS

- C. The awarded Fabricator will have provided their qualifications at or prior to the time of Bid. The Fabricator is required to submit as part of the submittal process additional qualifications for any subcontractors, including but not limited to, installers, electrician, specialty sub-contractor and/or project managers not included or accepted with the bid award of the project. The Owner reserves the right to accept or reject any sub-contractor and/or project manager submitted for review. Qualifications should include: a minimum of 5-10 years relevant experience and shall provide information that illustrates the following:
  - 1. Firm/Personnel qualifications.
  - 2. Projects of similar size and complexity.
  - 3. Demonstration of high quality craftsmanship.
  - 4. Project management team and experience.
- D. Regional Vendors:
  - 1. Urban Sign and Crane  
527 E. Chestnut Avenue  
Voorhees, NJ 08360  
856.691.8388  
www.urbansigncompany.com
  - 2. M.S. Signs, Inc.  
6 Morris Street  
Paterson, NJ 07501  
973.569.1111

www.mssign.com

3. L&H Sign Company  
425 North 3<sup>rd</sup> Street  
Reading, PA 19601  
www.lhsigns.com
4. Compass Sign Co LLC  
1505 Ford Road  
Bensalem, PA 19020  
215.639.677  
www.compass-sign.net
5. Allied Environmental Signage  
69 Megill Road  
Farmingdale, NJ 07727  
732.751.1818  
[www.allied-signs.com](http://www.allied-signs.com)
6. Or proposed qualified manufacturer, qualifications to be submitted to the owner for approval during bid process.

### 1.3 ACTION SUBMITTALS

#### A. SHOP DRAWINGS

Submit one (1) electronic set of shop drawings as outlined below: Include plans, elevations, sections and large-scale details of sign construction, wording, and lettering layout. Show anchorages and accessory items. Provide graphic layouts of each individual sign face and message for each sign location. Show fabrication and installation details, including all sign components such as: extrusions, brackets, bracing, hardware, internal framing, etc. Alphabet of each type style required by the contract documents, including upper and lowercase, with numerals, punctuation and accents. Shop drawings MUST include all field verified conditions and dimensions. Show installation and mounting heights.

#### B. PRODUCT SPECS AND WARRANTY INFORMATION

Provide documentation outlining all project warranties, including both product and manufacturing. Submit cut sheets for all specified products.

#### C. SAMPLES

Samples shall be clearly labeled on the back (where possible), designating item number, name of manufacturer, sign type and location. Fabricator shall submit a minimum of two (2) samples of each color and finish applied on each material type as indicated in the drawing package. Samples should represent the final finish of each element and will be used as control samples for production approval. Samples should represent extreme variations in color and texture that might occur during fabrication. Please submit the following samples as specified in the drawing package, list project specific submittal requirements.

#### D. COLOR SAMPLES

Color sample(s) for each specified color, process and finish. Color submittal(s) shall be submitted on each relevant substrate specified.

E. MATERIAL SAMPLES

Material samples of each specified Material (M1, M2 etc.) in each color and finish specified. Submit manufacturer's standard color palette where required for color and finish selection.

F. CHPL SAMPLES

Custom High Pressure Laminate (CHPL) manufacturer must supply project-specific electronic PDF proofs for content approval and minimum 8" x 10" x .060" actual material lab samples for color and finish approval from production-ready digital art work and specifications as provided by Designer.154 Philadelphia Parks and Recreation I SIGNAGE STANDARD MANUAL

G. PAPER TEMPLATES

Templates should be fully assembled or have complete registration marks for assembly. Fabricator shall provide for Designer approval, full-size paper templates for review and approval in the field of the following sign types:

PID.1, PLY.1 (FOR 2-5) AND PLY.2 (FOR 5-12), BUL1.C, AND RUL.2.

H. SIGN SAMPLES

A. Sign Contractor shall construct the following sign samples/mock-ups:

1. PLY.1 (only required by Fabricator on initial fabrication contract for this program)

1.4 REVIEW PROCESS

- A. Each reviewing party, i.e. Designer, Owner, Architect, etc. will each require a minimum of 10 business days to review all submittals. The process and sequence of submittal and review shall be discussed and agreed to during the project kickoff meeting. Designer reserves the right to reject any submittal (shop drawing, sample, etc.) that does not satisfy the requirements as outlined in this document including but not limited to: field conditions, construction, finish or color requirements. Submit additional drawings/samples as required to obtain final approval.

1.5 WORK INCLUDED

- A. Site verification, fabrication, and delivery-of all sign types and quantities indicated in the final approved locations.
- B. Installation of signs may be completed by the Fabricator or the General Contractor. Fabricator to verify the sign quantities from the Copy List and Sign Location Plans and if discrepancies exist, notify the Designer of any such discrepancies.
- C. Work shall include all support structures and fasteners required for installation. Work shall include all design engineering needed to produce the project to comply with all applicable municipal, state and federal code, and structural soundness. Fabricator to provide all services, subcontractors, labor, materials and equipment needed to complete the work described in this design drawings and specifications document.

- It is the Fabricator's responsibility to have all submittal drawings signed and sealed by a Structural Engineer.
- D. Fabricator shall visit site before construction begins and inspect each proposed sign location. Any issues or concerns shall be communicated to the Designer in writing within twenty-four (24) hours. Upon award of the bid, the selected Fabricator shall arrange a meeting with the Designer to review the scope of work.
  - E. Fabricator will be responsible for providing the Designer and Owner a project schedule that outlines durations for all work including delivery dates for submittals and Designer and Owner review time. Sign Contractor shall update and reissue the schedule throughout the project and communicate all changes/impacts on the schedule to Designer and Owner.
  - F. Prior to installation, the Fabricator shall conduct a pre-install walk through with the Designer and Owner to address any potential issues/questions.
  - G. At the substantial completion of the project the Fabricator shall perform a walk-through with the Designer and Owner to inspect the installation and create a punch list of all unsatisfactory items. Fabricator is required to complete all punch list items within 3-4 weeks of receipt of punch list.

## 1.6 WORK QUALITY

- A. All work to be done in a professional manner and to the highest trade standards. Fabricator is responsible for ensuring the quality standards above for all related professional and trade subcontracted work including: general carpentry, masonry, electrical, landscaping, or utilities required for the installation of all sign types as described, unless otherwise agreed to by Owner.
- B. All subcontracted work must meet the general accepted professional standards.

## 1.7 REFERENCE STANDARDS

- A. The following materials reference standards will apply to the work materials (use most current version of reference standards):
  - 1. ASTM A36 Structural Steel
  - 2. ASTM A123 Zinc (Hot Galvanized) coatings on products fabricated from rod, pressed, and forged steel shape, plates and bars.
  - 3. ASTM B221 Aluminum-alloy extruded bars, rods, wire, shapes and tubes.
  - 4. ASTM D822 Light and Water exposure apparatus (Carbon-arc type) for testing paint, varnish, lacquer, and related products.
  - 5. ASTM E84 Surface-burning characteristics of building materials, lacquer and related products.
  - 6. AWI Comply with applicable requirements of "Architectural Woodwork Quality Standards" published by the Architectural Woodwork Institute.
  - 7. CDA Copper Development Association, Inc.
  - 8. FS L-P-391 Plastic sheet, rods and tubing, rigid, cast materials
  - 9. FS L-P-387 Plastic sheet, laminated, thermosetting
  - 10. PS-1 Construction and industrial plywood
  - 11. PEI Porcelain Enamel Institute
  - 12. TM 8135 QQ-B-613 (Fed Spec) Brass, Muntz 280
  - 13. UL-943 Fluorescent lamp ballasts quality

14. ICC A117.1 – 2009 Accessible and Usable Buildings and Facilities

1.8 WARRANTIES

- A. Warrant all products (including, but not limited to: materials, hardware, and finishes) against any and all defects based on manufacturers' supplied warranties from date of installation. All manufacturer warranties should be submitted to the Designer and Owner for review.
  - 1. Vinyl die-cut letters: warranted against delimitation from substrate.
  - 2. Paint finishes: warranted against fading or chalking, corrosion developing beneath paint surfaces of the support systems (except for obvious vandalism or other external damage to the paint surfaces).
  - 3. Corrosion of the fastenings.
  - 4. The signs not remaining true and plumb on their supports during normal wear.
  - 5. Fading of the colors when matched against a sample of the original color and material.
  - 6. Discoloration of metal finishes.
  - 7. Adhesives, e.g. tape and epoxy
  - 8. Paneling not remaining true and plumb on their supports during normal wear.
- B. The Fabricator shall correct any and all material and/ or workmanship defects which may appear during the warranty period by restoring defective work to the standard of the contract documents at no cost to the Owner and to the Owner's satisfaction. Corrections include but are not limited to disfiguring of any surface due to chalking, rusting, bubbling, or other disintegration of the sign face or of the messages or of the edge finish of the sign inserts or panel.
- C. Manufacturer warrants that under normal wear and use the installation and signposts will not crack or fail for a period of ten (10) years from the date of substantial completion.
- D. Installer shall provide labor and material warranty for a period of one (1) full year from the date of substantial completion.

1.9 CHPL PRODUCT WARRANTIES

- A. Manufacturer warrants that under normal wear and use the workmanship and materials used in the CHPL product purchased from the Manufacturer will meet the standards set forth on the applicable specification materials and that the product will not delaminate, peel, blister, crack or fade for a period ten (10) full years from the date of purchase.
  - 1. In the event that the product does not perform as warranted:
  - 2. Manufacturer shall be allowed to conduct an on-site inspection and investigation, or be provided digital images of defects
  - 3. Manufacturer shall work directly with the end-user to resolve any warranty matter,



4. The sole remedy will be the repair or replacement of the defective product at the sole discretion of the Manufacturer, and/ or
5. The repair or replacement by Manufacturer shall be limited to the re-manufacture and shipment of the replacement or repaired product to the site of the end-user's product.

B. This warranty only applies to the manufacture and material used in the manufacture of the product. Manufacturer shall not be liable for any other costs, including but not limited to installation, labor or other costs or expenses. Any repair or replacement shall be warranted for a period up to the remaining life of the original warranty. Further the repair or replacement costs incurred by Manufacturer shall not exceed the purchase price paid for the product.

#### 1.10 QUALITY ASSURANCE

- A. Work done and materials furnished shall meet the highest industry standards in every respect and, unless otherwise specified, materials and equipment shall be new and of the latest design.
- B. The Design Intent Package should provide everything necessary for a complete contract.
- C. In the event of conflict or omission, the Fabricator shall consult the Designer for resolution. All clarifications are to be made in writing in the form of an RFI from the Fabricator to the Designer.
- D. Use only personnel thoroughly skilled and experienced with the products and method for fabrication and installation of signage specified.
- E. The Owner shall reserve the right to reject any shop drawings, samples or other submittals, as well as any finished product or installation, that cannot meet the standard of quality established. Any such decision will be considered final and not subject to recourse.
- F. Materials and hardware not specified, but necessary to the complete functioning of the sign, shall conform to the quality level established.
- G. Substitutions of items specifically indicated in this specifications package that serve the same function with equal performance will be considered upon submission of substitution. SEE DIV 1.

### PART 2 - MATERIALS AND PRODUCTS

#### 2.1 ALUMINIUM

- A. Aluminum shall be of best commercial quality and the various forms shall be straight and true. There shall be no scratches, scars or buckles. Size thickness and finish of aluminum shall be per NAAMM "Metal Finishes Manual". Comply with the following industry standards.
- B. Aluminum sheets shall conform to ASTM B209 6061-T6
- C. Aluminum extrusions shall conform to ASTM B241 6063 T6. Wall thickness shall be a minimum of 1/8" thick unless otherwise shown.

- D. Brushed Finishes-Brush with abrasive of increasing grit# in a linear directional pattern.
- E. Final surface shall have visible grain pattern to match sample approved by Designer. Spray with clear protective finish.
- F. Polished Finish-Brush with abrasive of increasing grit #. Buff to a mirror finish with no visible grain. Match sample approved by Designer. Spray with clear protective finish.
- G. Non-Directional Finish-Brush with abrasive mounted in a random orbital sander. Match sample approved by Designer. Spray with clear protective finish.

## 2.2 STAINLESS STEEL

- A. Structural Stainless steel shapes to be rolled or laser fused, as manufactured by Stainless Structurals, LLC. (936-538- 7600, [www.stainless-structurals.com](http://www.stainless-structurals.com))
- B. Chromium stainless steel sheet. Use type 304 or type 316 stainless steel with 16% chromium and 10% nickel.
- C. For steel exposed to view on completion, provide materials having flat, smooth surfaces without blemishes. Do not use materials whose surfaces exhibit pitting, seam marks, roller marks, rolled trade names, or roughness. Stainless Steel Plate, Sheet and Strip: Provide stainless steel plate, sheet, or strip, AISI Type 302, complying with requirements of ASTM A 167.
- D. Stainless Steel Finishes: Finish designations prefixed by "AISI" conform to the system established by the American Iron and Steel Institute for designating finishes.
- E. Finish: Bead blasted & Pickled.

## 2.3 CUSTOM HIGH PRESSURE LAMINATE

- A. Provide Custom High pressure laminate as manufacturer by iZone or an approved equal.
- B. Custom High Pressure Laminate material composed of required layers of phenolic resin impregnated brown kraft filler paper to produce specified thicknesses, surfaced by a layers of melamine overlay, graphics imaged on saturation grade paper with UV resistant pigment based process color inks, and with an optically clear UV overlay that will resist no less that 99% of all sunlight and UV rays, as well as provide a graffiti resistant surface that allows for removal with standard cleaners.
- C. Layers of material are to be assembled, and heat/ pressure consolidated at approximately 1200 PSI at temperatures exceeding 275° Fahrenheit at manufacturer's prescribed time frames.
- D. All manufacturing processes of printing, pressing, machining, finishing and crating to be accomplished within a single standalone manufacturing facility to ensure consistent quality control and providing standard product delivery times of three weeks.

## 2.4 WOOD

- A. #1 grade black locust lumber. Sustainably harvested. Eased edges. Apply a UV clear coat to enhance the wood grain and provide additional protection.

## 2.5 REFLECTIVE GRAPHICS

- A. Provide 3M Scotchlite enclosed lens reflective sheeting or approved equal.

## 2.6 CONCRETE

- A. All concrete footers are to be poured in place.
- B. All concrete footers are to be poured from thoroughly mixed and agitated concrete in order prevent unreasonable voids in the finished casting.
- C. Concrete to meet specified "PSI Test" for strength: 3,500 psi minimum. Concrete to meet specified "Slump test" before pouring footing. All footings to extend past the frost line.
- D. Any footers or posts for signs will be placed in wet concrete and allowed to fully cure in place before any signage is attached or mounted to it in any way. All exposed faces of concrete shall receive a finish to match existing, adjacent surfaces.

## 2.7 VHB FOAM TAPES

- A. Provide 3M Scotch VHB 4930
- B. Adhesive shall be Acrylic VHB
- C. Carrier shall be closed cell foam

## 2.8 ACCESSORIES ANCHORS AND FASTENINGS

- A. Provide anchors and fasteners required to secure work in place. Do not expose fastenings on surface of sign panels unless specifically noted otherwise. Do not deform, distort or discolor sign face surfaces by attachment of concealed fastenings.
- B. All fastenings shall be non-corrosive and resistant to oxidation or other corrosive action, of the same composition completely through their cross sections, particularly when used below grade. Use highest quality stainless steel hardware and fasteners.
- C. Anchors, inserts or fasteners shall be compatible with sign materials, shall not result in galvanic action or chemical interaction of adhesives and shall have demonstrable and sufficient strength for intended use.
- D. Steel anchors and fastenings for exterior use shall be galvanized in accordance with ASTM A153.

- E. Fabricate and install signs with fastenings to withstand all actions imposed by use; 30 psf wind perpendicular to surfaces, water, ice, snow loads and similar forces.
- F. Anchor bolts in concrete shall be cast in place. Fabricator shall furnish instructions for the setting of anchors and bearing plates. Fabricator shall ascertain that the items are properly set during the process of the work.
- G. Secure work with fastenings of same color and finish as the components they secure where they are exposed to view, unless noted otherwise. All exposed fasteners must be vandal resistant and have vandal-proof "spanner" type slots to be removed only with a special driver head.

### PART 3 - EXECUTION

#### 3.1 PROTECTION AND STORAGE

- A. Fabricator is responsible for storage of signs and assemblies and protection from damage at the shop, in transit and until erected in place, complete, inspected and accepted by Owner.
- B. Fabricator is responsible for the replacement pilferage both prior to and until inspection and acceptance of installation by the Owner.

#### 3.2 INSPECTION

- A. All production materials, color samples and paints, fabricated or partially fabricated items shall be available for inspection, on-site or in the shop, by the Owner or Designer during the manufacturing process and until final delivery, installation and acceptance, to determine compliance with the requirements of these specifications. Shop inspection approvals do not guarantee final acceptance of installed work.

#### 3.2 INSTALLATION

- A. Install sign units and components with concealed fasteners unless otherwise shown. Refer to drawings for general method of installation. Verify each surface in field to determine appropriate mounting hardware. Fabricator is responsible for determining where below ground or in-wall structural tie-ins may be required. All elements should be installed true and plumb in accordance with the design intent of this document. Fabricator is responsible for determining the location of underground structures and utilities on ground-mounted signs. Any conflicts should be brought to the attention of the Owner and Designer.
- B. Sign location drawings show approximate locations of signs. Fabricator, Designer and Owner shall conduct a pre-install mark out walk through to confirm all locations and identify areas of conflict.

#### 3.3 REGULATORY REQUIREMENTS

- A. All installation work shall comply with applicable municipal, state and federal codes, sign ordinances and ADA guidelines for handicapped and fire/life safety signing.

- B. All OSHA safety requirements will be implemented during fabrication and installation as needed or required to comply with safety regulations.
- C. All field/site work shall be conducted in compliance with the Owner/Construction Manager's requirements/ regulations for the site, particularly areas open and accessible to the public. Work area protection shall be required as needed and all site-specific rules should be reviewed and outlined during the project kick-off meeting.

#### 3.4 CLEAN UP

- A. Daily and upon completion of installation remove all waste, dirt, wrappings and excess materials, tools and equipment, and thoroughly clean all surfaces to the satisfaction of the Owner.

#### 3.5 REORDERING

- A. Reordering all items specified in this package shall be available to the Owner in additional quantities for a period of 10 years after completion of all work called for in this specification.

END OF SECTION 10 06 10

SECTION 12 93 00

SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bench
2. Trash Receptacle
3. Short Heavy Duty Security Concrete Bollard
4. Removable Bollard
5. X-Post Monoslope Shelter
6. Restroom Prefabricated Unit

B. Related Requirements:

1. Section 133400 "Fabricated Engineered Structures" for Restroom and X-Post Monoslope Shelter.
2. Section 321613 "Cast-in-Place Concrete" for installing equipment and/or anchor bolts cast in concrete footings.
3. Section 312000 "Earth Moving" for excavation for installing concrete footings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For Prefabricated Restroom to show coordination between electrical and plumbing.
- C. Test results showing soil has vertical soil capacity of 1,500 pounds per square foot for restroom building.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Anchors, Fasteners, Fittings, and Hardware: Provide Stainless steel; commercial quality, tamperproof, vandal and theft resistant unless indicated otherwise on the Drawings.
- B. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107; recommended in writing by manufacturer, for exterior applications.
- C. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound; resistant to erosion from water exposure without needing protection by a sealer or waterproof coating; recommended in writing by manufacturer, for exterior applications.

### 2.2 BENCHES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide furnishings manufactured by Dumor, Inc., P.O. Box 142, Mifflintown, PA 17059, 717-436-2106 or 800-598-4018, [www.dumor.com](http://www.dumor.com), or approved comparable product.
  - 1. Model: 160-60 (Backed)
  - 2. Finish / Color: Powdercoat / Black.
  - 3. Length: 6'
  - 4. With center arm and 'Fairmount Park' security panel.
  - 5. Mount: As shown on Drawings.

### 2.3 TRASH RECEPTACLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide furnishings manufactured by Dumor, PO Box 142, Mifflintown, PA 17059, 1-800-598-4018, or approved comparable product.
  - 1. Model: 157-32-FTO
  - 2. Finish / Color: Powdercoat / Black.
  - 3. Mount: As shown on Drawings.

### 2.4 SHORT HEAVY DUTY SECURITY CONCRETE BOLLARD

- A. Basis-of-Design Product: Subject to compliance with requirements, provide furnishings manufactured by Crowd Control Warehouse, 1525 W Homer St #203, Chicago, IL 60642, Phone: (877) 885-1600, Email: [sales@crowdcontrolwarehouse.com](mailto:sales@crowdcontrolwarehouse.com) or approved comparable product.
  - 1. Model: CCW-33-038-00274
  - 2. Finish / Color: A20 White Standard Acid Wash
  - 3. Mount: As shown on Drawings.

2.5 REMOVABLE BOLLARD

- A. Basis-of-Design Product: Subject to compliance with requirements, provide furnishings manufactured by Dumor, PO Box 142, Mifflintown, PA 17059, 1-800-598-4018, or approved comparable product.
1. Model: 400-42/S-1SL
  2. Finish / Color: Powdercoat / Black
  3. Mount: As shown on drawings per manufacturer's recommendation.

2.6 X-POST MONOSLOPE SHELTER

- A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide furnishings manufactured by Coverworx, 11800 East 9 Mile Road, Warren, MI 48089 Phone: 586-486-1088, or 1-800-657-6118 Web: [www.coverworx.com](http://www.coverworx.com), or approved equal.
1. Model: MO-2637-SW-XP
  2. Size: 26'x 37'
  3. Frame & Beam Material: Tubular Steel
  4. Frame & Beam Finish / Color: Powder Coat / Matte Black
  5. Metal Roof Style / Color: Multi-Rib (Standard) / Buckskin
  6. Mount: As shown on drawings per manufacturer's recommendation.

2.7 PREFABRICATED RESTROOM BUILDING

- A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide furnishings manufactured by M&W Precast & Construction Supply, 210 Durham Road, Ottsville, PA 18942, Phone: 610-847-1423; E-mail: [dworthington@mwprecastsupply.com](mailto:dworthington@mwprecastsupply.com), Web: [precastbuildings.com](http://precastbuildings.com) or approved equal.
1. Model: 20'-6"x8' Restroom custom design for Nicetown Park, drawing included in specification.
  2. Installation: As shown on drawings and per manufacturer's recommendation.
  3. Contractor to confirm that soil has vertical soil capacity of 1,500 pounds per square foot.
  4. Contractor to coordinate utility locations and make all final connections.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.



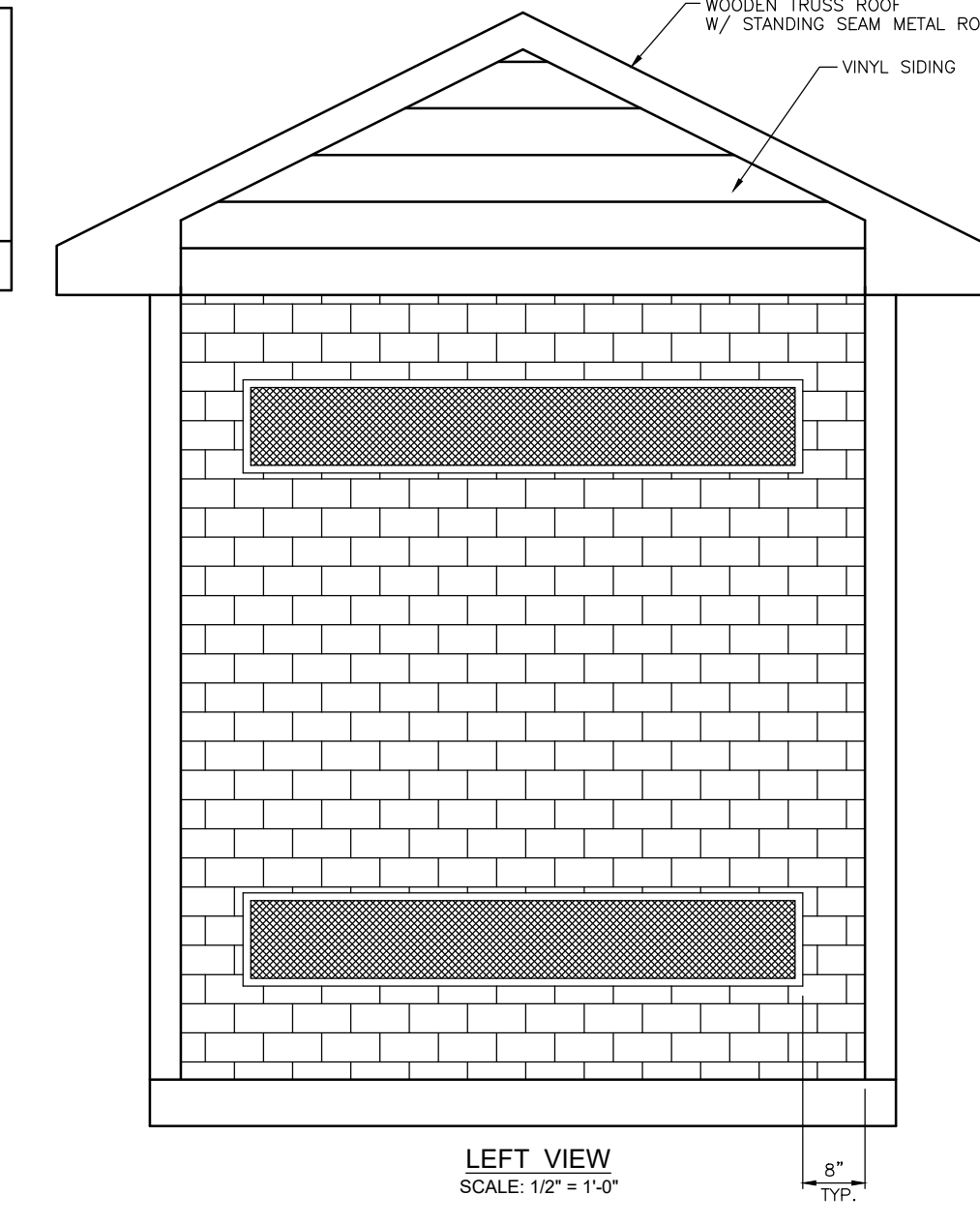
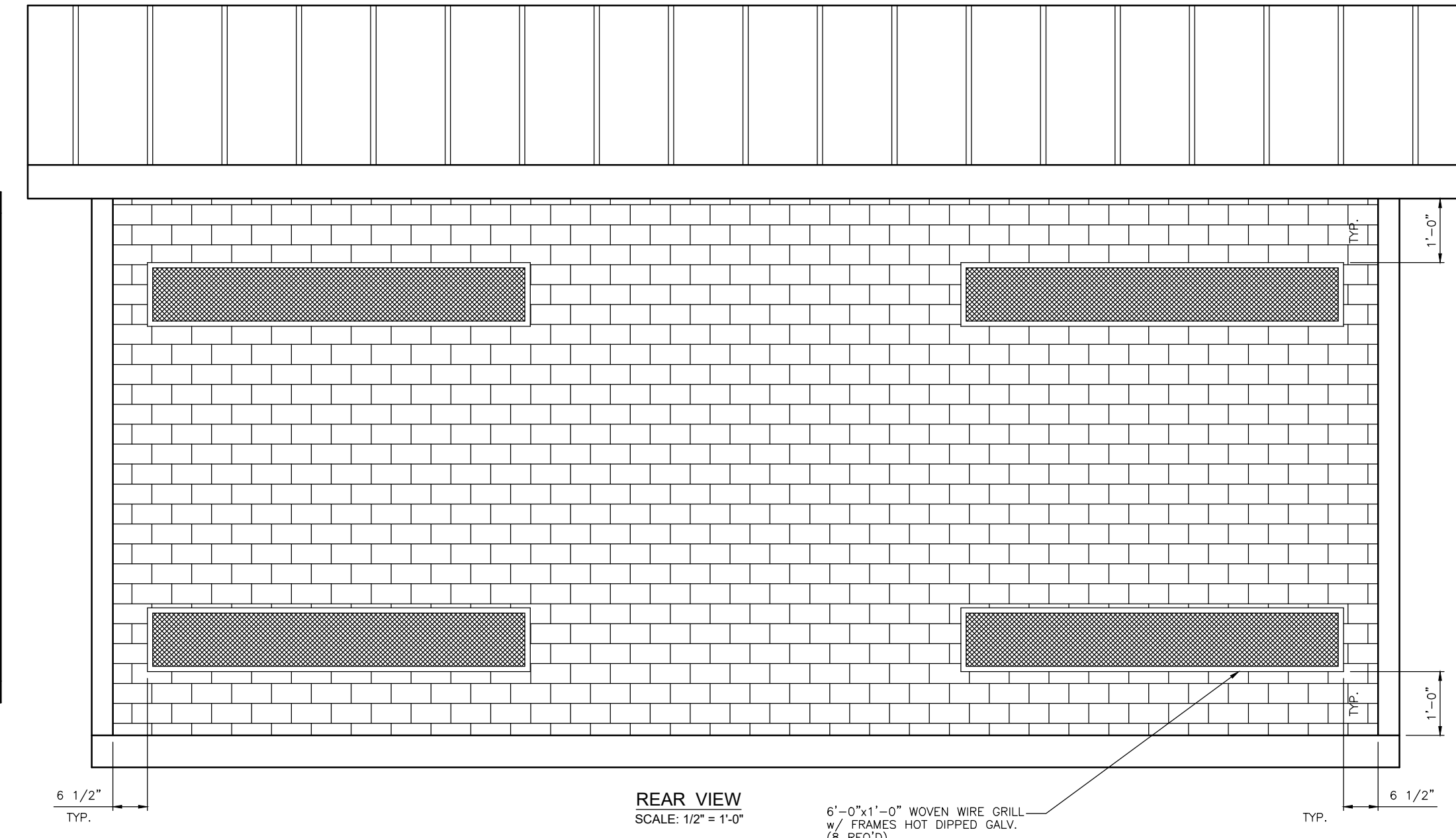
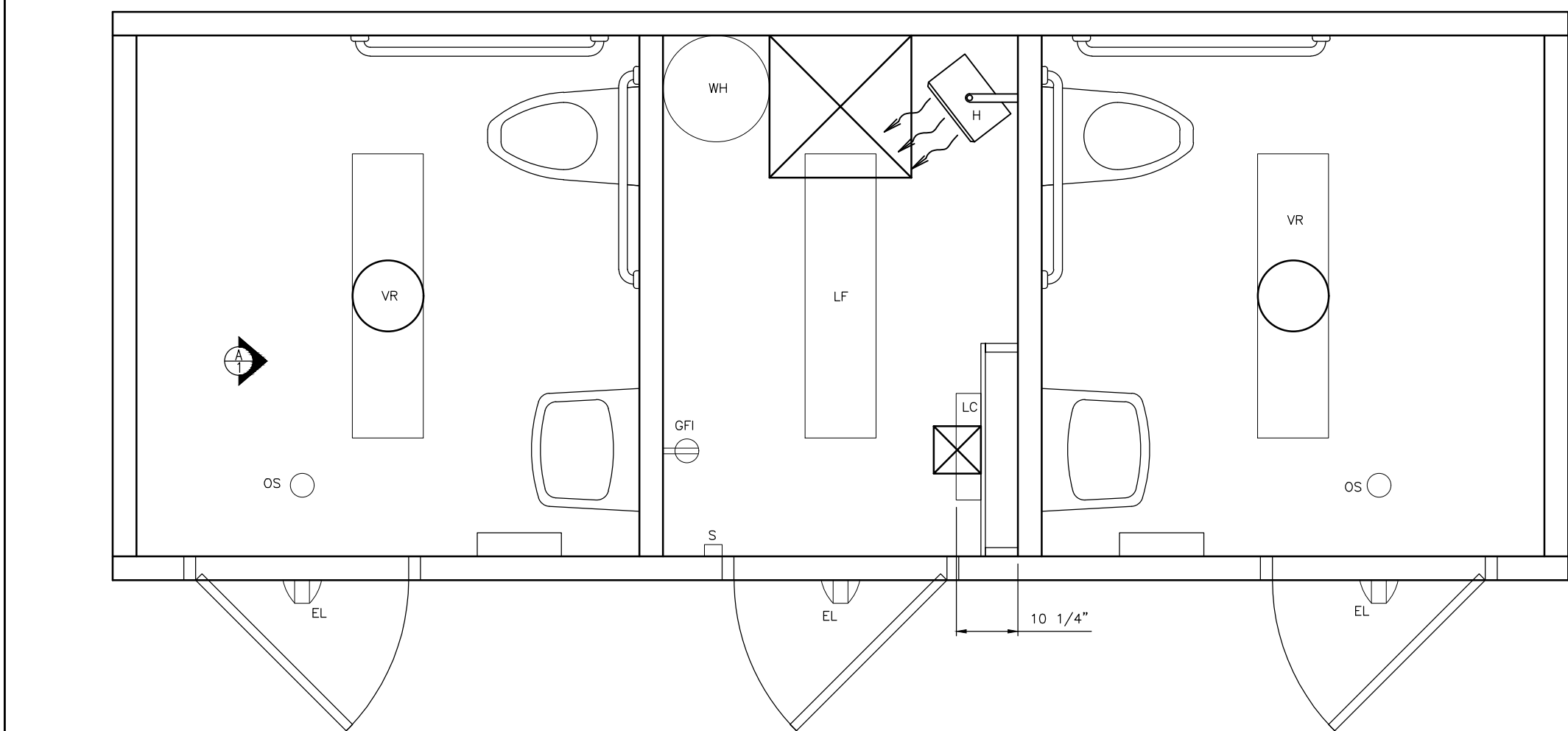
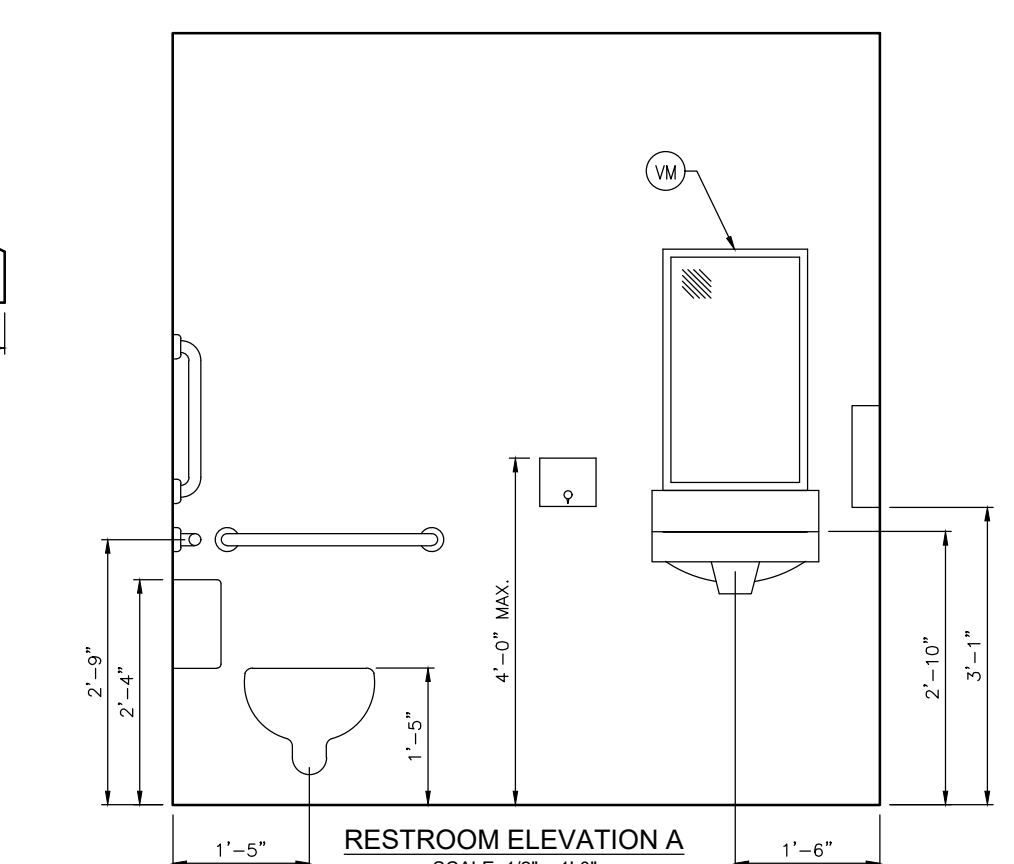
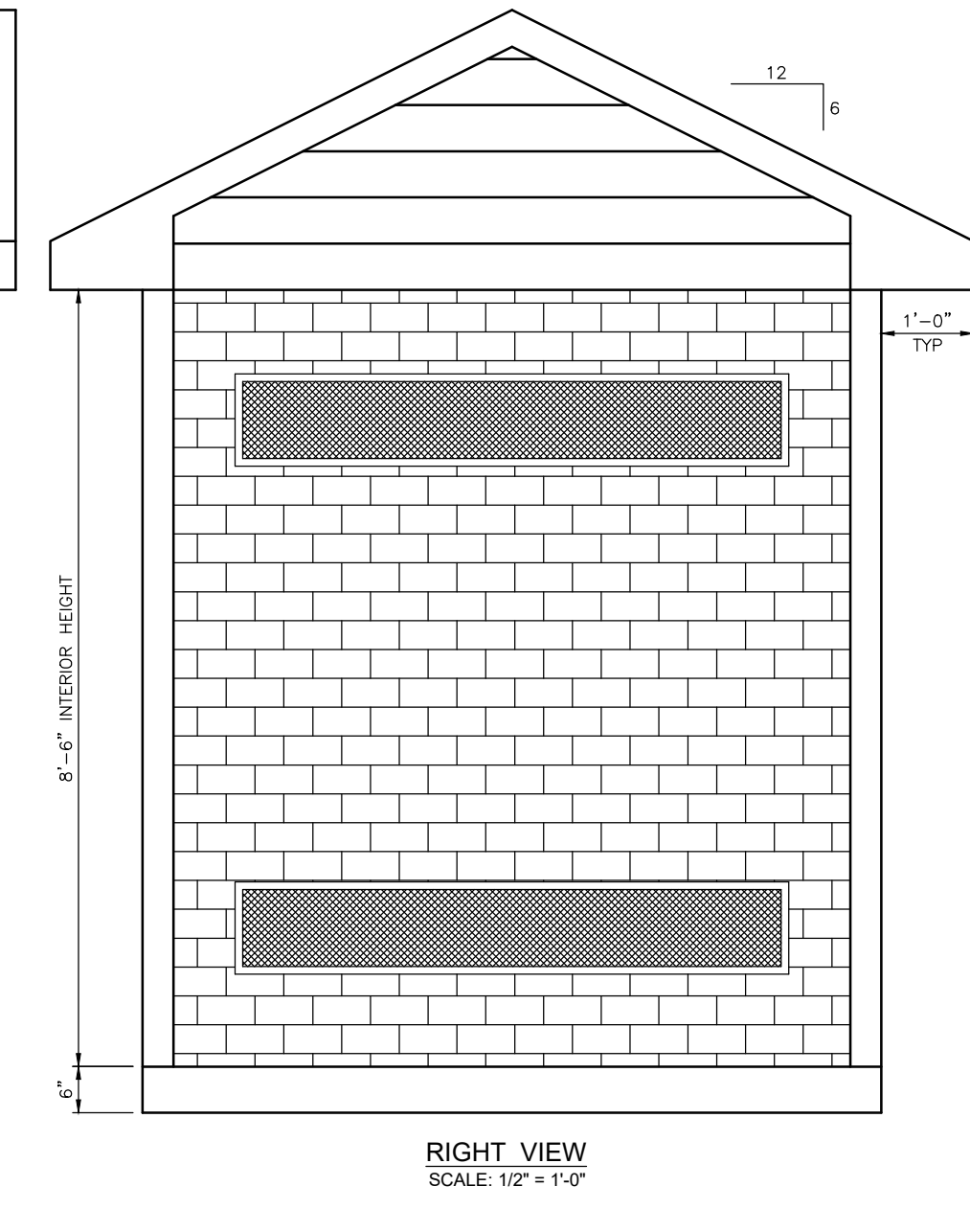
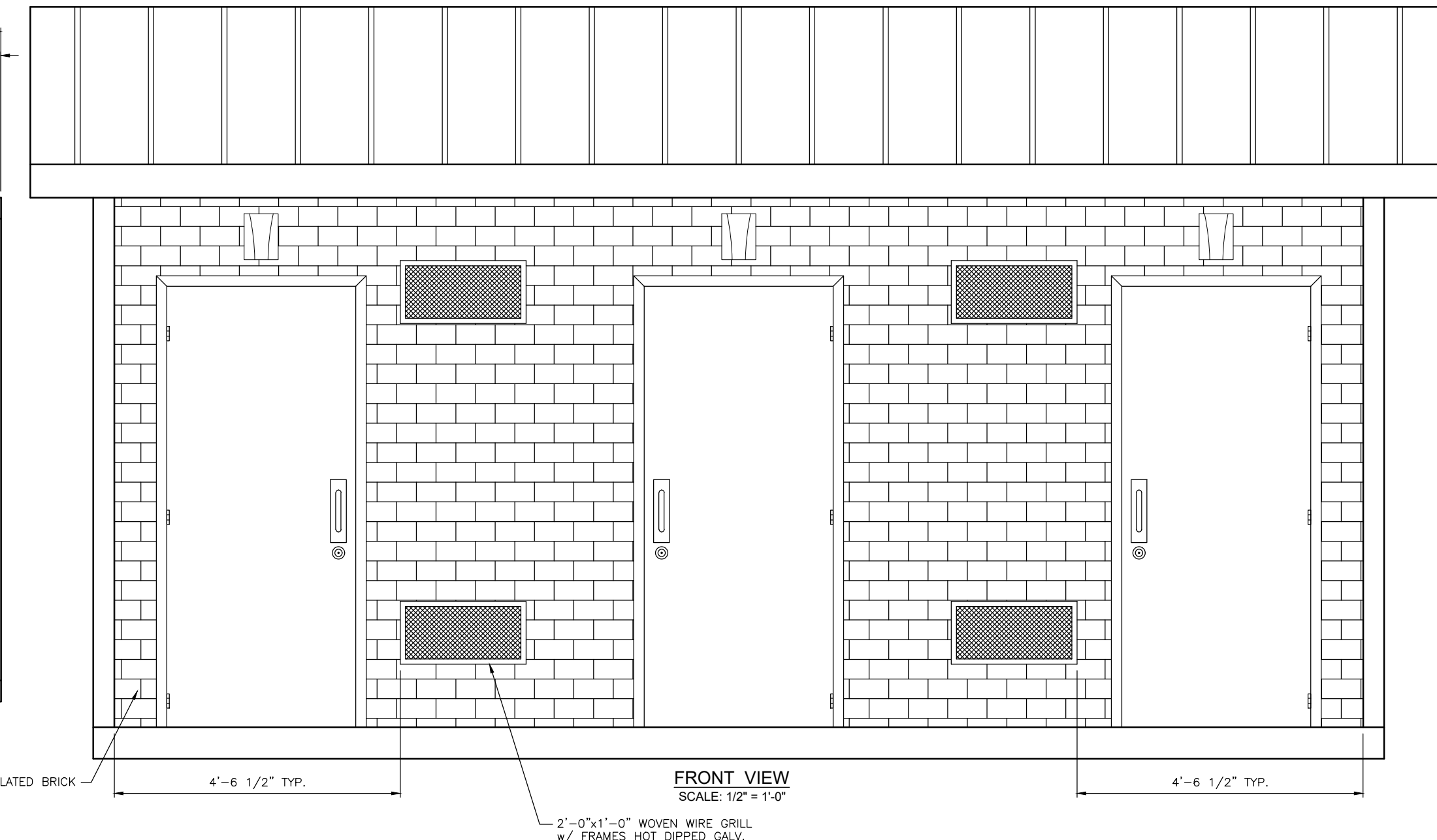
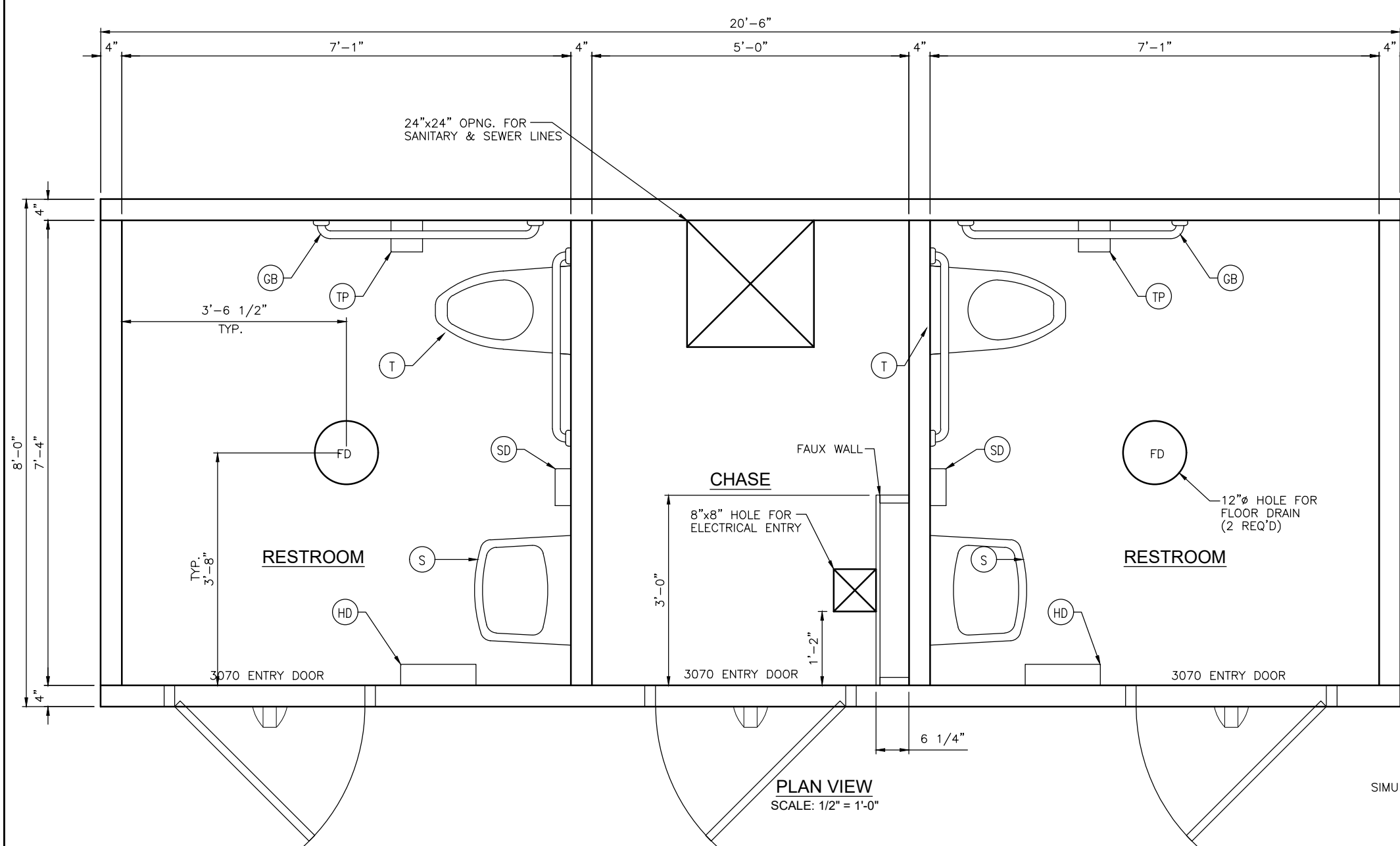
3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and **securely anchored** at locations indicated on Drawings and per manufacturer's instructions.
- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.
- E. Pipe Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions, with top smoothed and shaped to shed water.

3.3 CLEANING

- A. After completing site furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION 12 93 00



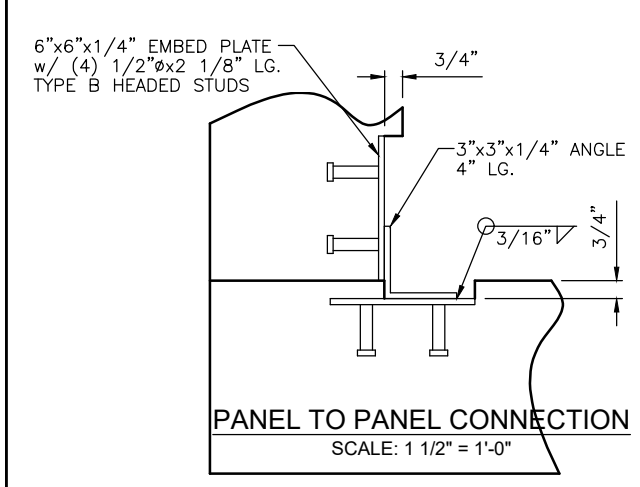
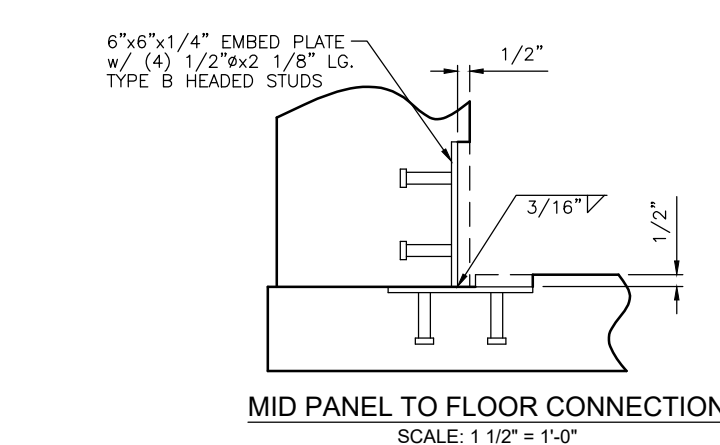
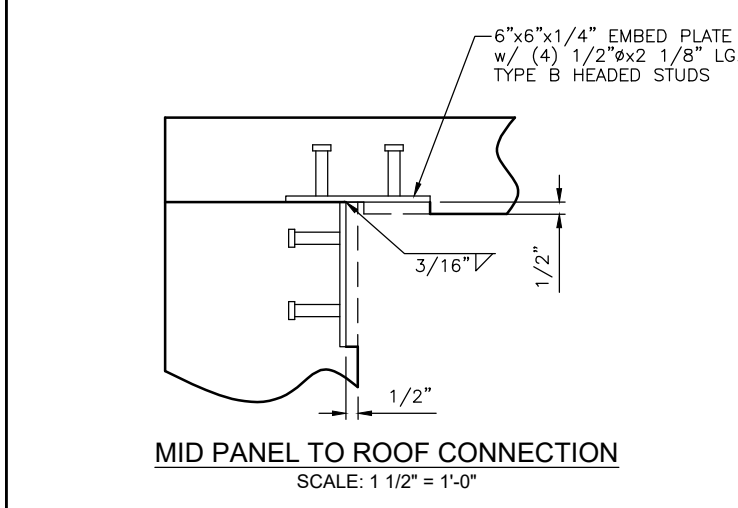
DURAREST DOOR, FRAME & HARDWARE SCHEDULE		
DESCRIPTION	QTY.	
CURRIES 3070 18 GADE GALV., INSULATED DOOR	3	
CURRIES 3070 18 GADE GALV., SINGLE RABBIT FRAME	3	
MCKINNEY NRP TAZ2314 HINGES	7	
MCKINNEY NRP ELECTRIC HINGE WITH ELECTROLYNX CABLE (RESTROOM DOORS)	2	
BEST 9K-3-7-AB-15-A-STK-826 LOCKSET	1	
SARGENT SC-28-10C71-LL-26D 24V ELECTRIFIED LOCK (RESTROOM DOORS)	2	
SECURITRON BPS-24-1 POWER SUPPLY	1	
SECURITRON DT-7 DIGITAL TIMER	1	
SCHLAGE BBS71 DEADBOLT w/ OCCUPANCY INDICATOR (RESTROOM DOORS)	2	
ROCKWOOD 107470C STAINLESS STEEL PUSH/PULL PLATE	3	
NORTON SERIES 8501 DOOR CLOSER (RESTROOM)	2	
RIXSON FIREMARK 9-326 OVERHEAD DOOR HOLDER (CHASE)	1	
PEMKO 346C DRIP CAP	3	
PEMKO 170A THRESHOLD	3	
PEMKO 315CN DOOR SWEEP	3	

DURAREST ACCESSORIES SCHEDULE		
DESCRIPTION	QTY.	
GB BOBRICK SERIES B-6806 GRAB BARS (1 @ 36", 1 @ 42", 1 @ 18" VERT.)	2	
TD BOBRICK SERIES B-4288 CONTURA TOILET TISSUE DISPENSER	2	
SD BOBRICK SERIES B-4112 CONTURA SOAP DISPENSER	2	
HD XLERATOR MODEL XL-GR HAND DRYER	2	
VM BOBRICK SERIES B-1556 VANDAL RESISTANT MIRROR	2	
ROCKWOOD BFB89 RESTROOM SIGN	2	

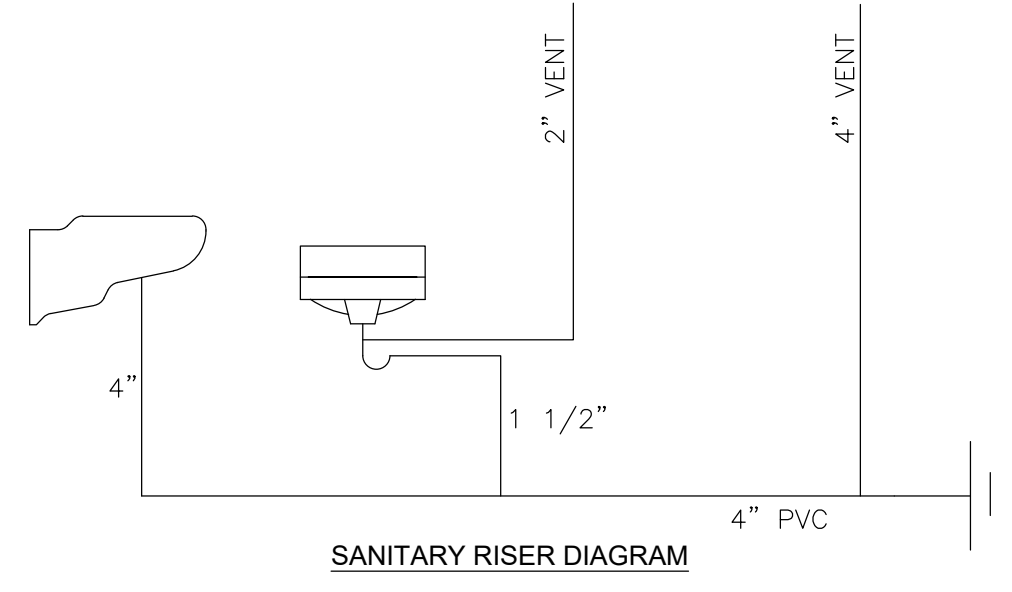
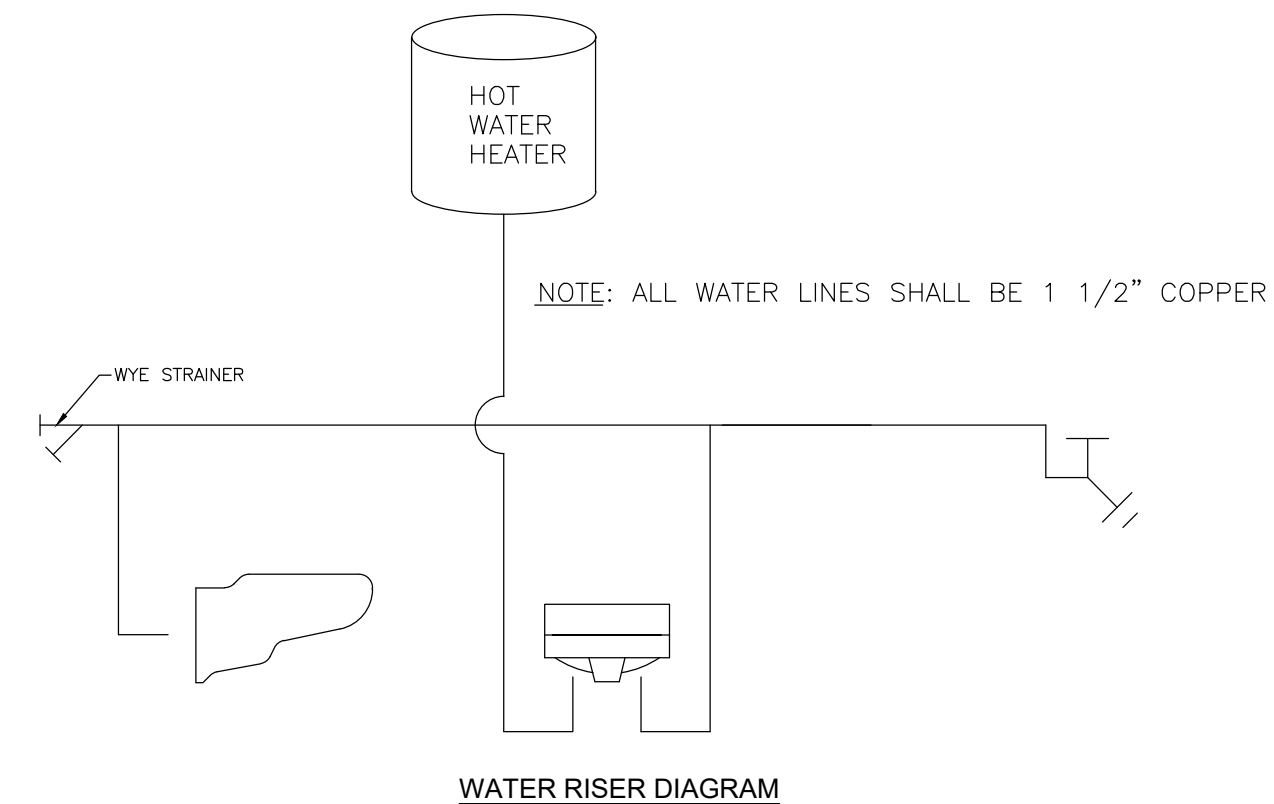
DURAREST FIXTURES SCHEDULE		
DESCRIPTION	QTY.	
WILLOUGHBY ETW-1490-FM-BS-HC-1.6-TWE-FV1.6-TFE-WS-HS TOILET FIXTURE, ADA APPROVED, BACK SUPPLY, WALL HUNG, 14 GA. 304 STAINLESS STEEL, SLOAN ROYAL PRISON MODEL 9603-1.2B FLUSHMETER, SLOAN HYDRAULIC PUSH BUTTON ACTUATOR	2	
WILLOUGHBY HS-1013-46-HC-SBPH-FML2-PBH-EB-LWE LAVATORY FIXTURE, ADA APPROVED, HOT & COLD, PNEUMATIC VALVE, 304 GAUGE STAINLESS STEEL	2	
AO SMITH DEL-30 GALLON ELECTRIC WATER HEATER	1	
SIUX CHIEF 832-35PNR FLOOR DRAIN	2	
3/4" HOSE BIB WITH VACUUM BREAKER	1	
MATCO #14507 WYE STRAINER (OR EQUAL)	1	
SHUT OFF VALVE TO DRAIN AND WINTERIZE BUILDING	1	

DURAREST ELECTRICAL SCHEDULE		
DESCRIPTION	QTY.	
SQUARE D QD124M100 LOAD CENTER 240V/100A/1PH/24SP NEMA	1	
LUMINAIRE CL7-4-50-120/277-CP-WHT VANDAL RESISTANT INTERIOR LED LIGHT FIXTURE	2	
COLUMBIA LAM4-40ML-EDU NON-VANDAL RESISTANT INTERIOR LED LIGHT FIXTURE	1	
RAB SLM12/PC EXTERIOR LIGHT w/ PHOTOCCELL	2	
LEVITON GFR12-1 GFCI RECEPTACLE	1	
LEVITON CS120-21 SINGLE POLE SWITCH (CHASE)	1	
OS CEILING MOUNTED OCCUPANCY SENSOR (RESTROOMS)	2	
QMARK MMUHS004 HEATER w/ THERMOSTAT	1	
CIRCUIT FOR WATER HEATER	1	

FINISH SCHEDULE			
ELEMENT	SURFACE	MATERIAL	COLOR
BUILDING EXTERIOR	DOORS	PAINT	-
	SIMULATED BRICK	CONCRETE STAIN	-
BUILDING INTERIOR	WALLS	PAINT	-
	CEILING	PAINT	-
	FLOOR	EPOXY	-
	STANDING SEAM	METAL	-
ROOF	VINYL SIDING	VINYL	-
	FASCIA	ALUMINUM	-
	SOFFIT	VINYL	-



EMBED PLATED SHALL BE PATCHED FLUSH WITH INTERIOR WALLS, ROOF AND FLOOR WITH SPEED CRETE REDLINE GROUT



- NOTES:**
- ALL FINAL FIELD CONNECTIONS (WATER, SEWER & ELECTRIC) SHALL BE THE RESPONSIBILITY OF OTHERS.
  - CRANE FOR SETTING SHALL BE SUPPLIED BY OTHERS.
  - THE INTERIOR CEILING HEIGHT SHALL BE 8'-6".
  - THE BUILDING IS CONSTRUCTED FROM INDIVIDUALLY POURED PRECAST CONCRETE PANELS THAT ARE ASSEMBLED ON A BASE SLAB AND SHIPPED AS A MODULAR UNIT.
  - THE FOUNDATION CONSTRUCTION SHALL BE BY OTHERS.
  - EXTERIOR WALLS SHALL RECEIVE A SIMULATED BRICK FINISH THAT IS STAINED TO MATCH THE CUSTOMERS COLOR SELECTION. ALL EXTERIOR SURFACES SHALL THEN BE COATED WITH SHERWIN WILLIAMS 2K ANTI-GRAFFITI COATING.
  - INTERIOR SURFACES SHALL RECEIVE A SMOOTH STEEL TROWEL FINISH. THE WALLS, FLOOR AND CEILINGS OF THE RESTROOM SHALL BE PAINTED TO MATCH THE CUSTOMERS COLOR SELECTION. THE CHASE AREA SHALL BE BARE CONCRETE.
  - THE WOODEN TRUSS ROOF SHALL BE SHIPPED AS A MODULAR UNIT AND INSTALLED ON SITE BY M&W PRECAST. FASCIA AND SOFFIT SHALL BE INSTALLED ON SITE BY M&W PRECAST.
  - GUTTER AND DOWNSPOUTS SHALL BE SUPPLIED AND INSTALLED BY OTHERS.
  - SECURITY SYSTEM PENETRATION LOCATIONS TO BE PROVIDED BY M&W PRECAST AT LOCATIONS APPROVED BY PHILADELPHIA PARKS & RECREATION.



210 Durham Road, Ottsville, PA 18942  
(610) 847-1423

**NICETOWN PARK**  
19'-0"x8'-0" RESTROOM  
PHILADELPHIA  
PA.

CUSTOMER PHILADELPHIA PARKS AND REC.					
DATE	SALES	DRAWN	ENGINEER	CHECKED	SALES ORDER
9/29/23	DW	S.V.	DT	-	-
DRAWING NUMBER				REVISION	SHEET
-				3	1 OF 1
				REV DATE	
				1/16/24	

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Sleeve-seal systems.
  - 2. Sleeve-seal fittings.
  - 3. Grout.
  - 4. Silicone sealants.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. GPT; an EnPro Industries company.
  - 4. Metraflex Company (The).
- B. Description:
  - 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 2. Designed to form a hydrostatic seal of 20 psig minimum.
  - 3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 of length required to secure pressure plates to sealing elements.

## 2.2 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Advance Products & Systems, Inc.
  2. CALPICO, Inc.
  3. GPT; an EnPro Industries company.
  4. Metraflex Company (The).
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab.
- C. Plastic or rubber waterstop collar with center opening to match piping OD.

## 2.3 GROUT

- A. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Design Mix: 5000-psi, 28-day compressive strength.
- C. Packaging: Premixed and factory packaged.

## 2.4 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. GE Construction Sealants; Momentive Performance Materials Inc.
    - b. Polymeric Systems, Inc.
    - c. Sherwin-Williams Company (The).
    - d. The Dow Chemical Company.

## PART 3 - EXECUTION

### 3.1 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### 3.2 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs. Position waterstop flange to be centered in concrete slab.
- C. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

### 3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system or Sleeve-seal fittings.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

END OF SECTION 22 05 17

SECTION 22 05 23

VALVES AND SPECIALTIES FOR PLUMBING PIPE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Brass ball valves.
  - 2. Drain valves.
  - 3. Water-hammer arresters.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. NRS: Non-rising stem.
- C. OS & Y: Outside screw and yoke.
- D. RS: Rising stem

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
  - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, and soldered ends.
  - 3. Set ball valves open to minimize exposure of functional surfaces.

- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B1.20.1 for threads for threaded end valves.
  - 2. ASME B16.1 for flanges on iron valves.
  - 3. ASME B16.5 for flanges on steel valves.
  - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 5. ASME B16.18 for solder-joint connections.
  - 6. ASME B31.9 for building services piping valves.
- C. Retain "NSF Compliance" Paragraph below if products come into contact with potable water.
- D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Actuator Types:
  - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- I. Valves in Insulated Piping:
  - 1. Include 2-inch stem extensions.
  - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
- J. RS Valves in Insulated Piping: With 2-inch stem extensions.
- K. Valve Bypass and Drain Connections: MSS SP-45

## 2.2 BRASS BALL VALVES

- A. Two-Piece, Brass Ball Valves with Full Port and Brass Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
    - b. Conbraco Industries, Inc.
    - c. Crane; Crane Energy Flow Solutions.
    - d. DynaQuip Controls.
    - e. Hammond Valve.
    - f. Jomar Valve.
    - g. KITZ Corporation.
    - h. Legend Valve & Fitting, Inc.
    - i. Marwin Valve; Richards Industries.
    - j. Milwaukee Valve Company.
    - k. NIBCO INC.
    - l. Red-White Valve Corporation.
    - m. Stockham; Crane Energy Flow Solutions.
    - n. Watts; a Watts Water Technologies company.
  2. Description:
    - a. Standard: MSS SP-110.
    - b. CWP Rating: 600 psig.
    - c. Body Design: Two piece.
    - d. Body Material: Forged brass.
    - e. Ends: Threaded and soldered.
    - f. Seats: PTFE.
    - g. Stem: Brass.
    - h. Ball: Chrome-plated brass.
    - i. Port: Full.

## 2.3 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
  2. Pressure Rating: 400-psig minimum CWP.
  3. Size: NPS 3/4.
  4. Body: Copper alloy.
  5. Ball: Chrome-plated brass.
  6. Seats and Seals: Replaceable.
  7. Handle: Vinyl-covered steel.
  8. Inlet: Threaded or solder joint.
  9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.



## 2.4 WATER-HAMMER ARRESTERS

### A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Jay R. Smith Mfg. Co.
  - c. Josam Company.
  - d. MIFAB, Inc.
  - e. Precision Plumbing Products.
  - f. Sioux Chief Manufacturing Company, Inc.
  - g. Tyler Pipe; a subsidiary of McWane Inc.
  - h. Watts; a Watts Water Technologies company.
  - i. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and performing balancing. Replace valves if persistent leaking occurs.
- B. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

3.5 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.6 DOMESTIC HOT- AND COLD-WATER BALL VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. Two-piece, brass ball valves with full port and brass trim.

END OF SECTION 220523

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SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Copper tube and fittings.
  - 2. Piping joining materials.
  - 3. Transition fittings.
  - 4. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report upon completion to owner.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

- B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
  - 1. MSS SP-123.
  - 2. Cast-copper-alloy, hexagonal-stock body.
  - 3. Ball-and-socket, metal-to-metal seating surfaces.
  - 4. Solder-joint or threaded ends.
- G. Copper, Brass, or Bronze Pressure-Mechanical Seal-Joint Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Apollo Flow Controls; Conbraco Industries, Inc.
    - b. Viega
    - c. NIBCO INC.
  - 2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
  - 3. Minimum 200-psig working-pressure rating at 250 deg F.

## 2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
  - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
  - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.

## 2.4 TRANSITION FITTINGS

- A. General Requirements:
  - 1. Same size as pipes to be joined.
  - 2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cascade Waterworks Mfg. Co.
    - b. Dresser, Inc.
    - c. Ford Meter Box Company, Inc. (The).
    - d. Jay R. Smith Mfg. Co.

## 2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Matco-Norca.
  2. Standard: ASSE 1079.
  3. Pressure Rating: 125 psig minimum at 180 deg F.
  4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Matco-Norca.
  2. Standard: ASSE 1079.
  3. Factory-fabricated, bolted, companion-flange assembly.
  4. Pressure Rating: 125 psig minimum at 180 deg F.
  5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Calpico, Inc.
  - b. Central Plastics Company.
  - c. Pipeline Seal and Insulator, Inc.
2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

#### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install shutoff valve immediately upstream of each dielectric fitting.
- E. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.

- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

### 3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- G. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- H. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.



- I. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### 3.4 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

### 3.5 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

### 3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  1. Plumbing Fixtures: Cold- and hot-water-supply piping shall match existing conditions, and shall not be smaller than that required by plumbing code.

### 3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
  - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
    - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
    - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
  - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
  - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
2. Piping Tests:
- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
  - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
  - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
  - d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
  - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
  - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
  2. Open shutoff valves to fully open position.
  3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
  4. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
  - 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  - 2. Use purging and disinfecting procedures prescribed by Philadelphia Water Department; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    - b. Fill and isolate system according to either of the following:
      - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
    - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    - d. Repeat procedures if biological examination shows contamination.
    - e. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Under-building-slab, domestic water, building-service piping, NPS 2 and smaller, shall be the following:
  - 1. Soft copper tube, ASTM B 88, Type K; wrought-copper, solder-joint fittings; and brazed joints.
- E. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
  - 1. Hard copper tube, ASTM B 88, Type L copper, solder-joint fittings; and soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

### 3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
  2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
  3. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
- C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 22 11 16

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Hub-and-spigot, cast-iron soil pipe and fittings.
  - 2. Hubless, cast-iron soil pipe and fittings.

1.3 ACTION SUBMITTALS

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

1.4 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Charlotte Pipe and Foundry Company.
  - 2. NewAge Casting.
  - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 74, Service class(es).
- C. Gaskets: ASTM C 564, rubber.
- D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Charlotte Pipe and Foundry Company.
  - 2. NewAge Casting.
  - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 888 or CISPI 301.
- C. CISPI, Hubless-Piping Couplings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Charlotte Pipe and Foundry Company.
    - b. Fernco Inc.
    - c. NewAge Casting.
    - d. Tyler Pipe; a subsidiary of McWane Inc.
  - 2. Standards: ASTM C 1277 and CISPI 310.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. Indicated locations and arrangements were used to size pipe.
  - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
  - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  - 3. Do not change direction of flow more than 90 degrees.
  - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- K. Lay buried building waste piping beginning at low point of each system.
  - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
  2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
  3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    - a. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
  2. Install drains in sanitary waste gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."



### 3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

### 3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
  - 1. Install transition couplings at joints of piping with small differences in ODs.
  - 2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
- B. Dielectric Fittings:
  - 1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
  - 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.

### 3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to existing sanitary piping.
- C. Connect waste and vent piping to the following:
  - 1. Plumbing Fixtures: Connect waste piping to existing system, but not smaller than required by plumbing code.
  - 2. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  - 3. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.6 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

3.7 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
    - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    - c. Inspect joints for leaks.
  - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

- a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
  - b. Air pressure must remain constant without introducing additional air throughout period of inspection.
  - c. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  6. Prepare reports for tests and required corrective action.

### 3.8 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

### 3.9 PIPING SCHEDULE

- A. Aboveground, soil and waste piping NPS 4 and smaller shall be the following:
  1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- B. Aboveground, vent piping NPS 4 and smaller shall be the following:
  1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
- C. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
  1. Service class, cast-iron soil piping.
- D. Underground, soil and waste piping NPS 5 and larger shall be the following:
  1. Service class, cast-iron soil piping.

END OF SECTION 22 13 16

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Connectors, splices, and terminations rated 600 V and less.

1.2 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Inc.
2. Encore Wire Corporation.

3. Service Wire Co.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B496 for stranded conductors.

E. Conductor Insulation:

1. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
2. Type THHN and Type THWN-2: Comply with UL 83.
3. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
4. Type UF: Comply with UL 83 and UL 493.
5. Type XHHW-2: Comply with UL 44.

## 2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. 3M Electrical Products.
2. Hubbell Power Systems, Inc.
3. Service Wire Co.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Copper.
2. Type: Two hole with standard barrels.
3. Termination: Compression.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- D. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- E. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- C. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

### 3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

### 3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
  - 2. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using one of the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey.
    - c. Inspect compression-applied connectors for correct cable match and indentation.
    - d. Inspect for correct identification.
    - e. Inspect cable jacket and condition.
    - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    - g. Continuity test on each conductor and cable.
    - h. Uniform resistance of parallel conductors.
  - 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove



box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

- a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
  - 1. Underground distribution grounding.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For grounding to include in operation and maintenance manuals.
- B. Plans showing as-built, dimensioned locations of system including:
  - 1. Conduit/conductor locations
  - 2. Hand hole locations
  - 3. Light fixture/pole locations

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

## PART 2 - PRODUCTS

### 2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

### 2.2 CONDUCTORS

- A. Insulated Conductors: Copper or tinned-copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B3.
  - 2. Stranded Conductors: ASTM B8.
  - 3. Tinned Conductors: ASTM B33.
  - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

### 2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- D. Conduit Hubs: Mechanical type, terminal with threaded hub.
- E. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- F. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- G. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.
- H. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

- I. Straps: Solid copper, copper lugs. Rated for 600 A.
- J. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.
- K. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

## 2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

## PART 3 - EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 30 inches below grade.
  - 2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.
- C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

### 3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

### 3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
  - 1. Feeders and branch circuits.
  - 2. Lighting circuits.
  - 3. Receptacle circuits.
  - 4. Single-phase motor and appliance branch circuits.
  - 5. Three-phase motor and appliance branch circuits.
  - 6. Flexible raceway runs.
- C. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  2. Use exothermic welds for all below-grade connections.
  3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.
1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
  2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.
- E. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.
- F. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
  - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  - b. Perform tests by fall-of-potential method according to IEEE 81.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 05 26

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Boxes, enclosures, and cabinets.
4. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 26 05 43 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. AFC Cable Systems; a part of Atkore International.
  - b. Allied Tube & Conduit; a part of Atkore International.
  - c. Plasti-Bond.
  - d. Thomas & Betts Corporation; A Member of the ABB Group.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. ARC: Comply with ANSI C80.5 and UL 6A.
5. IMC: Comply with ANSI C80.6 and UL 1242.
6. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - a. Comply with NEMA RN 1.
  - b. Coating Thickness: 0.040 inch, minimum.
7. EMT: Comply with ANSI C80.3 and UL 797.
8. FMC: Comply with UL 1; zinc-coated steel or aluminum.
9. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - a. AFC Cable Systems; a part of Atkore International.
  - b. FSR Inc.
  - c. Thomas & Betts Corporation; A Member of the ABB Group.
  - d. Topaz Electric; a division of Topaz Lighting Corp.
2. Comply with NEMA FB 1 and UL 514B.
3. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
4. Fittings, General: Listed and labeled for type of conduit, location, and use.
5. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
6. Fittings for EMT:
  - a. Material: Steel.
  - b. Type: compression.
7. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
8. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

- C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 NONMETALLIC CONDUITS AND FITTINGS

### A. Nonmetallic Conduit:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. AFC Cable Systems; a part of Atkore International.
  - b. Thomas & Betts Corporation; A Member of the ABB Group.
  - c. Topaz Electric; a division of Topaz Lighting Corp.
- 2. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- 3. Fiberglass:
  - a. Comply with NEMA TC 14.
  - b. Comply with UL 2515 for aboveground raceways.
  - c. Comply with UL 2420 for belowground raceways.
- 4. ENT: Comply with NEMA TC 13 and UL 1653.
- 5. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- 6. LFNC: Comply with UL 1660.
- 7. Rigid HDPE: Comply with UL 651A.
- 8. Continuous HDPE: Comply with UL 651A.
- 9. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D3485.
- 10. RTRC: Comply with UL 2515A and NEMA TC 14.

### B. Nonmetallic Fittings:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. AFC Cable Systems; a part of Atkore International.
  - b. Thomas & Betts Corporation; A Member of the ABB Group.
  - c. Topaz Electric; a division of Topaz Lighting Corp.
- 2. Fittings, General: Listed and labeled for type of conduit, location, and use.
- 3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

- a. Fittings for LFNC: Comply with UL 514B.
- 4. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.3 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Hubbell Incorporated; Wiring Device-Kellems.
  - 2. Thomas & Betts Corporation; A Member of the ABB Group.
  - 3. Topaz Electric; a division of Topaz Lighting Corp.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- L. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4X with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

M. Cabinets:

1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armorcast Products Company.
  - b. Oldcastle Precast, Inc.
  - c. Quazite: Hubbell Power Systems, Inc.
2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC."
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.

2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

### PART 3 - EXECUTION

#### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  1. Exposed Conduit: GRC or RNC, Type EPC-40-PVC.
  2. Concealed Conduit, Aboveground: GRC or RNC, Type EPC-40-PVC.
  3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Minimum Raceway Size: 3/4-inch trade size.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
  1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

#### 3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

- C. Complete raceway installation before starting conductor installation.
- D. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- F. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- G. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
  - 1. Change from ENT to GRC IMC before rising above floor.
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- J. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- O. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- Q. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a

blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- R. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where an underground service raceway enters a building or structure.
  - 2. Where otherwise required by NFPA 70.
- S. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- T. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
  - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semi recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  - 1. Use LFMC in damp or wet locations subject to severe physical damage.
  - 2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

#### A. Direct-Buried Conduit:

1. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength.
2. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
  - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
  - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
4. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

### 3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.



3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
  - 2. Rigid nonmetallic duct.
  - 3. Duct accessories.
  - 4. Precast concrete handholes.
  - 5. Polymer concrete handholes and boxes with polymer concrete cover.

1.3 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
  - 1. Two or more ducts installed in parallel, with or without additional casing materials.
  - 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include duct-bank materials, including spacers and miscellaneous components.
  - 2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Include accessories for manholes, handholes, boxes.
  - 4. Include underground-line warning tape.
  - 5. Include warning planks.
- B. Shop Drawings:

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1. Precast or Factory-Fabricated Underground Utility Structures:
  - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
  - b. Include duct entry provisions, including locations and duct sizes.
  - c. Include reinforcement details.
  - d. Include grounding details.
  - e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
  - f. Include joint details.
2. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
  - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
  - b. Include duct entry provisions, including locations and duct sizes.
  - c. Include cover design.
  - d. Include grounding details.
  - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For duct and duct bank. Show duct profiles and coordination with other utilities and underground structures.
  1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  2. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- C. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C858.
- D. Source quality-control reports.
- E. Field quality-control reports.

#### 1.6 MAINTENANCE MATERIALS SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

#### 1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.8 FIELD CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions, and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Owner's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Coated Steel Conduit: PVC-coated GRC.
  - 1. Comply with NEMA RN 1.
  - 2. Coating Thickness: 0.040 inch, minimum.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ABB, Electrification Products Division.
  - 2. AFC Cable Systems; Atkore International.
  - 3. Allied Tube & Conduit; Atkore International.
  - 4. Anaconda Sealtite; Anamet Electrical, Inc.
  - 5. Calconduit; Atkore International.
  - 6. Champion Fiberglass, Inc.
  - 7. Electri-Flex Company.
  - 8. FSR Inc.
  - 9. Korkap.
  - 10. NEC, Inc.
  - 11. NewBasis.
  - 12. Opti-Com Manufacturing Network, Inc (OMNI).
  - 13. O-Z/Gedney; Emerson Electric Co., Automation Solutions, Appleton Group.
  - 14. Patriot Aluminum Products, LLC.
  - 15. Perma-Cote; Robroy Industries.
  - 16. Picoma; Zekelman Industries.
  - 17. Plasti-Bond; Robroy Industries.
  - 18. Republic Conduit; Nucor Corporation, Nucor Tubular Products.
  - 19. Southwire Company.
  - 20. Topaz Lighting & Electric.
  - 21. Western Tube; Zekelman Industries.
  - 22. Wheatland Tube; Zekelman Industries.

- D. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

## 2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. ARNCO Corp.
  - 2. Beck Manufacturing.
  - 3. Cantex Inc.
  - 4. CertainTeed Corporation; Saint-Gobain North America.
  - 5. Condux International, Inc.
  - 6. Crown Line Plastics.
  - 7. ElecSys, Inc.
  - 8. Electri-Flex Company.
  - 9. Endot Industries Inc.
  - 10. IPEX USA LLC.
  - 11. Lamson & Sessions.
  - 12. Manhattan/CDT.
  - 13. National Pipe & Plastics.
  - 14. Opti-Com Manufacturing Network, Inc (OMNI).
  - 15. Spiraduct/AFC Cable Systems, Inc.
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

## 2.3 PRECAST CONCRETE HANDHOLES AND BOXES

- A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Christy Concrete Products.
  - 2. Elmhurst-Chicago Stone Co.
  - 3. Oldcastle Infrastructure Inc.; CRH Americas.
  - 4. Rinker Group, Ltd.
  - 5. Riverton Concrete Products.
  - 6. Utility Concrete Products, LLC.
  - 7. Utility Vault Co.
  - 8. Wausau Tile Inc.
- C. Comply with ASTM C858 for design and manufacturing processes.
- D. Frame and Cover:

1. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
  2. Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
  3. Weatherproof steel frame, with hinged steel access door assembly with tamper-resistant, captive, cover-securing bolts.
    - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    - b. Cover Handle: Recessed.
  4. Weatherproof aluminum frame with hinged aluminum access door assembly with tamper-resistant, captive, cover-securing bolts.
    - a. Cover Hinges: Concealed, with hold-open ratchet assembly.
    - b. Cover Handle: Recessed.
- E. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- F. Cover Legend: Molded lettering, "ELECTRIC".
- G. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- H. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
  1. Extension shall provide increased depth of 12 inches.
  2. Slab: Same dimensions as bottom of enclosure and arranged to provide closure.
- I. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- J. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
  1. Splayed location.
  2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
  3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct.
  4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
  5. Knockout panels shall be 1-1/2 to 2 inches thick.
- K. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
  1. Type and size shall match fittings to duct to be terminated.
  2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.
- L. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armorcast Products Company.
  - 2. MacLean Highline.
  - 3. NewBasis.
  - 4. Oldcastle Infrastructure Inc.; CRH Americas.
  - 5. Quazite; Hubbell Incorporated, Power Systems.
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC".
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by an independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.

3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Engineer if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed and protect vegetation to remain according to Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication according to Section 311000 "Site Clearing."

### 3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Branch Circuits: Type EPC-40-PVC RNC, direct-buried unless otherwise indicated.

### 3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes and Boxes for 600 V and Less:
  1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-25 structural load rating.
  2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 or Polymer concrete, SCTE 77, Tier 15 structural load rating.
  3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 or Polymer concrete units, SCTE 77, Tier 8 structural load rating.
  4. Cover design load shall not exceed the design load of the handhole or box.

### 3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 310000 "Earthwork" and 312316.13 "Trenching," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.



- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Lawn & Meadow" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to Section 312350 "Sawcutting," Section 321116 "Subbase Course," and Section 321216 "Asphalt Paving."

### 3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- E. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- F. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
  - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
  - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.

2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.
- H. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- I. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psi hydrostatic pressure.
- J. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.
- K. Concrete-Encased Ducts and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312316.13 "Trenching" for pipes less than 6 inches in nominal diameter.
  2. Width: Excavate trench 12 inches wider than duct on each side.
  3. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
  4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
  5. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  6. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
  7. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
  8. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
    - a. Couple RNC duct to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
    - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
      - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
    - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

- 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
  9. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
  10. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
  11. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
  12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions or use other specific measures to prevent expansion-contraction damage.
    - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.
  13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033053 "Site Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- L. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 310000 "Earthwork" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
  2. Width: Excavate trench 12 inches wider than duct on each side.
  3. Width: Excavate trench 3 inches wider than duct on each side.
  4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
  5. Set elevation of bottom of duct bank below frost line.
  6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
  7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
  9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
  10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

- a. Couple RNC duct to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
  - b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.
    - 1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.
  - c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.
    - 1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.
11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 310000 "Earthwork" for installation of backfill materials.
- a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
  - b. Place minimum 6 inches of engineered fill above concrete encasement of duct.
- M. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.
- N. Underground-Line Warning Tape: Bury nonconducting underground line no less than 12 inches above all concrete-encased duct and duct banks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES
- A. Precast Concrete Handhole and Manhole Installation:
- 1. Comply with ASTM C891 unless otherwise indicated.
  - 2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
  - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1- inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
- 1. Install handholes with bottom below frost line.
  - 2. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
  - 3. Where indicated, cast handhole cover frame integrally with handhole structure.

- C. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Waterproofing materials and installation are specified in Section 071353 "Elastomeric Sheet Waterproofing". After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.
- D. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

### 3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
  - 1. Concrete: 3000 psi, 28-day strength, complying with Section 033053 "Site Cast-in-Place Concrete," with a troweled finish.
  - 2. Dimensions: 10 inches wide by 12 inches deep.

### 3.8 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
  - 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.10 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
  - 1. Sweep floor, removing dirt and debris.
  - 2. Remove foreign material.

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Tapes and stencils.
4. Tags.
5. Cable ties.
6. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.



- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service and branch-circuit conductors.
  - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: White or gray.
  - 6. Color for Equipment Grounds: Green.
  - 7. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 600 V:
  - 1. Black letters on an orange field.
  - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.

- E. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."
- F. Equipment Identification Labels:
  - 1. Black letters on a white field.

### 2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brady Corporation.
    - b. Grafoplast Wire Markers.
    - c. Marking Services, Inc.
    - d. Seton Identification Products.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Marking Services, Inc.
    - b. Seton Identification Products.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. A'n D Cable Products.
    - b. Brother International Corporation.
    - c. Grafoplast Wire Markers.
    - d. Marking Services, Inc.
    - e. Seton Identification Products.
  - 2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.

3. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  4. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. A'n D Cable Products.
    - b. Brother International Corporation.
    - c. Grafoplast Wire Markers.
    - d. Marking Services, Inc.
    - e. Seton Identification Products.
  2. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. 3-1/2 by 5 inches for equipment.
    - c. As required by authorities having jurisdiction.

#### 2.4 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Marking Services, Inc.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Marking Services, Inc.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Marking Services, Inc.
- b. Seton Identification Products.

D. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Marking Services, Inc.
  - b. Seton Identification Products.
2. Tape:
  - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
  - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
  - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
3. Color and Printing:
  - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
  - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
4. Tag: Type I:
  - a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - b. Width: 3 inches.
  - c. Thickness: 4 mils.
  - d. Weight: 18.5 lb/1000 sq. ft.
  - e. Tensile according to ASTM D882: 30 lbf and 2500 psi.
5. Tag:
  - a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
  - b. Width: 3 inches.
  - c. Overall Thickness: 5 mils.
  - d. Foil Core Thickness: 0.35 mil.
  - e. Weight: 28 lb/1000 sq. ft.
  - f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

## 2.5 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Marking Services, Inc.
    - c. Seton Identification Products.
  
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Grafoplast Wire Markers.
    - c. Marking Services, Inc.
    - d. Seton Identification Products.
  
- C. Write-on Tags:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlton Industries, LP.
    - b. Seton Identification Products.
  - 2. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
  - 3. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
  - 4. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.6 CABLE TIES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
  - 1. Marking Services, Inc.
  
- B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
  - 1. Minimum Width: 3/16 inch.

2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black, except where used for color-coding.
- C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black.

## 2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- L. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- M. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- N. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- O. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- P. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- Q. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- R. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- S. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- T. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
  2. Limit use of underground-line warning tape to direct-buried cables.
  3. Install underground-line warning tape for direct-buried cables and cables in raceways.
- U. Metal Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using UV-stabilized cable ties.
- V. Nonmetallic Preprinted Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using plenum-rated cable ties.
- W. Write-on Tags:
1. Place in a location with high visibility and accessibility.
  2. Secure using plenum-rated cable ties.
- X. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- Y. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- Z. Laminated Acrylic or Melamine Plastic Signs:



1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

AA. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

### 3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive raceway labels.
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
  1. "EMERGENCY POWER."
  2. "POWER."
- E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels to identify the phase.
  1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags with the conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.
- H. Conductors to Be Extended in the Future: Attach marker tape to conductors.

- I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:
  - 1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
  - 2. Wall surfaces directly external to raceways concealed within wall.
  - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.
- L. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- N. Arc Flash Warning Labeling: Self-adhesive labels.
- O. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- P. Equipment Identification Labels:
  - 1. Outdoor Equipment: Laminated acrylic or melamine sign.
  - 2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    - e. Emergency system boxes and enclosures.
    - f. Enclosed switches.
    - g. Enclosed circuit breakers.
    - h. Enclosed controllers.
    - i. Contactors.

END OF SECTION 26 05 53

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Time switches.
  - 2. Photoelectric switches.
  - 3. Lighting contactors.

1.3 ACTION SUBMITTALS

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

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control software.
    - b. Faulty operation of lighting control devices.
  - 2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Cooper Industries, Inc.
  2. Invensys Controls.
  3. Leviton Manufacturing Co., Inc.
- B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.
1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
  2. Contact Rating: 20-A ballast load, 120-/240-V ac.
  3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
  4. Astronomic Time: All channels.
  5. Automatic daylight savings time changeover.
  6. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 ELECTROMECHANICAL DIAL-TIME SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Eaton.
  2. Leviton Manufacturing Co., Inc.
  3. Schneider Electric USA, Inc.
- B. Electromechanical-Dial Time Switches: Comply with UL 917.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Contact Rating: 20-A ballast load, 120-/240-V ac.
  3. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.
  4. Astronomic time dial.
  5. Eight-Day Program: Uniquely programmable for each weekday and holidays.
  6. Skip-a-day mode.
  7. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.

2.3 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries, Inc.
  2. Intermatic, Inc.
  3. Leviton Manufacturing Co., Inc.
- B. Description: Solid state, with SPST dry contacts rated for 1800 VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
1. Listed and labeled as defined in NFPA 70, by a agency NRTL, and marked for intended location and application.
  2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
  3. Time Delay: Fifteen-second minimum, to prevent false operation.
  4. Surge Protection: Metal-oxide varistor.
  5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.
  6. Failure Mode: Luminaire stays ON.

2.4 LIGHTING CONTACTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. ASCO Power Technologies.
  2. Eaton.
  3. Leviton Manufacturing Co., Inc.
  4. Square D; Schneider Electric USA.
- B. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as scheduled, matching the NEMA type specified for the enclosure.

## 2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

### 3.3 CONTACTOR INSTALLATION

- A. Comply with NECA 1.
- B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Lighting control devices will be considered defective if they do not pass tests and inspections.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 26 09 23

SECTION 262416  
PANELBOARDS

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. Lighting and appliance branch-circuit panelboards.

1.03 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. GFEP: Ground-fault equipment protection.
- C. MCCB: Molded-case circuit breaker.
- D. SPD: Surge protective device.
- E. VPR: Voltage protection rating.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details.
  - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
  - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  - 4. Detail bus configuration, current, and voltage ratings.
  - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 6. Include evidence of NRTL listing for series rating of installed devices.



7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.05 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. Include the following:
  1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.07 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Keys: Two spares for each type of panelboard cabinet lock.

1.08 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

- A. Environmental Limitations:
  1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and

temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
  - b. Altitude: Not exceeding 6600 feet.

#### 1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
  1. Panelboard Warranty Period: 36 months from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Surface-mounted, dead-front cabinets.
  1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
  2. Height: 84 inches maximum.
  3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
  4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
  5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:
  - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
  - b. Back Boxes: Same finish as panels and trim.
  - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.
  - a. Plating shall run entire length of bus.
  - b. Bus shall be fully rated the entire length.
2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
  5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
  6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Percentage of Future Space Capacity: 20 percent.
- K. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.
1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.
- 2.02 PERFORMANCE REQUIREMENTS
- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.03 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Eaton.
  - 2. Siemens Industry, Inc., Energy Management Division.
  - 3. Square D; by Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton.
  2. Siemens Industry, Inc., Energy Management Division.
  3. Square D; by Schneider Electric.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers:
    - a. Inverse time-current element for low-level overloads.
    - b. Instantaneous magnetic trip element for short circuits.
    - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic Trip Circuit Breakers:
    - a. RMS sensing.
    - b. Field-replaceable rating plug or electronic trip.
    - c. Digital display of settings, trip targets, and indicated metering displays.
    - d. Multi-button keypad to access programmable functions and monitored data.
    - e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
    - f. Integral test jack for connection to portable test set or laptop computer.
    - g. Field-Adjustable Settings:
      - 1) Instantaneous trip.
      - 2) Long- and short-time pickup levels.
      - 3) Long and short time adjustments.
      - 4) Ground-fault pickup level, time delay, and I squared T response.
  4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
  5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
  6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
  7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  8. Subfeed Circuit Breakers: Vertically mounted.
  9. MCCB Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Breaker handle indicates tripped status.
    - c. UL listed for reverse connection without restrictive line or load ratings.
    - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

- e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
- f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- g. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 A must have interchangeable rating plugs or electronic adjustable trip units

## 2.06 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## 2.07 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.

- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NECA 407.
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
  - 2. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 1-1/4 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
  - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.



- L. Install filler plates in unused spaces.
- M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- O. Mount spare fuse cabinet in accessible location.

### 3.03 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

### 3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:
  - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
  - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
  - c. Instruments and Equipment:
    - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.05 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
  1. Measure loads during period of normal facility operations.
  2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.

4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.06 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Standard-grade receptacles, 125 V, 20 A.
  - 2. GFCI receptacles, 125 V, 20 A.
  - 3. Wall plates.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- C. SPD: Surge protective device.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.

- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with the requirements in this Section.
- F. Devices for Owner-Furnished Equipment:
  - 1. Receptacles: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Essential Electrical System: Red.
  - 3. SPD Devices: Blue.
- H. Wall Plate Color: For plastic covers, match device color.
- I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

## 2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Eaton (Arrow Hart).
    - b. Hubbell Incorporated; Wiring Device-Kellems.
    - c. Pass & Seymour/Legrand (Pass & Seymour).
  - 2. Description: Two pole, three wire, and self-grounding.
  - 3. Configuration: NEMA WD 6, Configuration 5-20R.
  - 4. Standards: Comply with UL 498 and FS W-C-596.
- B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Eaton (Arrow Hart).
  - b. Hubbell Incorporated; Wiring Device-Kellems.
  - c. Leviton Manufacturing Co., Inc.
2. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
  3. Configuration: NEMA WD 6, Configuration 5-20R.
  4. Standards: Comply with UL 498.
  5. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

## 2.3 GFCI RECEPTACLES, 125 V, 20 A

### A. Duplex GFCI Receptacles, 125 V, 20 A:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Eaton (Arrow Hart).
  - b. Hubbell Incorporated; Wiring Device-Kellems.
  - c. Leviton Manufacturing Co., Inc.
2. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
3. Configuration: NEMA WD 6, Configuration 5-20R.
4. Type: Non-feed through.
5. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

## 2.4 WALL PLATES

### A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

### B. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Unfinished Spaces: Galvanized steel.
3. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

### C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

### D. Antimicrobial Cover Plates:

1. Contact surfaces treated with a coating that kills 99.9 percent of certain common bacteria within two hours when regularly and properly cleaned.
2. Tarnish resistant.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
  - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
  - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
  - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
  - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
  - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
  - 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
  - 4. Existing Conductors:
    - a. Cut back and pigtail, or replace all damaged conductors.
    - b. Straighten conductors that remain and remove corrosion and foreign matter.
    - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
  - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
  - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
  - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  - 8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.2 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles where protection of downstream receptacles is not required.

### 3.3 IDENTIFICATION

- A. Comply with Section 26 05 53 "Identification for Electrical Systems."
- B. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

### 3.4 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
  1. Test Instruments: Use instruments that comply with UL 1436.
  2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Receptacles:
  1. Line Voltage: Acceptable range is 105 to 132 V.
  2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.



3. Ground Impedance: Values of up to 2 ohms are acceptable.
  4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  5. Using the test plug, verify that the device and its outlet box are securely mounted.
  6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 26 27 26

SECTION 31 00 00

EARTHWORK

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work under this Section shall include all labor, material, equipment and all else necessary for cutting, proof rolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements as hereinafter specified and/or as otherwise required for the proper and timely completion of this Contract. Work under this Section includes, but is not limited to, subgrade preparation, excavating, backfilling, and compaction for structures and foundations, pavements, sidewalks, landscaping areas, and utilities. The contractor shall pay for and coordinate the services of a geotechnical engineer and testing agency to perform quality control of the earthwork.
- B. Scarifying, compaction, moisture content conditioning and control, and removal of unsuitable material to ensure proper preparation of areas for the proposed improvements.
- C. Undertake any special construction procedures for the project as shown in the drawings and described by these specifications for preparation of pavement areas.

1.2 RELATED DOCUMENTS

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

1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM), latest edition
  - 1. C 33 Concrete Aggregates
  - 2. D 698 Laboratory Compaction Characteristics of Soil Using Standard Effort
  - 3. D 1556 Density and Unit Weight of Soils in Place by the Sand-Cone Method
  - 4. D 1557 Laboratory Compaction Characteristics of Soil Using Modified Effort
  - 5. D 2167 Density and Unit Weight of Soil in Place by Rubber Balloon Method
  - 6. D 2216 Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
  - 7. D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System)
  - 8. D 2937 Density of Soil in Place by the Drive-Cylinder Method
  - 9. D 3740 Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
  - 10. D 4318 Liquid Limit, Plastic Limit, and Plasticity Index of Soils
  - 11. D 4254 Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
  - 12. D 6938 In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- B. American Association of State Highway and Transportation Officials (AASHTO), latest edition
  - 1. T 88 Particle Size Analysis of Soils

- C. Associated General Contractors of America
  - 1. Manual of Accident Prevention in Construction

#### 1.4 QUALITY ASSURANCE

- A. A geotechnical engineer familiar with the project requirements, selected and paid by the Owner, may be retained to perform construction inspection on site based on density testing, visual observation, and judgement. This inspection will not relieve the Contractor from their responsibility to complete the work in accordance with the drawings and specifications.
- B. Visual field confirmation and density testing of subgrade preparation and fill placement procedures shall be performed by the field geotechnical engineer as part of the construction testing requirements. The Contractor shall be informed as soon as possible of the test results.
- C. The geotechnical engineer shall prepare field reports that indicate compaction test location, elevation data, testing results and acceptability. The Owner, engineer, and Contractor shall be provided with written copies of the results within 24 hours of time test was performed.
- D. All costs related to reinspection due to failures shall be paid for by the Contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.

#### 1.5 SUBMITTALS

- A. Testing Agency Qualifications: Provide a statement of qualifications of the geotechnical engineer and testing agency that will perform the quality control tasks required in Article 3.08.
  - 1. The geotechnical engineer shall be an experienced inspector working under the direction of the professional engineer licensed to practice in the Commonwealth of Pennsylvania who is experienced in providing engineering services related to earthwork.
  - 2. The testing agency shall be an independent laboratory having a minimum of three (3) years' experience in conducting the testing indicated herein.
  - 3. The testing laboratory shall meet the requirements of ASTM D 3740.
- B. Material Test Reports: Shall be provided from the testing agency indicating and interpreting test results for compliance on the following:
  - 1. Classification according to ASTM D 2487 of each on-site or borrow soil material proposed for fill and backfill.
  - 2. Laboratory compaction curve according to ASTM D 1557 for each on-site or borrow soil material proposed for fill and backfill; provide for each material type and for every 5,000 cubic yards of each material.
  - 3. Material Gradation Tests.
  - 4. Electrical Resistivity and pH tests for sand used for water pipe bedding and backfill.
- C. Within 10 days after award of the contract, the Contractor shall submit to the Owner and engineer a schedule detailing the sequence, and time of completion of all phases of work under this section.

- D. At least two weeks in advance of imported fill use, the Contractor shall submit the following laboratory test data to the geotechnical engineer for each type of imported soil/gravel material to be used as compacted fill.
  - 1. Moisture and Density Relationship: ASTM D1557;
  - 2. Particle-Size Analysis: ASTM D2487; and,
  - 3. Plasticity Index: ASTM D 4318.
- E. Together with the above test data, the Contractor shall submit a 25-pound sample of each type of off site fill material in an air tight container for the approval of the geotechnical engineer.
- F. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Owner and the engineer.

#### 1.6 DEFINITIONS

- A. Backfill: Soil materials used to fill an excavation.
- B. Base Course: Layer placed between the subgrade and paving.
- C. Bedding Course: Layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow: Approved soil materials imported from off-site for use as fill or backfill.
- E. Classification: No consideration will be given to the nature of earthen materials, and all excavation required for this Project will be designated as unclassified.
- F. Degree of Compaction: Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 1557 abbreviated hereinafter as percent laboratory maximum density. For granular material, relative density is determined in accordance with ASTM D 4254.
- G. Excavation: Removal of material encountered down to subgrade elevations:
  - 1. Bulk Excavation: Excavation more than 10 feet in width.
  - 2. Overexcavation: Excavation of existing unsuitable material beyond limits shown on the Drawings for replacement with structural fill as directed by the Owner.
  - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond limits shown on the Drawings without direction by the Owner.
- H. Hard Material: Weathered rock, dense consolidated deposits, or buried construction debris (i.e., demolished brick walls, concrete, etc.) which are not included in the definition of “rock” but which usually require the use of heavy excavation equipment, ripper teeth, or jack hammers for removal.
- I. Rock:
  - 1. General Excavation - Any material that cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rated at not less than 71,000 lbs. (Caterpillar D9N or equivalent), and occupying an original volume of at least 2 cubic yards or more; and,

2. Trench Excavation - Any material that cannot be excavated with a backhoe having a breakout force rated at not less than 44,000 lbs. (Caterpillar 235D or equivalent), and occupying an original volume of at least 2 cubic yards.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below base or topsoil materials.

K. Subbase: Material shown on the Drawings between the pavement base and subgrade.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

#### 1.7 REGULATORY COMPLIANCE

A. Codes and Standards: Perform earthwork complying with federal, state, and local regulations including the Occupational Safety and Health Act of 1970 as amended. Excavation and trenching are regulated by OSHA. The Contractor shall perform all excavation and trenching work in accordance with 29 CFR 1926 Subpart P.

B. Conform with Pennsylvania Act 287 and all amendments and other applicable regulations regarding notification of utility companies.

C. Any pumped water shall be discharged from the Site in accordance with federal, state and local codes and regulations. Comply with all Philadelphia Water Department permit requirements.

#### 1.8 PROJECT CONDITIONS

A. Utility Identification: Notify PA One-Call System at 1-800-242-1776 at least 3 days prior to excavation.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the Owner not less than 72 hours in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Owner's written permission.

C. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

D. Existing improvements, adjacent property, and other facilities and trees and plants that are not to be removed shall be protected from injury or damage, which may result from Contractor's operation.

## PART 2 - PRODUCTS

### 2.1 ON-SITE FILL

- A. On-site excavated materials may be used as backfill provided they meet the following criteria:
  - 1. Suitable backfill materials include soil that complies with ASTM D 2487 soil classifications GW, GP, GM, SW, SP, and SM and having a maximum particle size of three (3) inches in any one dimension.
  - 2. Unsuitable backfill materials include any material having an excess of wood, timber, metal, rebar, organics, debris, or any other deleterious materials.
- B. It is not permitted for excavated materials unsuitable for fill in their as-is state to be processed on-site to comply with suitable backfill requirements. Concrete, brick, asphalt debris is not permitted to be broken or crushed on site to meet the above particle size requirement.
- C. The Contractor shall use the on-site soil judiciously to facilitate the construction schedule.
- D. Prior to placement, on-site material to be used as fill shall not contain:
  - 1. Debris other than crushed concrete and brick meeting the above requirements.
  - 2. Timber or railroad ties.
  - 3. Other deleterious materials such as steel rails, rebar, trash, etc.
  - 4. Hazardous material - Unsuitable and deleterious materials and debris shall be disposed of off-site in accordance with all applicable regulations.
- E. Any bituminous concrete on the site shall be milled/removed prior to placing any fill and shall be reused only onsite immediately below the pavement stone base course.

### 2.2 OFF-SITE IMPORTED FILL

- A. If necessary, off-site fill shall be obtained and provided by the Contractor;
- B. Fill shall be clean, well graded granular soil which is non-expansive and non-collapsible and shall have between 5% and 15% by weight passing the #200 sieve. The portion passing the #200 shall be non-plastic with a plasticity index not greater than five. Fill with less fines (less than #200) may be required on project specific basis and as required by geotechnical engineer. Likewise, fill with more than 20% fines may be acceptable on a project specific basis or as identified in the geotechnical engineering study;
- C. Imported fill shall be free of all hazardous substances. Certification of compliance and, if requested, test results substantiating compliance shall be furnished to the Owner and geotechnical engineer by the Contractor not less than one week prior to its intended use;
- D. The Owner reserves the right to test off-site fill material for conformance with these specifications; and,
- E. The Contractor shall be responsible for all permits and regulatory requirements associated with off-site borrow sources.

2.3 STONE BACKFILL

- A. In accordance with PennDOT Publication 408, Section 703 for AASHTO No. 57 Stone.

2.4 GEOTEXTILES

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

2.5 EQUIPMENT

- A. Compactor for mass earthwork shall be minimum 10-ton static-drum weight vibratory roller or 10-ton static-drum weight sheep foot compactor as appropriate for the type of soil material at the site or other compactor approved by the geotechnical engineer.
- B. Compactor for trenches and where access or maneuverability is limited, use a double drum walk-behind roller or vibratory plate compactor or "jumping jack" tampers.

PART 3 - EXECUTION

3.1 GENERAL

- A. Prior to all work of this section, the Contractor shall become thoroughly familiar with the site, site conditions, and all portions of the work falling under this section.
- B. The Contractor shall refer to the soil erosion and sediment control drawings for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.
- C. Locate and identify existing utilities that are to remain and protect them from damage.
- D. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.
- E. Protect fences, structures, sidewalks, paving, curbs, etc. to remain from equipment and vehicular traffic.
- F. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the Owner.

- G. Remove from the site, material encountered in grading operations that, in opinion of Owner or geotechnical engineer, is unsuitable or undesirable for backfilling as per Article 2.01.
- H. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the drawings.
- I. Do not allow or cause any of the work performed or installed to be covered by work of this section prior to all inspections, tests and approvals.
- J. Perform excavation using capable, well maintained equipment and methods acceptable to the Owner and regulatory authorities having jurisdiction.
- K. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and ground water control, and moisture control of soils (i.e., wetting or drying, scarify and discing) so as to place and compact the soil within the moisture content range two (2) percentage points of its optimum water content. Any disturbed areas should be proofrolled at the end of each day.
- L. Sloping, shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all regulatory authorities having jurisdiction.
- M. Allow no debris to accumulate on-site. Haul debris away from the site and dispose of at no cost to the Owner.

3.2 COMPACTION OF SUBGRADE SURFACES

- A. In areas to receive fill and at the final cut subgrade, proof roll and compact the exposed ground surface following clearing and grubbing and any required excavation with a minimum of four (4) passes of an approved compactor and obtain at least the following density requirement:

Location	Percent of Maximum Dry Density per ASTM D1557
Foundation Support, Pavements, Sidewalks and Wall Backfill	95%
Non-structural	90%

- B. The proof roll, truck and compactor equipment shall traverse the area at speed that permits the geotechnical engineer to comfortably walk alongside the equipment.
- C. Any soft areas exhibiting excessive weaving or unsatisfactory material identified during excavation, fill placement, compaction and proof testing shall be removed, replaced with suitable fill, and compacted as specified above.

3.3 UNDERCUT EXCAVATION

- A. When approved by the Owner and recommended by the geotechnical engineer, the Contractor may be required to remove natural soil materials in areas where fills are to be placed when determined to be undesirable in their location or condition. The Contractor shall be required to remove the undesirable material and backfill with approved material properly compacted.



- B. At locations where unstable or unsuitable soil is shown on the drawings or identified within the geotechnical engineering study, the removal and replacement of such soil shall be as directed on the drawings or as directed by the geotechnical engineer and the Owner.
- C. All material removed in the work of undercut excavation will be classified by the geotechnical engineer and Owner as either suitable for other use without excessive manipulation and utilized by the Contractor elsewhere in the work, or unsuitable for future use and manipulated as per Article 2.01.
- D. The Contractor shall conduct undercut operations in such a way that the necessary measurements can be taken before any backfill is placed.
- E. Backfill in undercut areas shall be placed as a continuous operation along with the undercutting operation. No backfill material shall be placed in water unless otherwise permitted by the geotechnical engineer.

### 3.4 EXCAVATION, FILL AND SUBGRADE PREPARATION

#### A. GENERAL

1. The Contractor shall cut or fill to the proposed subgrade elevations based on finished grades and the pavement thicknesses as shown on the drawings. Subgrade elevations shall be constructed to within 0 to minus ½ inch of the proposed grades specified.

#### B. EXCAVATION

1. Where existing grades are above proposed subgrade elevation, excavate materials to line and grade as shown in the drawings being careful not to over excavate beyond the elevations needed for building subgrades;
2. Excavate organic soils that do not provide adequate foundation support. Excavated on-site organic soils, which are unsuitable for fill may be used in landscaped areas and, if approved by the geotechnical engineer, as fill in parking area at least 5 feet below final elevation. Otherwise this material shall be disposed of as directed by Owner;
3. Excavated on-site soils, which meet the requirements of suitable fill may be used as fill; and,
4. Unsuitable material, such as wood and any other deleterious materials determined to be unsuitable by the geotechnical engineer for use as on-site fill, shall be disposed of as directed by Owner.

#### C. SUBGRADE PREPARATION FOR FILL

1. Existing grades below proposed grades and thus requiring fill shall be leveled prior to fill placement. The Contractor shall remove existing lawn and top soil in these areas prior to placement of any fill; and,
2. All existing grades to receive fill areas shall be proof rolled and compacted per Article 3.02.
3. Loose/Soft and unstable subgrade resulting from excessive moisture may be aerated and dried in-place. Following adequate drying time, the subgrade is to be densified in-place. Subgrade that cannot be aerated, dried, and densified in place shall be removed as described in Article 3.03.

D. FILL PLACEMENT

1. Rock or processed suitable debris pieces larger than six inches (6 inches) across shall not be part of fill;
2. Reduce soil clod size to a maximum of 2 inches before placement. Do not place frozen fill material;
3. No fill material shall be placed in areas of standing water, in areas of frozen or thawing ground, or in areas that have not been approved by the geotechnical engineer;
4. No fill materials shall be placed during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to a satisfactory moisture content as determined by the geotechnical engineer;
5. Fill lift surfaces shall be made smooth and free from ruts or indentations at the end of any work day when precipitation is forecast to prevent saturation of surficial fill material. Fill surfaces shall be graded to drain and sealed with a smooth drum roller at the completion of each work day;
6. The fill shall be placed in uniform loose lifts not exceeding 8-inches thick and compacted with at least 4 coverages of a 10-ton static-drum weight roller;
7. Each lift shall be compacted to the minimum densities listed in Article 3.02 as appropriate for the project and as specified in the geotechnical engineering study;
8. The Contractor shall adjust the water content by aeration or adding water to achieve the required density. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to achieve proper compaction and facilitate the construction schedule;
9. Wet, saturated material shall be air dried as necessary to achieve the field densities specified in this Section. Removal and replacement shall not occur without prior approval or Owner. Removal and replacement shall be used if necessary to facilitate the construction schedule;
10. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace with suitable compacted fill as approved by the Owner or Owners representative. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross section; and,
11. Fill placed on slopes greater than 1 vertical to 3 horizontal shall have each lift benched onto the slope at least 3 feet.

3.5 PROOFROLLING

- A. The work covered by this subsection consists of furnishing and operating, proofrolling equipment at the direction of the Owner's representative and/or geotechnical engineer.
- B. Proofrolling shall be under the observation of the Owner's representative and/or the geotechnical engineer as described herein and under the following schedule:
  1. Immediately following the completion of excavation to proposed subgrades in cut areas, proofrolling shall be performed as specified; and,
  2. Immediately prior to and following stone base course placement, in pavement and building pad areas for final floor slab preparation, all subgrade and stone base areas shall be proofrolled. Any areas which deflect, rut or pump under the roller shall be undercut and replaced with compacted fill material or stone base course as directed by the geotechnical engineer and approved by the Owner.
- C. Proofrolling shall be done with 1 pass of a fully loaded tandem dump truck equal to or exceeding 50,000 lbs., or other construction equipment if approved by the geotechnical engineer.

D. Construction methods shall be as follows:

1. After the subgrade or stone base course has been completed within 0.50 foot of final grade, the subgrade or stone base course shall then be compacted and tested prior to commencement of proofrolling. The coverage areas and methods will be identified by the Owner's representative and/or geotechnical engineer. However, the roll shall be operated in a systematic manner so that the number of coverages over all areas to be proofrolled can be readily determined and recorded;
2. The equipment shall be operated at a speed that the geotechnical engineer can comfortably and slowly walk alongside the equipment;
3. If it becomes necessary to take corrective action, such as but not limited to underdrain installation, undercut and backfill of an unsuitable material, and aeration of excessively wet material in areas that have been proofrolled, see Article 3.03. These areas shall be proofrolled again following the completion of the necessary corrections. If the corrections are necessary due to the negligence of the Contractor or weather, the corrective work and additional proofrolling shall be performed by the Contractor at no cost to the Owner; and,
4. The Contractor shall protect all structural facilities on the project, such as but not limited to box culverts, pipe culverts, and utilities, from damage by the proofrolling equipment.

3.6 MAINTENANCE OF SUBGRADE

- A. Finished subgrades shall be verified by the Contractor to ensure proper elevation and conditions for construction above subgrade.
- B. Protect subgrade from excessive construction traffic and wheel loading including concrete and dump trucks.
- C. Remove areas of finished subgrade judged to be unsatisfactory to the depth necessary and replace in a manner that will comply with compaction requirements by use of material equal to or better than the best subgrade material on site. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross section.

3.7 FINISH ELEVATIONS AND LINES

- A. For setting and establishing finish elevations and lines, secure the services of a licensed land surveyor acceptable to the Owner and engineer.
- B. Provide elevation grade stakes and any other surveying necessary for the layout of the work. The Contractor shall conduct their work in such a manner that survey stakes will be protected as long as their need exists. Grade stakes, which are damaged or stolen, shall be replaced by the Contractor's surveyor at the Contractor's expense.
- C. Graded areas shall be uniform, hard and smooth, free from rock, debris, or irregular surface changes. Any deviation shall not result in changes in drainage areas or ponding. All ground surfaces shall vary uniformly between indicated elevations. Finish drainage ditches shall be graded to allow for proper drainage without ponding and in a manner that will minimize the potential for erosion.
- D. Correct all settlement and eroded areas for one year after date of project completion at no additional expense to Owner. Bring paved and landscaped areas to proper elevation. Replant or replace any grass, shrubs, bushes, or other vegetation disturbed by construction using corrective measures.

3.8 FIELD QUALITY CONTROL

- A. The contractor shall coordinate all earthwork with the testing agency and geotechnical engineer to allow for inspection and testing. The geotechnical engineer shall provide full-time observation and testing of the compaction operations and provide documentation to the Owner.
- B. Allow geotechnical engineer to inspect and test each subgrade and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. The geotechnical engineer shall test compaction of soils in place according to ASTM D 1556, ASTM D 1557, ASTM D 2167, ASTM D 2922, ASTM D 2937, and ASTM D 4254 as applicable. Tests shall be performed at the following locations and frequencies:
  - 1. Paved Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2200 sq. ft. or less of paved areas or building slab, but in no case fewer than three tests.
  - 2. Trench Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.
  - 3. Structural Backfill: At each compacted initial and final backfill layer, at least one test for each 150 feet or less of trench, but no fewer than two tests.
- D. When the geotechnical engineer reports that subgrades, fills or backfills have not achieved degree of compaction specified, recompact and retest until specified compaction is obtained.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off site to a regulated and permitted facility. Provide two copies of load manifest and permit from owner of the property where material is deposited.

END OF DOCUMENT 310000

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## SECTION 311000

### SITE CLEARING

#### PART 1 - GENERAL

##### 1.1 RELATED DOCUMENTS

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

##### 1.2 SUMMARY

###### A. Section Includes:

1. Removing existing vegetation.
2. Clearing and grubbing.
3. Stripping and stockpiling topsoil.
4. Removing above- and below-grade site improvements.
5. Disconnecting, capping or sealing, and abandoning site utilities in place.

###### B. Related Sections:

1. Section 015000 "Temporary Facilities and Controls" for temporary utility services, construction and support facilities, security and protection facilities, and temporary erosion- and sedimentation-control measures.
2. Section 017300 "Execution" for field engineering and surveying.

##### 1.3 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

#### 1.4 MATERIAL OWNERSHIP

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

#### 1.5 INFORMATIONAL SUBMITTALS

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

#### 1.6 QUALITY ASSURANCE

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

#### 1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner representative and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises as directed by Owner representative.
- C. Utility Locator Service: Notify PAOne Call for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
  - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner representative.

### 3.2 EXISTING UTILITIES

- A. Owner representative will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
  - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Owner representative not less than two days in advance of proposed utility interruptions.

### 3.3 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.



1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

### 3.4 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil in a manner to prevent intermingling with underlying subsoil or other waste materials. Contractor to identify and determine depth of existing topsoil as defined in specification.

1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

### 3.5 SITE IMPROVEMENTS

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

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.6 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 311000

SECTION 31 23 50

SAWCUTTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes the saw-cutting of existing concrete, bituminous pavement, and footway at the locations indicated on the plans.

1.2 RELATED DOCUMENTS

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

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. Saws shall be equipped with guides, blade guards, water-cooling system and cut-depth control. Sawcut shall be done at the nearest joint, if applicable. The joint shall be sawed continuously and shall be of sufficient depth to allow removal of the paving without disturbing the paving that is to remain.
- B. Contractor to mark out sawcut lines in field for approval by the Owner or Authorized Representative prior to proceeding with the pavement removal.

END OF SECTION 31 23 50

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SECTION 31 25 00

SOIL EROSION & SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work of this Section includes all temporary erosion and sediment control and related and incidental operations, including:
  - 1. Filter Bag Inlet protection;
  - 2. Stone and Concrete Block Inlet Protection;
  - 3. Compost filter sock;
  - 4. Temporary seeding and mulching;
  - 5. Rumble Pad Construction Entrance;
  - 6. Pumped Water Filter Bag;
  - 7. Temporary Stockpile Protection;
  - 8. Compost Sock Washout Station; and,
  - 9. Maintenance and repair of erosion and sediment control measures.

1.2 SUBMITTALS

- A. Submit complete shop drawings and product information for all items to be furnished under this Section upon receipt of notice to proceed and prior to construction.

1.3 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workers who are thoroughly trained and experienced in the necessary trades and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this Section.
- B. Codes and Standards: Perform work in compliance with applicable requirements of governing authorities having jurisdiction. Construction operations shall be carried out in a manner such that soil erosion, air pollution, and water pollution is minimized. State, County, and Municipal laws concerning pollution abatement shall be followed.
- C. The recommendations and Standards set forth in the Erosion and Sediment Pollution Control Program Manual, published by the PA Department of Environmental Protection, shall be applicable where the work is not specifically detailed in this Specification, the accompanying Drawings, or the Erosion and Sediment Pollution Control Plan.
- D. The Contractor shall take action to remedy unforeseen erosion conditions and to prevent damage to adjacent properties as a result of increased runoff and/or sediment displacement. Stockpiles of wood chips, hay bales, crushed stone, and other mulches shall be held in readiness to deal immediately with emergency problems of erosion. All erosion control checks and structures shall be inspected after heavy rainfalls, and if damaged, repaired or replaced.

- E. No other construction activities may take place until appropriate Erosion and Sedimentation Control devices have been installed and approved by Owner/Authorized Representative. All changes to the Erosion and Sedimentation Control Plan must be approved by Owner/Authorized Representative prior to implementation.

#### 1.4 REFERENCES

- A. PennDOT, Publication 408 Specifications (most recent edition).
- B. Pennsylvania Department of Environmental Protection, Erosion and Sediment Pollution Control Program Manual (most recent version).
- C. Commonwealth of Pennsylvania, Department of Transportation (PennDOT)
  - 1. Bulletin No. 15: Approved Construction Materials.

### PART 2 - PRODUCTS

#### 2.1 FILTER BAG INLET PROTECTION

- A. Filter bags shall be provided in accordance with PennDOT Publication 408, Section 860.
- B. Filter bags shall be manufactured to fit the opening of the catch basin or drop inlet. Filter bags will have the following features:
  - 1. Two dump straps attached at the bottom to facilitate the emptying of the bag;
  - 2. Lifting loops as an internal part of the system to be used to lift the filter bag from the basin;
  - 3. Restraint cord approximately halfway up the sack to keep the sides away from the basin walls, this cord is also a visual means of indicating when the sack should be emptied.
- C. Filter bag seams shall have a minimum certified average wide width strength per ASTM D-4884 of 300 psi.
- D. Inlet filter bags for installation in new or existing highway grate and open mouth grate inlets shall be listed in PennDOT Bulletin 15 or approved equal.
- E. City inlet (and curb opening portion of open-mouth grate inlet) protection shall be a synthetic filter manufactured from recycled synthetic fibers listed in PennDOT Bulletin 15 or approved equal.

#### 2.2 STONE AND CONCRETE BLOCK INLET PROTECTION

- A. In accordance with PennDOT Publication 408, Section 860.2(b).
- B. Inlet protection in roadway is not to include stone or berms.

#### 2.3 COMPOST FILTER SOCK

- A. Compost filter sock shall be provided in accordance with PennDOT Publication 408, Section 867.
- B. The compost socks shall be Filtrexx Siltsox manufactured by Filtrexx International LLC of Grafton, Ohio or approved equal as listed in PennDOT Bulletin 15

2.4 PUMPED WATER FILTER BAG

- A. Pumped water filter bags shall be provided in accordance with PennDOT Publication 408, Section 855.
- B. Sediment filter bag shall be manufactured of non-woven geotextile material that filters soil particles while allowing discharge water to pass through the bag.
- C. The sediment filter bag seams shall be a double 401 lock chain stitch seam with minimum 200 lbs/inch sewn seam strength, tested in accordance with ASTM D-4884.
- D. The sediment filter bag shall have an adjustable spout large enough to accommodate a six-inch (6") diameter discharge hose.
- E. The pump discharge hose shall be inserted into the bags in the manner specified by the manufacturer and securely clamped.
- F. Filter bag shall be inspected daily. If any problem is detected pumping shall cease immediately and not resume until the problem is corrected.
- G. Filter bag shall be GTF-FB series from Frank Roberts and Sons, Inc., Dirtbag by ACF Environmental, or approved equal, and shall have a rated flow rate fifty percent (50%) greater than the attached pump.

2.5 TEMPORARY SEEDING AND MULCHING

- A. All stockpiles and inactive disturbed areas shall be seeded and mulched in accordance with the design plans if they are to be left exposed for more than twenty (20) days.

2.6 RUMBLE PAD CONSTRUCTION ENTRANCE

- A. Prefabricated rumble pad shall be installed according to manufacturer's recommendations. A sufficient number of pads shall be installed to provide a minimum of four (4) tire revolutions while on pad.
  - 1. More pads may be needed depending on site conditions.
- B. Accumulated materials shall be cleaned from the pads daily and as necessary and disposed of in accordance with all applicable regulations.

2.7 TEMPORARY STOCKPILE PROTECTION

- A. Compost Filter Sock provided in accordance with PennDOT Publication 408, Section 867.
- B. Seeding in accordance with PennDOT Publication 408, Section 804.2(b), Formula E.

2.8 COMPOST SOCK WASHOUT STATION

- A. Concrete washout water shall be directed to the compost sock washout station as indicated on the plans. The compost sock washout station shall be comprised of a compost filter sock in accordance with this specification.

## 2.9 TEMPORARY STABILIZATION MEASURES

- A. Rolled Erosion Control Products (RECPs) shall be in accordance with PennDOT Pub. 408 Section 806, and from an approved supplier named in Bulletin 15. Non-biodegradable materials shall not be acceptable (including pins or stakes). Installed RECPs shall also be seeded or mulched as appropriate.
- B. Temporary seeding or sodding shall be in accordance with the specified permanent seeding and/or sod requirements, or in the absence of such specified materials shall be in conformance with PennDOT Pub. 408 Section 804, Formula E seed mixture.
- C. Mulch shall be in accordance with the specified permanent mulch, or in the absence of such specified materials shall be in conformance with PennDOT Pub. 408 Section 805, Wood Fiber or Wood Chips. Recycled materials shall not be acceptable for use as mulch (wood pulp, cellulose, etc.).
- D. Straw or hay temporary stabilization shall only be permitted when use of seeding/sodding or mulch is impracticable (subject to approval by Owner/Authorized Representative). The use of blown straw shall only be accepted when used in conjunction with a tackifier as specified herein. Straw or hay shall be free of weed seeds or other contaminants.
- E. Tackifier shall be Earth Bond tackifier (Turf Guard Manufacturing Inc.) or approved equal. Tackifier shall be composed of organic compounds, and contain no toxins or hazardous materials.

## PART 3 - EXECUTION

### 3.1 GENERAL REQUIREMENTS

- A. All temporary erosion and sediment control measures specified herein shall be in place before the beginning of any earthwork or excavation.
- B. All erosion and sediment control devices shall be installed according to the manufacturer's specifications, or in accordance with PennDOT Pub. 408 if no manufacturer recommendation exists.
- C. When temporary erosion and sediment control measures as described herein do not provide adequate control, replacement or relocation of measures shall be required as directed by the Owner/Authorized Representative.
- D. Erosion and sediment control measures shall be inspected weekly and after every precipitation event.
- E. Contractor shall maintain complete written logs of inspections and shall make them available to PWD Inspector/Owner/Engineer upon request.
- F. All maintenance work, including but not limited to cleaning, repair, replacement, regrading, and restabilization of temporary erosion and sediment control measures shall be performed immediately.
- G. Contractor shall ensure that erosion and sedimentation control measures remain in place and fully functional until site achieves final stabilization.



- H. Orange fencing shall be used to delineate the limits of earth disturbance in all off street applications, and as specified in Section 015639 for tree protection.

### 3.2 PUMPED WATER FILTER BAG

- A. Sediment-laden water shall be pumped through a pumped water filter bag as specified herein.
- B. Filter bags shall be removed and replaced when they have reached their capacity to filter sediment effectively, or upon any breach of the filter bag.
- C. The Contractor shall not discharge to any sewer without the prior approval of PWD from the Industrial Waste Unit.

### 3.3 TEMPORARY INLET PROTECTION

- A. The downstream inlets from the site of any disturbance or construction on the project site shall be protected with approved inlet protection practices. Downstream inlets are considered to be the next immediate inlet downslope that will receive runoff from the site of any disturbance, as well as any and all inlets within the site itself.
- B. All new inlets shall be protected with approved inlet protection practices upon installation. Inlets draining exclusively to a stormwater feature shall remain fully closed to runoff until final site cleanup.
- C. Final site cleanup shall include removal of all temporary inlet protection, cleaning of all permanent inlet protection, and cleaning of all inlets (existing downstream inlets and newly installed) of accumulated construction debris and sediment.
- D. Highway grate and open mouth grate inlets shall be protected using inlet filter bags as specified herein.
- E. Open mouth grate inlets and open mouth inlets (city inlets) shall be protected with a compost sock or synthetic filter as specified herein.
- F. Inlet protection shall be installed, inspected, cleaned and replaced according to manufacturer's specifications.
  - 1. Inlet filter bags and open mouth inlet protection shall be removed and replaced when filled with silt or when extended periods of ponding occur following a precipitation event. New inlet filter bags or approved inlet protection devices shall be installed and secured immediately after removal of silted protection devices.

### 3.4 STORAGE STOCKPLIES

- A. Stockpiles of all loose materials (aggregate, fill, soils, etc) shall be protected from dust and rain by use of a cover. The cover shall be free of defects, and secured adequately to maintain protection of the materials. Owner/Authorized Representative reserves the right to refuse use of any material that has been compromised by inadequate protection onsite.
- B. Stockpiles shall not be placed upslope from any infiltration structure. Any drainage structure (such as but not exclusively inlets) downslope of a stockpile shall be adequately protected from runoff.

- C. Stockpile heights are not to exceed 20 feet high. Stockpile slopes shall be 2:1 or flatter.

### 3.5 TEMPORARY STABILIZATION

- A. Any disturbed surfaces to remain unfinished and unprotected for more than four (4) days shall be temporarily stabilized. Method to be used shall be approved by the Project Manager and shall be appropriate to the expected length of time employed (for example, use of hay alone without seeding would not be appropriate for a several month application, but could be appropriate for a week-long site delay).

### 3.6 REMOVAL AND FINAL CLEANUP

- A. Once the site has been fully stabilized and approval is given by Owner/Authorized Representative, temporary erosion and sedimentation control measures and all accumulated silt and sediment shall be removed. All permanent inlet protection measures shall be cleaned, inspected, and verified to be in working order.
- B. Any remaining dirt or debris within the public right of way shall be removed by the Contractor, using necessary means as sufficient to remove the dirt and debris from the public right of way. This may include, but is not limited to, street sweeping, sidewalk vacuuming, inlet cleaning, power washing, or hand removal.
- C. Silt and waste materials shall be disposed of in a proper manner. No extra construction materials are to remain onsite upon completion of the Work. The Work of this Contract shall not be considered complete until all extraneous construction-related items have been removed (temporary traffic control devices, signage, etc).

END OF SECTION 31 25 00

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work under this Section shall include all labor, on-site materials, and equipment necessary for the excavation of trench and grading as hereinafter specified and/or as otherwise required for the proper and timely completion of this Contract.

1.2 RULES AND REGULATIONS

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

1. ASTM C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
2. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
3. ASTM C535 Standard Test Method for Resistance to Degradation of Large-Size Aggregate by Abrasion and Impact in the Los Angeles Machine
4. ASTM D653 Standard Terminology Relating to Soil, Rock, and Contained Fluids
5. ASTM D1140 Standard Test Methods for Determining the Amount of Material Finer than 75- $\mu$ m (No. 200) Sieve in Soils by Washing
6. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
7. ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
8. ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes
9. ASTM D6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
10. ASTM D4253 Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
11. ASTM D4254 Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
12. ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
13. AASHTO T180 Standard Method of Test for Moisture-Density Relations of Soils Using 4.54-kg (10-lb) Rammer and 457-mm (18-in.) Drop

1.3 SUBMITTALS

- A. Samples

1. Furnish and deliver samples of fill and backfill materials as selected by the Engineer.

1.4 PERFORMANCE REQUIREMENTS

- A. If any hazardous waste materials are discovered on the site, the Contractor shall cease operations in that area until authorized to resume. The Contractor shall notify the Engineer of such material and cooperate with any outside agency or specialist that may be called in to determine the extent of the hazard and methods of its disposition.

B. Tolerances:

1. Construct finished sub-grades to plus 0 inches minus ½ inch of the elevation indicated.
2. Construct finished grade of slopes not steeper than 3H:1V to plus or minus 1/2 inch and on slopes steeper than 3H:1V to plus or minus 2 inches. Slopes shall not encroach upon roadbeds.
3. Maintain the moisture content of fill material as it is being placed within plus or minus 3 percent of the optimum, moisture content of the material as determined by the laboratory test herein specified.
4. Protect all existing and new construction including utilities, finishes and equipment from water, damage, weakening or other disturbance.

1.5 DEFINITIONS

A. Earthwork Terminology used in this Section and not defined herein shall be interpreted in accordance with the definitions given in ASTM D653.

1. Sub-grade: Sub-grade is the lowest elevation of excavation and the highest elevation if embankment required to accommodate the indicated construction.
2. Backfill: Soil or soil-rock material used to refill excavations and to refill excavated spaces around building walls.
3. Imported Material: Soil or granular material which is hauled in from off-site areas.
4. Unsuitable Material: Excavated material or material below the natural ground surface in embankment areas or below sub-grade elevation in excavated areas, which is unsuitable for its planned use.
5. Relative Compaction: The ratio, expressed as a percentage, of the in-place place dry density of fill material as compacted in the field to the maximum dry density of the same material as determined by laboratory test ASTM D1557, Method D.
6. Optimum Moisture Content: The water content at which a soil can be compacted to a maximum dry unit weight by a given compactive effort.
7. Relative Density: Refer to ASTM D4253 and ASTM D4254.
8. Excavation: Excavation is the removing of all materials encountered within the Contract Limits, regardless of the nature of the material encountered and the method by which it is removed, for grading, sub-grading for roadways or paved areas and other structures not specified elsewhere in these specifications. All excavation is unclassified and no additional compensation will be made for rock.

1.6 PROJECT CONDITIONS

A. Protection

1. Provide the necessary barricades, signs, lights, etc. to prevent accidents, to avoid all hazards and to protect the public, the work and property at all times, including Saturdays, Sundays, and holidays.
2. Be responsible for any and all damages which may arise or occur to any party whatsoever by reason of neglect in providing proper lights, guards, barriers or any other safeguards to prevent damage to property, life and limb.
3. Prior to any excavation the Contractor, with the cooperation of the Owner of the respective existing utility or its agents shall locate and paint the location of all water services, gas services, gas mains, water mains, sanitary sewers, telephone raceways or conduits and drains, within five (5) feet of the proposed excavations.

4. In case water, gas pipes, conduits, or other utilities are broken in the prosecution of the work, the Contractor shall stop work and give immediate notice to the proper authorities and shall be responsible for any damage to persons or property caused by such breaks. Failure to give prompt notice to the authorities shall deem the Contractor responsible for any damages legal or otherwise caused by the interruption or loss of utility service.

B. Parking and Storage

1. Parking of vehicles and storage of materials shall be confined to designated areas approved by the Owner.

C. Dust Control

1. During the progress or work, the Contractor shall conduct his operation and maintain the area of his activities so as to minimize the creation and dispersion of dust.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Unfavorable Weather Conditions

1. Excavating, filling, backfilling, and grading work shall not be performed during weather conditions which might damage the condition of existing ground, in-progress work, or completed work. When the work is interrupted by rain, excavating, filling, backfilling and grading work shall not resume until the site is suitable for the work.
2. Sub-grade shall be free from mud, snow, ice, and deleterious material when work is resumed.

PART 2 - PRODUCTS

2.1 FILL AND BACKFILL

- A. Material suitable for use as fill and backfill shall be an inert, non-expansive soil, free from organic matter and of such quality that it will compact thoroughly without the presence of voids. Excavated on-site soil will be considered suitable for fill and backfill.
- B. Suitable excavated material shall be conditioned for reuse and properly stockpiled for later filling and backfilling operations. Conditioning shall consist of spreading material in layers not to exceed 8 inches and raking free of debris and rubble. Rocks exceeding four inches in largest dimension and deleterious material shall be moved from the site and disposed of.

PART 3 - EXECUTION

3.1 EXISTING UTILITIES

- A. Verify on site the location and depth (elevation) of all existing utilities and services before performing any excavation work. Excavation within 3 feet of a utility line shall be performed by hand.

### 3.2 EXCAVATION

#### A. General

1. Excavation consists of the removal and on-site placement or disposal of whatever material is encountered when establishing required sub-grade elevations.
2. Excavation shall be made to the grades as shown on the Contract Drawings.
3. Where excavation grades are not shown on the Contract drawings, excavation shall be made as required to accommodate the installation of all facilities.

#### B. Cold Weather Protection

1. Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees Fahrenheit.

#### C. Stability of Excavations

1. Sloped sides of excavation shall comply with state and local codes and ordinances having jurisdiction. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated.
2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

#### D. Shoring and Bracing

1. Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross-braces, in good serviceable condition.
2. Establish requirements for trench shoring and bracing to comply with local Codes and authorities having jurisdiction.
3. Maintain shoring and bracing excavations regardless of the time period excavations will be open. Carry down shoring and bracing as excavation progresses.

#### E. Material Storage

1. Stockpile suitable excavated materials where directed, as required for fill.
2. Locate and retain soil materials away from edge of excavation.

### 3.3 BACKFILL

#### A. Backfill excavation as promptly as work permits, but not until waterproofing membrane is applied and is ready to be backfilled, if applicable.

#### B. Placement and Compaction

1. Place backfill materials in layers not more than 4" in loose depth for materials by hand-operated tampers.
2. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying the material uniformly around structure to approximately same elevation in each lift.

### 3.4 GRADING

#### A. Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish below the required sub-grade elevations.

3.5 CLEAN-UP

- A. Upon completion of the work of this section, place in stockpile areas all excess excavated material, rubbish, trash and debris resulting from operations. Leave the site in a neat and orderly condition.

END OF SECTION 31 50 00

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SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section includes Hot Mix Asphalt Wearing and Binder Course.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The following Standard Specifications and Codes shall be considered a part of this specification where such specifications are applicable, and shall include all current changes and revisions:
  - 1. American Society for Testing and Materials.
  - 2. Ordinances and Laws of the Commonwealth of Pennsylvania, County and Municipality within which the work is being performed.
  - 3. Philadelphia Streets Department Standard Specifications.
  - 4. Pennsylvania Department of Transportation.

1.3 DEFINITIONS

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- B. PennDOT: Pennsylvania Department of Transportation.

1.4 SUBMITTALS

- A. Product data: For each product specified, include technical data and tested physical and performance properties.
- B. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
- C. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.
- D. Material Certificates: Certificates signed by manufacturers certifying that each material complies with requirements.

1.5 QUALITY ASSURANCE

- A. Qualifications: Engage an experienced installer, certified in writing by tactile manufacturer as qualified for installation, who has completed asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful service performance.

- B. **Manufacturer Qualifications:** Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance. Firm shall be a registered and approved paving mix manufacturer with authorities having jurisdiction or with the DOT of the state in which Project is located.
- C. **Regulatory Requirements:** Conform to applicable standards of authorities having jurisdiction.
- D. **Asphalt-Paving Publication:** Comply with AI MS-22, "Construction of Hot Mix Asphalt Pavements," unless more stringent requirements are indicated.
- E. **Paving contractor to have a minimum of ten (10) years of demonstrated successful experience in the installation of asphalt surfaces.**
- F. **Pre-installation Conference:** Conduct conference at Project site to comply with requirements in project General and Supplementary Conditions.

## 1.6 PROJECT CONDITIONS

- A. **Environmental Limitations:** Do not apply asphalt materials if substrate is wet or excessively damp or if the following conditions are not met:
  - 1. **Prime and Tack Coats:** Minimum surface temperature of 40 degrees F and rising at the time of placement.
  - 2. **Asphalt Base Course:** Minimum surface temperature 35 degrees F at time of placement.
  - 3. **Asphalt Surface Course:** Minimum surface temperature of 40 degrees F at time of placement.

## PART 2 - PRODUCTS

### 2.1 ASPHALT MATERIALS

- A. **Asphalt Cement:** ASTM D 3381 for viscosity-graded material. ASTM D 946 for penetration-graded material.
- B. **Asphalt:** ASTM D 3141, Pumping consistency.
- C. **Tack Coat:** ASTM D 977, emulsified asphalt or ASTM D 2397, emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- D. **Fog Seal:** ASTM D 977, emulsified asphalt or ASTM D 2397, emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- E. **Water:** Potable.

### 2.2 MIXES

- A. **Hot-Mix:** Provide dense, hot-laid, hot-mix asphalt plant mixes approved by Pennsylvania Department of Transportation; designed according to PennDOT Standard Specifications for Road and Bridge Construction and complying with the following requirements:
  - 1. **Provide mixes with a history of satisfactory performance in geographical area where project is located.**

2. Base Course: PennDOT Superpave, Thickness to achieve conditions indicated on plans.
3. Wearing Course: PennDOT Superpave, Thickness to achieve conditions indicated on plans

### 2.3 AGGREGATE BASE

- A. In accordance with PennDOT Publication 408, Section 350.2(a).

### 2.4 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by Environmental Protection Agency (EPA). Provide granular, liquid, or wet table powder form.
- B. Sand: ASTM D 1073, Grade Nos. 2 or 3.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas that are unstable or that require further compaction. Completely proof-roll subbase in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph. Notify Engineer in writing of unsatisfactory conditions.
  1. Excavate soft spots, and areas of excessive pumping or rutting, as determined by project professional. Replace with compacted subbase as directed. Remedial work required to establish suitable subbase is to be performed by contract at no additional cost to the Owner.
  2. Do not begin paving installation until these conditions have been satisfactorily corrected.

### 3.2 REPAIRS

- A. Where it is determined that repairs are required after proof-rolling the contractor shall sawcut an area larger than the required repair area with neat orthogonal and straight lines and remove all unsuitable material.
- B. The contractor shall prepare the area with subbase material suitable for placement of full depth asphalt paving.

### 3.3 SURFACE PREPARATION

- A. General: Ensure that prepared substrate surfaces are ready to receive paving. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb compacted surface of base course.
- B. Herbicide Treatment: apply according to manufacturer's recommended rates and application instructions. Apply to dry, prepared applying paving materials. Mix herbicide with prime coat when formulated by manufacturer for that purpose.

- C. Tack Coat: Application of a tack coat shall be in accordance with Section 460 of PennDOT Publication 408 and shall be considered incidental to this item of work.
  - 1. A tack coat shall not be applied to new bituminous base courses. However, a tack coat shall be applied to the new bituminous base course or binder course when, in the opinion of the Engineer, the condition of the surface is unsatisfactory for the direct placement of the succeeding operation.

### 3.4 AGGREGATE BASE

- A. In accordance with PennDOT Publication 408, Section 350.3.

### 3.5 HOT-MIX ASPHALT PLACEMENT

- A. Machine place hot-mix asphalt mix on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness, when compacted. Place hot-mix asphalt base course in number of lifts and thicknesses indicated on the plans. Place hot-mix surface course in single lift. Spread mix at a minimum temperature of 250 degrees F (121 degrees C). Begin mix along centerline of crown for crowned sections and high side of one-way slopes, unless otherwise indicated. Paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat. Place in consecutive not less than 10 feet (3 m) wide, except where edge strips of a lesser width are required. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete asphalt base course for a section before placing asphalt surface course. Correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.6 JOINTS

- A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course. Clean contact surfaces and apply tack coat. Offset longitudinal joints in successive courses a minimum of 6 inches (150 mm). Offset transverse joints in successive courses a minimum of 24 inches (600 mm) and as described in AIMS-22 "Construction of Hot Mix Asphalt Pavements".

### 3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers. Complete compaction before mix temperature cools to 185 degrees F (85 degrees C).
- B. Breakdown Rolling: Accomplish breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Repair surfaces by loosening displaced material, filling with hot-mix asphalt, and rerolling to required elevations.

- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling, while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 1559, but not less than 94 percent nor greater than 100 percent.
  - 2. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- D. Edges: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while still hot, with back of rake or smooth iron. Compact thoroughly using tamper or other satisfactory method.
- E. Repairs: Remove paved areas that are defective or contaminated with foreign materials. Remove paving course over area affected and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.8 INSTALLATION TOLERANCE

- A. Thickness: Compact each course to produce the thickness indicated on the plans within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch (13 mm);
  - 2. Wearing Course: Plus 1/4 inch (6 mm), no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch (6 mm).
  - 2. Wearing Course: 1/8 inch (3 mm).
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

### 3.9 FIELD QUALITY CONTROL

- A. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- B. Testing Agency: Contractor will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

- D. In-Place Density: Samples of uncompacted paving mixtures and compacted pavement will be secured by testing agency according to ASTM D 979.
  - 1. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
  - 2. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
  - 3. Replace and compact hot-mix asphalt where core tests were taken.
- E. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from project site and legally dispose of them. Do not allow excavated materials to accumulate on-site.

END OF SECTION 32 12 16

SECTION 32 14 00

UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. SECTION INCLUDES

1. Unit Pavers
2. Setting beds
3. Joint filler
4. Geotextile

B. RELATED SECTIONS

1. Section 033000 Cast-in-Place Concrete
2. Section 129300 Site Furnishings

1.2 REFERENCES

A. The following apply to work in this Section:

1. ASTM: Specifications of the American Society for Testing and Materials latest editions. Modifications specified herein shall govern where conflicts with ASTM standards occur.

1.3 SUBMITTALS

A. Submit prior to delivery of materials to site.

B. Product Data: Submit manufacturer's product data, test reports and installation instructions for each material and product used.

C. Samples: Submit three representative samples of each material specified indicating visual characteristics and finish. Include wider range if variation of finish is anticipated.

1. Unit pavers
2. Jointing sand, ½ lb. bag, submit three (3) sample options for color range selection

1.4 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers that have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

- B. Construction Tolerance: Unit-to-unit offset tolerance of 1/16 inch from flush, 1/8 inch in 2 feet and 1/4 inch in 10 feet from level or required slope.
- C. Field-Constructed Mock-ups: Provide sample panel of each type of unit paving as specified herein. Build mock-ups in place at the site and obtain the Landscape Architect's acceptance of visual qualities of sample panels before commencing work. Replace unsatisfactory mock-up work until acceptance is obtained. Mock-up may be used as part of the work if conforming to specified requirements and accepted by the Landscape Architect. Accepted mock-up establishes minimum standard of quality and workmanship for paver work.
  - 1. Build 4' x 8' panels of full thickness using concrete and brick pavers, base, setting bed, joint materials, and all edge conditions. Build composite mock-up that demonstrates relationship of different pavers to one another utilizing specified setting and jointing materials.
  - 2. If initial mock-ups are rejected, build additional mock-ups to arrive at desired features. Retain all mock-ups until acceptable mock-up is selected by Landscape Architect. Retain and protect acceptable mock-up during construction as standard for judging work. Do not alter, move, damage or destroy mock-up until work is complete.
  - 3. Acceptable mock-ups may become part of the permanent installation.

#### 1.5 DELIVERY STORAGE AND HANDLING

- A. Deliver, store, handle and protect all materials from damage.
- B. Handle pavers to prevent chipping, breakage, soiling, or other damage.
- C. Store pavers on wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and pavers to distribute weight evenly and to prevent breakage and cracking.
- D. Store asphalt cement and other bituminous materials in tightly closed containers.

#### 1.6 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

### PART 2 - PRODUCTS

#### 2.1 UNIT PAVERS

- A. Brick Paver, for 18<sup>th</sup> St. Walkway
  - 1. Manufacturer: Pine Hall Brick, (800) 952-7425, [www.pinehallbrick.com](http://www.pinehallbrick.com)
  - 2. Product: 4" x 8" by 2.75" English Edge Heavy Vehicular Paver
  - 3. Color and finish: Autumn.



## 2.2 SETTING BEDS

- A. Bituminous setting beds
  1. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.
  2. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.
  3. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.

## 2.3 JOINT FILLER

- A. Clean, washed, well graded sand free of deleterious materials, conforming to ASTM C33. Do not use mason's sand, stone dust or limestone screenings.

## PART 3 - EXECUTION

### 3.1 MATERIALS

- A. Verify substrate is level, smooth, and capable of supporting pavers and imposed loads, and ready to receive Work of this section.
  1. Verify that concrete substrate has cured at least 28 days and attained 75 percent design strength.
  2. Vacuum clean concrete substrates to remove dirt, dust, debris and loose particles.
  3. Verify that gradients and elevations of substrate are correct.
  4. Beginning installation means acceptance of existing conditions.

### 3.3 INSTALLATION OF SETTING BEDS, PAVERS AND JOINT FILLER

- A. Install edge restraint according to and in locations indicated on Drawings.
- B. Subgrade: Proof-roll the subgrade with heavy pneumatic-tired equipment to locate unstable areas and to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - a. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Landscape Architect, and replace with compacted backfill or fill as directed.
  - b. The surface of the completed subgrade shall be bladed to a smooth and uniform texture.
  - c. The finished subgrade shall be uniform and free from deleterious debris such as organic materials, nails, stones and loose soil.
- C. Subbase: Install aggregate subbase to the compacted depth shown in drawings. Install the subbase in multiple 3 to 4-inch lifts, and compact to a minimum 95% density.
  - a. Compaction: Compact each lift of the subgrade, subbase and final finish decomposed granite surfacing materials with a one to three-ton roller or compactor. In small areas that are difficult to access with compaction equipment, hand tamping may be performed with

multiple passes to achieve the required density. 1. Lightly spray surface area following compaction. Do not disturb aggregate surface with spray action.

- B. Place bituminous setting bed.
  - a. Use control bars to control the depth of the bituminous setting bed. Place bituminous between control bars and strike off. Fill low spots with more bituminous material to produce smooth, even, firm setting bed.
  - b. Screed setting bed with power roller to nominal depth of 3/4" while still hot.
  
- D. Place paver units in pattern indicated on Drawings.
  - 1. Maintain proper joint alignment and pattern as indicated on Drawings.
  - 2. Protect newly laid pavers with plywood panels placed over pavers where installers stand.
  - 3. Cut pavers as required and as shown on Drawings. Machine saw partial units.
  - 4. Roll pavers if necessary to achieve additional leveling, before installing joint filler, after heat has built-up in the surface from several days of hot weather.
  
- E. Sweep joint filler into joints. Vibrate pavers and add sand until joints are completely filled. Remove surplus joint filler from surface of pavement.
  
- F. Remove and replace pavers which are loose, out of line or grade, chipped, broken, stained or otherwise damaged or if units do not match adjoining units as intended or present a tripping hazard. Provide new units and install in same manner as original units, with same joint treatment to eliminate evidence of replacement.

### 3.4 PROTECTION OF FINISHED WORK

- A. Do not permit construction traffic over unprotected paver surface.

### 3.5 CLEAN UP

- A. Maintain the site in an orderly condition during the progress of work. Promptly remove debris and trash. Leave the site in a neat, orderly condition, broom clean.

END OF SECTION 32 14 00

SECTION 32 16 13.13

CAST-IN-PLACE CONCRETE CURB AND GUTTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. This Section includes construction of City of Philadelphia Type B Curb.

PART 2 - PRODUCTS

2.1 CAST-IN-PLACE CONCRETE CURB

- A. Concrete: Class A, in accordance with PennDOT Publication 408, Section 704.
- B. Expansion Joint Material: PennDOT Publication 408, Section 705.1.
- C. Cure: PennDOT Publication 408, Section 711.2 (a).

2.2 AGGREGATE BASE

- A. In accordance with PennDOT Publication 408, Section 350.2(a).

PART 3 - EXECUTION

3.1 CAST-IN-PLACE CONCRETE CURB

- A. In accordance with PennDOT Publication 408, Section 630.3 with the following additions:
  - 1. Concrete may be placed in the forms in one lift provided there are sufficient workmen and equipment on the project to thoroughly consolidate the concrete.
  - 2. Cure shall be applied to the top of the curb before any marked dehydration of the concrete surface occurs. The forms shall be removed within 24 hours and all exposed concrete surfaces cured.
  - 3. When directed, the Contractor shall provide additional protection by covering the curb with salt hay at expense of the contractor.

END OF SECTION 32 16 13.13

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SECTION 32 16 23

CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SCOPE OF WORK

- A. This Section includes construction of Concrete Sidewalks on aggregate subbase.

PART 2 - PRODUCTS

2.1 CONCRETE PAVING

- A. Concrete: Class A, in accordance with PennDOT Publication 408, Section 704.
- B. Aggregate: PennDOT Publication 408, Section 703.2 for Type C or better Number 2A material.
- C. Cure: PennDOT Publication 408, Section 711.2 (a).
- D. Joint Material: PennDOT Publication 408, Section 705.1.

2.2 AGGREGATE BASE

- A. In accordance with PennDOT Publication 408, Section 350.2(a).

PART 3 - EXECUTION

3.1 CONCRETE PAVING

- A. In accordance with PennDOT Publication 408, Section 676.3. The thickness of the sidewalk paving and aggregate shall be as defined in the construction plans.

3.2 AGGREGATE BASE

- A. In accordance with PennDOT Publication 408, Section 350.3.

END OF SECTION 32 16 23

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SECTION 32 91 00

PLANTING PREPARATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. The scope of work includes all labor, materials, tools, supplies, equipment, facilities, transportation and services necessary for, and incidental to performing all operations in connection with furnishing, delivery, and installation of Planting Soils. Scope of work includes, but is not limited to, sourcing, purchase, delivery and installation of Planting Soil and soil amendments and clean up and disposal of all excess and surplus material.
- B. The specific soil types in this section include:
  - 1. Planting Soil for trees, plant beds, and lawn

1.3 RELATED REQUIREMENTS

- A. Section 311000 Site Clearing
- B. Section 312000 Earthwork
- C. Section 329200 Lawn and Fine Grading
- D. Section 329300 Plants

1.4 REFERENCE STANDARDS

- A. In the event that the requirements of any of the referenced standards and specifications herein conflict with each other the more stringent requirement shall prevail. Where reference is made to one of the standards, the revision in effect at the time of bid opening shall apply.
- B. American Society for Testing Materials (ASTM):
  - 1. ASTM C33 – Gradation Requirements for Coarse Aggregates.
  - 2. ASTM C602 Standard Specification for Agricultural Liming Materials.
  - 3. ASTM D422 – Standard Test Method for Particle Size Analysis of Soils.
  - 4. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.

5. ASTM D3385 – Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer.
6. ASTM D4972 – Standard Test Method for pH of Soils.
7. ASTM D5298 – Standard Specification for Topsoil Used for Landscaping Purposes.
8. ASTM D7481 – Standard Test Methods for Determining Loose and Tapped Bulk Densities of Powders using a Graduated Cylinder.
9. ASTM F1632 – Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes.
10. ASTM F1647 – Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes.
11. ASTM F1815 – Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Athletic Field Rootzones.

C. Other Standards:

1. U.S. Department of Agriculture (USDA), Natural Resources Conservation Service, Soil Texture Calculator.
2. USDA, Natural Resources Conservation Service, 2003. National Soil Survey Handbook, title 430-VI, current edition.
3. USDA Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, current edition.
4. Environmental Protection Agency (EPA) Section 503 Regulations.
5. Department of Environmental Protection (DEP), Pennsylvania Bulletin, Management of Fill, Clean Fill Policy, current edition.
6. U.S. Composting Council (USCC), Test Methods for the Examination of Composting and Compost (TMECC), current edition.
7. USCC, Landscape Architecture / Design Specifications for Compost Use, Planting Bed Establishment with Compost.
8. Association of Official Analytical Chemists (AOAC), Official Methods of Analysis, current edition.
9. Soil Science Society of America (SSSA), Methods of Soil Analysis, current edition.

1.5 DEFINITIONS

- A. Bulk Density: is an indicator of soil compaction calculated as the dry weight of soil by its volume typically expressed in g/cm<sup>3</sup>.
- B. Coarse Sand: sharp natural or manufactured fine aggregate and further defined in this specification.
- C. Compacted soil: soil where the density of the soil is greater than the threshold for root limiting, and further defined in this specification.
- D. Compost: Well decomposed stable organic material as defined by the US Composting Council and further defined in this specification.
- E. Planting Soil: Planting soil shall be harvested from fields or development sites or manufactured uniformly mixed individual soil components (Topsoil, Sand, Compost) or existing mineral soil at the locations of proposed planting meeting the criteria specified herein.



- F. Topsoil: Naturally produced and harvested soil from the A horizon or upper layers or the soil as further defined in this specification.
- G. Salvaged Topsoil: Topsoil stripped from the Project Site and prepared for reuse at the Project Site.

1.6 SUBMITTALS

- A. Submit a list of materials to be provided for work under this Section including the name and address of the materials producer and the location from which the materials are to be obtained.
- B. Submit dated certificates or letters, signed by the materials producer, stating that materials meet or exceed the specified requirements.
- C. For each type of manufactured product, submit data and certificates that the product meets the specification requirements, signed by the product manufacturer, and complying with testing requirements and referenced standards and specific requested testing.
- D. Laboratory soil testing requirements:
  - 1. Samples of soil(s) to be submitted to an approved soil testing laboratory for testing in accordance with specifications herein. Submit the soil testing laboratory for review and approval prior to commencing with any soil testing.
  - 2. Test results shall be submitted to the Landscape Architect for approval in conjunction with soil amendment products in accordance with soil testing laboratory recommendations.
  - 3. Submit soil test reports including test results for each criteria listed within the Products section herein for:
    - a. Individual Components for Soil Mixes: Topsoil, Compost and Sand.
    - b. Soil Mixes Using Individual Components.
    - c. Test reports for Individual Components and Soil Mixes must be submitted concurrently.
    - d. The source of supply for Individual Components for Soil Mixes and Soil Mixes Using Individual Components must be indicated on the test report submittals.
  - 4. Test reports must be the same material to be supplied and must be current within the period of time defined as follows unless approved otherwise by the Landscape Architect:
    - a. Topsoil: no more than 6 months old.
    - b. Salvaged Topsoil: no more than 6 months old.
    - c. Compost: no more than 3 months old.
    - d. Sand: no more than 6 months old.
    - e. Planting Soil: test data must be no more than 1 month old.
    - f. Sample test results shall be considered valid until the time of construction and for the material supplied.
  - 5. If tests fail to meet the specifications, obtain other sources of material, retest and resubmit until accepted by the Landscape Architect.
  - 6. Soils shall not contain any traces of hydrocarbons, petroleum products, chemically prohibited substances, or any other elements considered to be toxic to any vegetation that is used. Clean fill certification shall be submitted by the manufacturer.
  - 7. All soil testing will be at the expense of the Contractor.
- E. Physical samples:
  - 1. All samples must be submitted simultaneously with the laboratory test reports. Samples are required for the following:

- a. Salvaged Topsoil
    - b. Manufactured Planting Soil
  2. Provide one (1) one-gallon sample in a resealable plastic bag to the Landscape Architect.
- 1.7 On-site verification soil testing requirements:
  - A. Landscape Architect may require Compaction Testing:
    1. Maintain an up-to-date written report of compaction test results. Test compaction every 12-inch lift of soil for every 300 square feet of soil installed for each planting area designated on the Drawings. The Landscape Architect may review the written report at any time to confirm conformance with the specification. Submit final report at the completion of soil installation.
    2. Maintain at the site at all times a soil cone penetrometer with pressure dial and a soil moisture meter to check soil compaction and soil moisture.
      - a. Penetrometer shall be AgraTronix Soil Compaction Meter or approved equal.
      - b. Moisture meter shall be “general digital soil moisture meter”.
  - B. Should any verification test results indicate soil material is not consistent with the approved submittals or requirements specified herein, the Contractor shall remove the installed soil and re-install soil at the Contractors expense until the Contract Document requirements are met.
- 1.8 Accompany each delivery of soil mixes, bulk materials, fertilizers and soil amendments provide the appropriate certificates and delivery tickets to the Landscape Architect. The soil supplier must be indicated on delivery tickets for all soil mix deliveries and the supplier must match the approved submittals.
- 1.9 Quality Assurance
  - A. All materials, methods of construction, and workmanship shall conform to applicable requirements of ASTM, PTM, PennDOT Standard Specifications and AASHTO Standards, PADEP Clean Fill Guidance, unless otherwise specified.
  - B. Soil Testing Laboratory Qualifications: The laboratory shall be an independent laboratory, recognized by the State Department of Agriculture. The testing laboratory must have experience in performing agronomic testing including physical and chemical properties of soil. Tests shall be made in strict compliance with the standards of the Association of Official Analytical Chemists and follow standards from the NRCS Soils Manual and ASTM testing methods applicable to the specific tests requested. Laboratory shall have staff fully qualified to review test results, and to make recommendations to amend samples based on what is planned to grow in the soil. American Association for Laboratory Accreditation (A2LA) certification is preferred.
    1. Compost that participates in the US Composting Council’s Seal of Testing Assurance (STA) Program and tested through an STA program lab, using appropriate test methods from the TMECC (Test Methods for the Examination of Compost and Composting) is preferred. Test data shall be presented on a Compost Technical Data Sheet.
  - C. Any fill or topsoil sources, disposal areas, or temporary offsite storage locations shall be subject to review and approval by the Landscape Architect.
  - D. Installer Qualifications: The installer shall be a firm having at least five (5) years of experience of a scope similar to that required for the work.

1. Installer Field Supervision: When any soil work is in progress, installer shall maintain, on-site, an experienced full-time supervisor.
2. Installer's field supervisor shall have a minimum of five (5) years experience as a field supervisor installing soil, shall be trained and proficient in the use of field surveying equipment to establish grades.

1.10 Delivery, Storage, and Handling

- A. Preparation, amendment, and mixing of soils shall be performed at the soil supplier location.
- B. Weather: Do not mix, deliver, place or grade soils when frozen or with moisture above field capacity. Soils shall not be handled, hauled, placed, or compacted when wet or frozen. Soil shall only be handled when the moisture content is between the specified ranges in percent water by volume.
- C. Protect soil and soil stockpiles, including the stockpiles at the soil blender's yard, from wind, rain and washing that can erode soil or separate fines and coarse material, and contamination by chemicals, dust and debris that may be detrimental to plants or soil drainage. Once spread, soils shall be protected with staked erosion control blankets.
- D. All manufactured packaged products and material shall be delivered to the site in unopened containers and stored in a dry enclosed space suitable for the material and meeting all environmental regulations. Biological additives shall be protected from extreme cold and heat. All products shall be freshly manufactured and dated for the year in which the products are to be used.
- E. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
- F. 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.
- G. None of the soil materials shall be delivered to the site until sample certifications are approved by the Landscape Architect, however, such approval does not constitute final acceptance. Certification submittal shall include recommended soil amendment products if proposed to modify the soils. Any approval of soils made conditional upon utilizing one or more amendments shall be understood to afford to the Landscape Architect the right for further testing and refusal of materials that do not meet these Specifications.

PART 2 - PRODUCTS

2.1 Individual Components for Soil Mixes

- A. Topsoil
  1. Topsoil definition: Topsoil shall be a harvested from the Project Site or fields or development sites and shall be loose, friable mineral particles resulting from natural soil formation from the A, E and upper B horizons, or "solum" where most plant roots grow. Manufactured soils where sand, composted organic material, chemical additives or similar elements has been

blended to meet the requirements of Topsoil is not acceptable. The soil shall be free of construction and trash debris, rocks, hydrocarbons, petroleum materials, herbicides, or other harmful contaminants that would impact plant growth.

- a. Topsoil shall comply with the following parameters:
  - i) Organic matter (ASTM F1647, Method A): 1.5% minimum (by dry weight).
  - ii) pH (1 soil : 1 water): 5.0 - 7.0.
- b. Stockpiled Existing Topsoil at the site meeting the above criteria may be acceptable.

B. Organic Amendment / Compost

- 1. Compost is as defined by the “US Composting Council Landscape Architecture / Design Specifications for Compost Use, Planting Bed Establishment with Compost”. Compost shall be a well decomposed, stable, weed free organic matter source. It shall be derived from: agricultural, food, or industrial residuals; leaf litter and yard trimmings; or source-separated waste. The product shall contain no substances toxic to plants and shall be reasonably free (< 1% by dry weight) of man-made foreign matter. The compost will possess no objectionable odors and shall not resemble the raw material from which it was derived.
- 2. Compost shall comply with the following parameters:
  - a. pH: 6.0 - 8.0.
  - b. Soluble salt content (electrical conductivity, 1 soil : 2 water): maximum 5 dS/m (mmhos/cm).
  - c. Compost derived from stabilized mushroom soil compost may possess a maximum EC of 10 dS/m (1:2), if the maturity testing is a minimum of 95% and ammonia (NH4) content is a maximum of 250 ppm.
  - d. Moisture content %, wet weight basis: 30 – 60.
  - e. Organic Matter Content, % dry weight basis: 30 – 65.
  - f. Particle size, dry weight basis: 98% pass through 1/2 inch screen.
  - g. Stability carbon dioxide evolution rate: mg CO<sub>2</sub>-C/ g OM/ day ≤ 3.
  - h. Maturity, seed emergence and seedling vigor, % relative to positive control: minimum 80%.
  - i. Physical contaminants (inerts), %, dry weight basis: <0.5%.
  - j. Chemical contaminants, mg/kg (ppm): meet or exceed US EPA Class A standard, 40CFR § 503.13, Tables 3 levels.
  - k. Biological contaminants select pathogens fecal coliform bacteria, or salmonella, meet or exceed US EPA Class A standard, 40 CFR § 503.32(a) level requirements.

C. Coarse Sand

- 1. Sharp natural or manufactured fine aggregate shall be hard and durable and free of limestone (calcareous sand), shale and slate particles and free of harmful contaminants that would impact plant growth complying with the following parameters:

- a. pH shall be lower than 7.0.
- b. Sieve analysis:
 

Sieve	Percent passing (by mass)
3/8 inch (9.5 mm)	100
No 4 (4.75 mm)	95-100
No 8 (2.36 mm)	80-100
No 16 (1.18 mm)	50-85
No 30 (.60 mm)	25-75

No 50 (.30 mm)	5-40
No 100 (.15 mm)	2-20
No 200 (0.75 mm)	2-15

- c. Particle analysis must be per USDA classification, Sand.
  - Sand (2 - 0.05 mm):  $\geq 88\%$
  - Silt (0.05 - 0.002 mm):  $\leq 9\%$
  - Clay (< 0.002 mm):  $\leq 3\%$

D. Chemical Amendments

- 1. Lime, ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
  - a. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
  - b. Provide lime in form of dolomitic limestone.

2.2 Soil Mixes Using Individual Components

A. Definition

- 1. Manufactured uniformly mixed individual soil components (Salvaged Topsoil, Topsoil, Sand, Compost) meeting the criteria specified herein. Provide Soils at the locations indicated on the Drawings complying with the following parameters.

B. Planting Soil, Plant Beds and Lawn

- 1. Planting soil shall be manufactured from uniformly mixed individual soil components (Salvaged Topsoil, Sand, Compost) or existing mineral soil at the locations of proposed planting meeting the criteria specified herein.
- 2. Provide Planting Soil at the locations indicated on the Drawings complying with the following parameters:
  - a. Particle analysis must be per USDA classification for loam, sandy loam, sandy clay loam, or silt loam within the following parameters using ASTM D422:
    - Sand: 45 - 55%
    - Silt: no more than 30%
    - Clay: no more than 20%
 Gravel content larger than 2mm shall be less than 12%.
  - b. pH (1 soil : 1 water): 6.0 - 7.2.
  - c. Organic matter (ASTM F1647, Method A): 3 - 6% (by dry weight).
  - d. Hydraulic conductivity (ASTM F1815) at 85% Proctor (ASTM D698): 1.0 in/hr +/- 0.5 in/hr
  - e. Soluble salt content (electrical conductivity, 1 soil : 2 water): maximum 1.60 mmho/cm. Sodium (Na) salinity shall not exceed 700 ppm.
  - f. Cation Exchange Capacity (CEC): >15 meq/100g.
  - g. Nutrient analysis including macronutrients and micronutrients (Mehlich-3) with soil fertility interpretation and recommendations relevant to the specified plant species.
  - h. Compost shall not be added at more than 30% by volume.

C. Erosion Control Mat

1. Straw Blanket
  - a. For use on 4:1 to 3:1 slopes with moderate runoff conditions: utilize ECS-1 Single Net Straw Rolled Erosion Control Blanket, East Coast Erosion Blankets, 443 Bricker Road, Bernville, PA 19506, 800-582-4005, [www.erosionblankets.com](http://www.erosionblankets.com), or approved equal.
  - b. Matting containing non-degradable plastic mesh is prohibited.
2. Straw Mulch:
  - a. For use on slopes less than or equal 4:1 with minimal runoff conditions: utilize mildew-free and seed-free salt hay with a nonasphaltic liquid tackifier.

D. Amendments

1. At the time of final grading, add fertilizer if required to the Planting Soil at rates recommended by the testing results for the species of plants to be grown.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. Prior to installation of soil, examine site to confirm that existing conditions are satisfactory for the work of this section to proceed. The Landscape Architect shall approve the condition of the subgrade and the previously installed subgrade preparation and the installation of subsurface drainage.
  1. Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope toward the under drain lines as shown on the Drawings.
    - a. Subgrade definition: surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing Planting Soil.
  2. Confirm that all surface areas to be filled with Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches diameter, soil crusting films of silt or clay that reduces or stops drainage from the Soil into the subsoil; and/or standing water. Remove unsuitable material from the site.
    - a. Debris definition: Elements including, but not limited to, concrete, concrete masonry, wood, excavated rock and rock fragments, rubble, overburden soils, abandoned utility structures, trash, refuse and litter.
  3. Confirm that no adverse drainage conditions are present.
  4. Confirm that no conditions are present which are detrimental to plant growth.
- B. If unsatisfactory conditions are encountered, notify the Landscape Architect immediately to determine corrective action before proceeding.

3.2 SOIL INSTALLATION

- A. All equipment utilized to install or grade Soils shall be wide track or balloon tire machines rated with a ground pressure of 4 psi or less. All grading and soil delivery equipment shall have buckets equipped with 6 inch long teeth to scarify any soil that becomes compacted.
- B. In areas of soil installation above existing subsoil, scarify the subgrade material prior to installing Soil.

1. Scarify the subsoil of the subgrade to a depth of 3 – 6 inches with the teeth of the back hoe or loader bucket, tiller or other suitable device.
  2. Immediately install the Planting Soil. Protect the loosened area from traffic. DO NOT allow the loosened subgrade to become compacted.
  3. In the event that the loosened area becomes overly compacted, loosen the area again prior to installing the Planting Soil.
- C. Install the Planting Soil in 6 inch lifts to the required depths. Refer to the Drawings for minimum planting soil depths.
1. Apply compacting forces to each lift as required to attain the required compaction. Scarify the top of each lift prior to adding more Planting Soil by dragging the teeth of a loader bucket or backhoe across the soil surface to roughen the surface.
  2. Approved compaction equipment includes a smooth drum roller or plate compactor. Typically one to three passes per lift will achieve the desired compaction. Contractor to test desired compaction methodology with actual soil to be installed to confirm installation method and material properties are compatible and will achieve the specified compaction rates.
  3. Provide adequate equipment to achieve consistent and uniform compaction of the Soils. Use the smallest equipment that can reasonably perform the task of spreading and compaction. Use the same equipment and methods of compaction for the entire project area once soil, installation methodology, and compaction criteria have been coordinated and confirmed.
- D. Do not pass motorized equipment over previously installed and compacted soil except as authorized below.
1. Light weight equipment such as trenching machines or motorized wheel barrows is permitted to pass over finished soil work.
  2. If work after the installation and compaction of soil compacts the soil to levels greater than the above requirements, follow the requirements of Over Compaction Reduction herein.
- E. Phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil. Work in rows of lifts the width of the extension of the bucket on the loader. Install all lifts in one row before proceeding to the next. Work out from the furthest part of each bed from the soil delivery point to the edge of each bed area.
- F. Where travel over installed soil is unavoidable, limit paths of traffic to reduce the impact of compaction in Planting Soil. Each time equipment passes over the installed soil it shall reverse out of the area along the same path with the teeth of the bucket dropped to scarify the soil. Comply with Over Compaction Reduction herein in the event that soil becomes over compacted. Access over finished grade soils shall be restricted. If access is required across placed soils, Contractor shall be required to rework compacted soil areas prior to fine grading to the full depth of the placed soils as directed by the Landscape Architect.
- G. The depths and grades shown on the Drawings are the final grades after settlement and shrinkage of the compost material. The Contractor shall install the Planting Soil at a higher level to anticipate this reduction of Soil volume. A minimum settlement of approximately 10 - 15% of the soil depth is expected. All grade increases are assumed to be as measured prior to addition of surface Compost till layer, or mulch.

H. Maintain moisture conditions within the Soil during installation or modification to allow for satisfactory compaction.

1. Volumetric soil moisture level during installation shall be above permanent wilt point and below field capacity for each type of soil texture within the following ranges.

Soil texture	Permanent wilting point	Field capacity
Sand, Loamy sand, Sandy loam	5-8%	12-18%
Loam, Sandy clay, Sandy clay loam	14-25%	27-36%
Clay loam, Silt loam	11-22%	31-36%
Silty clay, Silty clay loam	22-27%	38-41%

2. The Contractor shall confirm the soil moisture levels with a moisture meter (Digital Soil Moisture Meter, DSMM500 by General Specialty Tools and Instruments, or approved equivalent). Suspend operations if the Soil becomes wet. Apply water if the soil is overly dry.

I. Installing Planting Soil with soil or mulch blowers or soil slingers is not permitted.

### 3.3 SOIL COMPACTION REQUIREMENTS FOR PLANT BEDS AND LAWN

A. The following are threshold levels of compaction as determined by each method for the subsoil surface and full profile of Planting Soil, testing each lift of Soil with a penetrometer. The same penetrometer and moisture meter shall be used to test installed soil throughout the work.

1. Acceptable Compaction
  - a. Standard Proctor Method – 75-85%.
  - b. Penetration Resistance Method – about 75-250 psi.
  - c. Soil below 75 psi soil becomes increasingly unstable and will settle excessively.
2. Unacceptable Compaction
  - a. Standard Proctor Method – Above 85%.
  - b. Penetration Resistance Method – Approximately above 300 psi
3. Prior to testing the soil with the penetrometer check the soil moisture. Penetrometer readings are impacted by soil moisture and excessively wet or dry soils will read significantly lower or higher than soils at optimum moisture.
4. The penetrometer readings shall be within 20% plus or minus of the specified levels.
5. Where the Standard Proctor Method is utilized, the following Bulk Density levels based on 75% minimum and 85% maximum standard Proctor indicate acceptable compaction.

Soil Texture	Bulk Density (g/cm <sup>3</sup> )	
	Max.	Min.
Loamy Sand	1.80	1.65
Sandy Loam	1.65	1.45
Sandy Clay Loam	1.55	1.35
Loam	1.50	1.30
Silt Loam	1.45	1.25



3.4 OVER COMPACTION REDUCTION

- A. Compacted soil: soil where the density of the soil, at each lift for the full profile, is greater than the threshold for root limiting, and further defined in this specification.
- B. Any soil that becomes compacted to a density greater than the specified density shall be dug up and reinstalled. This requirement includes compaction caused by other sub-contractors after the Planting Soil is installed and approved.
- C. Surface roto tilling shall not be considered adequate to reduce over compaction at levels 6 inches or greater below finished grade.

3.5 INSTALLATION OF CHEMICAL ADDITIVES

- A. Following the installation of each soil and prior to fine grading and installation of the Compost till layer, apply chemical additives as recommended by the soil test, and appropriate to the soil and specific plants to be installed.
- B. Types, application rates and methods of application shall be approved by the Landscape Architect prior to any applications.

3.6 FINE GRADING

- A. Fine grading: The final grading of the soil to achieve exact contours and positive drainage, often accomplished by hand rakes or drag rakes or other suitable devices, and further defined in this specification, and further defined in this specification.
- B. The Landscape Architect shall approve all rough grading prior to the installation of Compost, fine grading
- C. Grade the finish surface of all planted areas to meet the grades shown on the Drawings, allowing the finished grades to remain higher than the grades on the grading plan, as defined in paragraph Soil Installation, to anticipate settlement over the first year.
- D. Utilize hand equipment, small garden tractors with rakes, or small garden tractors with buckets with teeth for fine grading to keep surface rough without further compaction. Do not use the flat bottom of a loader bucket to fine grade, as it will cause the finished grade to become overly smooth and or slightly compressed.
- E. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual constructed field conditions of paving, wall and inlet elevations. Notify the Landscape Architect in the event that conditions make it impossible to achieve positive drainage.
- F. Provide smooth, rounded transitions between slopes of different gradients and direction. Modify the grade so that the finish grade before adding mulch and after settlement is one or two inches below all paving surfaces or as directed by the Drawings.

3.7 INSTALLATION OF IN-SITU COMPOST AMENDMENT

- A. After Planting Soil is installed in planting bed areas, spread 2 – 3 inches of Compost over the beds and roto till into the top 4 - 6 inches of the Planting Soil. This step will raise grades slightly above the grades required in Fine Grading herein. This specification anticipates that the raise in grade due to this tilling will settle within a few months after installation as Compost breaks down. Additional settlement as defined in paragraph “Soil Installation” must still be accounted for in the setting of final grades.
- B. Soil Tilling: Loosening the surface of the soil to the depths specified with a rotary tine tilling machine, roto tiller, (or spade tiller), and further defined in this specification.

3.8 PROTECTION

- A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- B. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by the Landscape Architect and replace contaminated planting soil with new planting soil.

3.9 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

END OF SECTION 329100

SECTION 32 92 00

LAWN AND FINE GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Reseeding of existing lawns disturbed during construction.
- 2. Seeding of new lawns.
- 3. Maintenance of lawn areas until acceptance.

B. Related Sections:

- 1. Division 2 Section "Planting".
- 2. Division 2 Section "Soil Preparation".

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Topsoil: Native or Imported topsoil. See Soil Preparation section.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

1.4 SUBMITTALS

- A. Submit prior to delivery of materials to site.
    - 1. Submit seed mixes for review.
  - B. Certifications: Submit certificate with names of materials and manufacturer.
    - 1. Ground limestone: Include guaranteed analysis, and weight for packaged material.
    - 2. Commercial fertilizers: Include guaranteed analysis.
    - 3. Seed: include origin of seed.
  - C. Product data: Submit product literature or tear sheets with name of product, and manufacturer.
    - 1. Commercial fertilizer, including type and application rate.
  - D. Source of supply: Submit in writing all proposed sources.
  - E. Test reports: Submit test reports at least three (3) weeks prior to delivery of materials to site.
    - 1. Seed: Test for purity, proportion by weight, weed seed content and germination percentage of all seed mixture proposed for use. No seed shall be delivered until the test reports are approved. All seed shall be tested within six (6) months immediately preceding date of sowing. Seed must comply with all Commonwealth of Pennsylvania seed certifications.
- 
- A. Qualification Data: For qualified landscape Installer.
  - B. Maintenance Instructions: Recommended procedures to be established by Owner / owner's representative for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  - 1. Experience: Five (5) years' experience in turf installation in projects of similar complexity in addition to requirements in Division 1 Section "Quality Requirements."
  - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 3. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
  - 4. Pesticide Applicator: State licensed, commercial.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged materials: Deliver packaged materials in clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration during delivery and during storage at site.

1. Deliver fertilizer and limestone in waterproof bags.
2. All seed shall be labeled to show compliance with requirements of governmental agencies having jurisdiction. All bag tags of seed used shall be retained and if requested, submitted to the owner / owner's representative. Seed shall be kept in dry storage away from contaminants, insects and rodents.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

1.7 PROJECT CONDITIONS

A. Protection of existing conditions adjacent to and within construction zone:

1. All necessary precautions for safety including barricades and other protection measures shall be taken during all work.
2. All heavy equipment shall be driven or parked on the site only where approved by owner / owner's representative.
3. Existing pavements, lawns, structures, walls, etc. damaged or disturbed during construction shall be repaired or replaced to the satisfaction of the Owner / owner's representative.
4. Repair and replace all active utility lines, above and below grade, damaged in the course of construction operations.
5. Avoid damaging existing trees. Damage includes but is not limited to: cutting, breaking, skinning or compacting of roots, skinning and bruising of bark and breaking of branches and limbs.
  - a. Contractor shall not park or store equipment and supplies within the dripline of existing trees to remain.

B. Environmental requirements:

1. Seed only between April 1 - May 15 and September 1 - October 15, unless otherwise permitted by the Owner / owner's representative.
2. Do not seed during adverse weather, windy conditions or on wet or frozen ground.

PART 2 - PRODUCTS

2.1 SEED

- A. Fresh, clean, new seed. Seed shall be packed in sealed 50 lb. bags showing net weight, composition of mix, date of germination tests and supplier's name. Germination test must be done within a nine-month period prior to sale of the seed.
1. Seed shall not contain in excess of 0.1% by weight weed seed, no more than 1.5% inert matter, and no more than 0.1% other crop seed and no noxious weed seed or

undesirable grass species. Comply with state laws governing noxious weeds. Seed containing prohibited or restricted noxious weeds shall not be accepted.

2. Seed shall be Pennsylvania certified and blue tagged.
- B. Seed mixture: areas of permanent turf grass shall adhere to the following mixture ratios, unless otherwise approved by the Landscape Architect or Parks and Recreation.

Seed Type	Proportion by Weight	Minimum Purity	Minimum Germination
Turf-Type Tall Fescue (3 Varieties Min.)	60%	95%	80%
Perennial Rye Grass	30%	95%	85%
Kentucky Blue Grass	10%	90%	80%

2.2 LIMESTONE

- A. In accordance with soil test recommendations, provide ground, high magnesium limestone containing not less than 85% total carbonates, 95% passing a 20 mesh sieve, 40% passing a 60 mesh sieve and a minimum of 30% percent passing a 100 mesh sieve.

2.3 MULCH

- A. Mulch shall consist of specially prepared wood cellulose processed into a uniform fibrous physical state. Wood cellulose fiber mulch shall be dyed green or contain a green dye in the package that will provide an appropriate color to facilitate visual inspection of the uniformly spread slurry. The fiber mulch, including dye, shall contain no germination or growth inhibiting factors. The mulch material shall be manufactured and processed in such a manner that the wood cellulose fiber mulch will remain in uniform suspension in water under agitation and will blend with other additives to form a homogenous slurry. The mulch material shall form a blotter-like ground cover, on application, having moisture absorption and percolation properties and shall cover and hold grass seed in contact with the soil without inhibiting the growth of the grass seedlings.
- B. Mulch shall contain no elements or compounds at concentration levels that will be phytotoxic. Wood cellulose fiber must conform to the following physical requirements:
1. fiber length to be approximately 10 mm
  2. diameter approximately 1 mm
  3. pH range of 4.0 to 8.5
  4. ash content of 1.6% maximum
  5. water holding capacity of 90% minimum
- C. Slope stabilization: in areas where erosion may occur, use an organic tackifier such as CONTACT or an erosion fabric or approved equal, in accordance with manufacturer’s instructions.

2.4 WATER

- A. Potable, clean fresh and free from harmful materials. Contractor shall provide all means of conveyance including hoses, sprinklers, tank trucks or other means which may be required to water lawns until accepted by Owner / owner’s representative.

## 2.5 FERTILIZER

- A. A standard complete slow release fertilizer. At least 50% by weight of the nitrogen content of the fertilizer shall be derived from organic materials with the remainder in urea form or equivalent. Fertilizer shall contain percent nitrogen, phosphorous, and potash by weight of ingredients dictated by the topsoil test results.
  - 1. Fertilizer shall be in bags showing weight, analysis, and manufacturer's name

## 2.6 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent and Post-Emergent Herbicides (Selective and Non-Selective) shall only be used with written authorization by the Owner / owner's representative.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Do not work soil in frozen, wet, or muddy conditions.
  - 3. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner / owner's representative and replace with new planting soil as specified in Division 2 Section "Soil Preparation".

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

- A. Grass seed shall be applied to all disturbed areas a result of this project.
- B. Preparation of surface for seeded areas (except within root zones of existing trees):
  - 1. Vertically aerate soil if it has become compacted as a result of construction activities.
  - 2. Prior to applying soil amenities, roll lawn area with a filled water roller. Correct any surface irregularities to prevent formation of low spots.
  - 3. If required by soil test, evenly distribute ground limestone at the recommended rate. Work lightly into the top four (4) inches of topsoil at least one full week prior to applying fertilizer.
  - 4. Spread starter fertilizer uniformly, at the rate determined by soil test for new lawns. Add organic matter 1" deep, if required by soil test.
  - 5. Go over the entire area with a spike drag or rototiller and loosen surface at least 3" deep and then hand rake to a smooth, even surface.
- C. Seeding
  - 1. As soon as ground has been properly prepared, sow grass seed at the rate of 6 lbs. per 1,000 sq. ft. total. Distribute seed evenly over entire area by sowing equal quantity in two directions at right angles to each other.
    - a. Use suitable mechanical seeder to sow by hand for small areas.
  - 2. Cover seed with a thin layer of topsoil by light raking.
  - 3. Roll seed in both directions very lightly with an empty water roller.
  - 4. After seed application, apply mulch at a net dry weight of 1,500 lbs. per acre. Mulch shall be mixed with water and the mixture shall contain a maximum of 50 lbs. of wood cellulose fiber per 100 gallons of water. Use a slope stabilizing device in areas where erosion may occur.
  - 5. Water with a fine spray immediately after seeding operations are completed.
    - a. Water all newly installed seeded areas as necessary to keep lawn healthy. Apply water in sufficient quantities so it penetrates four (4) inches into planting soil without puddling. Continue watering until seeded areas are accepted by the Owner / owner's representative.
  - 6. Protect all newly seeded lawn areas from damage.
  - 7. When seeding occurs after acceptable seeding dates, over winter protection shall consist of applying five bales clean straw per 1,000 sq. ft. and anchor mulch by commercial mulch netting or 20 lbs./1,000 sq. ft. cellulose fiber. Asphalt emulsion anchoring is not permitted.

3.4 TURF MAINTENANCE

- A. Begin maintenance immediately after each lawn area is restored.
  - 1. All lawn areas shall be watered and kept moist to maximize germination.
    - a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch.



- b. Seed: Water seeded areas as often as required to keep the top 1-inch of soil moist until the seed germinates. Avoid excessive water that will cause the seeds to rot. Once seedlings have germinated and established reduce watering frequency and increase volume for deeper watering. Continually adjust irrigation system until intervals have been stretched to the greatest extent practical.
2. All areas and spots which do not show a prompt catch of grass shall be reseeded and this operation repeated until complete coverage is obtained.
3. When the area does not need to be reseeded, it shall be thoroughly wetted every time the surface shows evidence of drying out and this shall continue through entire period of maintenance.
4. When the average height is 3-4" and the lawn areas are fully germinated, firmly rooted and secure in place, grass shall be cut to 2-3" or 1/3 of the grass blade. Any depressions or irregularities in the lawn surface shall be leveled off and reseeded.
5. Maintenance shall cease after the third mowing, provided all grass areas are properly established and free of washouts, depressions, bare spots, weeds and large off-color areas. If seeding is done in the autumn, the Contractor shall complete the three mowings in the following spring.
6. All lawns shall show a uniform, thick, well-developed stand of grass. If the grass stand is unsatisfactory, the Contractor's maintenance responsibility shall continue until an acceptable stand of grass is achieved.

### 3.5 SATISFACTORY LAWN

- A. Seed installations shall meet the following criteria as determined by Owner / owner's representative:
  1. Satisfactory Lawn: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
  2. Provide at minimum three (3) mowings in accordance with grass height requirements.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

### 3.6 PESTICIDE APPLICATION

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

- C. Notification signage must be posted at every entrance in a highly visible location at least five (5) days in advance of application and maintained five (5) business days following application, or as recommended by the manufacturer's instructions, whereby it is then removed from the site.
  - 1. Notification Signage shall be brightly colored, laminated and at least 8.5" by 11" format including the following information:
    - a. Date of Notification.
    - b. Date of Application.
    - c. Name of Chemical.
    - d. Reason for Chemical Application.
    - e. Information informing as to the precautions that must be taken including humans and pets.

### 3.7 CLEANUP AND PROTECTION

- A. Do not allow soil and debris created by turf work onto permeable unit paving areas. Promptly clean up any soil or debris on impervious paving areas, such as concrete sidewalk or roadway paving. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Protection of newly planted lawn areas is critical to healthy establishment. Erect temporary protection fencing and warning signs to protect newly planted areas from traffic. Maintain fencing throughout initial maintenance period. Remove protection fencing only after lawn areas have become well established and are able to tolerate regular use. Install temporary protection fencing and signage in accordance with the following:
  - 1. Temporary Protection Fencing
    - a. Fencing shall cordon off the entire perimeter of lawn area to prevent access.
    - b. Fencing shall be supported securely as required to remain erect for duration of site protection. Utilize heavy-duty 12 gauge minimum metal fence posts spaced at 6 to 8 feet on center, or as required. Posts shall be driven into the soil sufficient depth to support fencing against heavy wind load.
    - c. Fencing shall be at least 4-foot high. Secure fencing to posts at the top and bottom and in at least one location in the middle with zip or cable ties. Fencing may also be woven through each post and secured at the top only with a zip tie.
  - 2. Signage: Notification signage shall be brightly colored, laminated and at least 8.5" by 11" format attached to fencing every 10 to 12 feet, including the following information.
    - a. "Please keep off lawn areas. Lawn will be available once protection fencing has been removed."
- C. If utilized, remove non-degradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 00

SECTION 32 93 00

PLANTS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
  - 1. Provide trees, shrubs and groundcover, as well as all necessary accessories.
  - 2. Maintenance and replacement during Establishment Period.
  - 3. Provide and install decorative boulders.

1.2 RELATED SECTIONS

- A. Section 329100 – Planting Preparation
- B. Section 329200 – Lawns and Fine Grading

1.3 REFERENCES

- A. The following apply to work in this Section:
  - 1. ASNS: “American Standard for Nursery Stock,” latest edition, published by the American Nursery and Landscape Association.
  - 2. NAA: “National Arborist Association Standards for Pruning”, latest edition, published by the National Arborist Association.
  - 3. ANSI: “American National Standards Institute”, latest edition.

1.4 SUBMITTALS

- A. Certifications: Submit certificate with names of materials and manufacturer.
  - 1. Plants: Furnish certificates of inspection as may be required by Federal, State or other authorities that plants are free of disease or hazardous insects.
  - 2. Commercial fertilizers: Include guaranteed analysis.
  - 3. Ground limestone: include guaranteed analysis and weight for packaged material.
  - 4. Commercial fertilizers: include guaranteed analysis.
- B. Instructions: Submit planting and maintenance schedule.
  - 1. Submit the proposed planting installation schedule indicating dates for tagging and installation, dates and duration of plant storage at an off-site location, and a detailed program of Establishment Period maintenance.
- C. Product data: Submit product literature or tear sheets with name of product, and manufacturer.
  - 1. Commercial fertilizer.
  - 2. Mulch.

- E. Samples: Submit loose materials in sealed bags labeled with name of material and manufacturer.
  - 1. Mulch, 1/2 lb. bag.
  
- F. Source of supply: Submit in writing all proposed sources.
  - 1. Locate trees and make all pre-selection arrangements at the source of supply required to ensure an efficient selection procedure. Landscape Architect, with Contractor present, will select plants at nursery on the basis of their compliance with the Drawings. Contractor shall inspect the selected plants on the basis that the plants are free of disease and otherwise conform to the requirements of the Contract Documents. The accuracy of the varieties of species specified for plant material shall be the Contractor's responsibility. Request visit at least 14 days in advance of desired inspection date.
    - a. Trees will be inspected and approval given by Landscape Architect at the source for conformity to Specification requirements. Such approval shall not affect the right of inspection and rejection during delivery and installation.
    - b. All trees specified as B&B must be in the ground at the growing source at the time of inspection. Pre-dug trees shall not be acceptable.
  - 2. Locate boulders and make all pre-selection arrangements at the source of supply required to ensure sufficient selection procedure. Landscape Architect, with contractor present, will select boulders based on the compliance with size and shape on the basis of compliance with the Drawings, as well as product data provided herein.

#### 1.5 QUALITY ASSURANCE

- A. Contractor shall have had experience with at least two (2) other projects of similar scope and complexity and shall perform work with personnel totally familiar with planting installation and general construction techniques under the supervision of an experienced landscape foreperson.
  
- B. Plants: Meet or exceed applicable AAN standards.
  - 1. Plant List: Investigate sources of supply prior to submitting bid. Confirm that size, variety and quantity of plants specified on Plant List can be supplied. Failure to take this precaution shall not relieve the successful bidder from responsibility for furnishing and installing all plants in strict accordance with Contract requirements.
    - a. Substitutions shall not be permitted unless substantiated written proof is supplied that a specified plant is not obtainable. In this situation a proposal to use the nearest equivalent size or variety with an equitable adjustment of Contract Price will be considered.
    - b. Plant substitutions will be permitted only upon approval by the Owner's representative and Landscape Architect.
    - c. All plants shall be grown on their own roots. No grafted species shall be acceptable.
    - d. Plants shall be of the quantity and quality indicated, true to name, properly labeled with botanical name and in accordance with the sizes and grades specified.

#### 1.6 PROJECT CONDITIONS

- A. Protection of existing conditions adjacent to and within construction zone:
  - 1. All necessary precautions for safety including barricades and other protection measures shall be taken during all work.
  - 2. All heavy equipment shall be driven or parked on the site only where approved by Owner / owner's representative's representative.

3. Existing pavements, structures, walls, etc. damaged or disturbed during construction shall be repaired or replaced to the satisfaction of the owner / owner's representative.
4. Repair and replace all active utility lines, above and below grade, damaged in the course of construction operations.
5. Avoid damaging existing trees. Damage includes but is not limited to: cutting, breaking, skinning or compacting of roots, skinning and bruising of bark and breaking of branches and limbs.
  - a. Contractor shall not park or store equipment and supplies within dripline of existing trees to remain.

B. Environmental requirements:

1. Plant only within the following dates, weather permitting. Do not plant when ground is frozen, when the soil is excessively wet, when ambient air temperature exceeds 85 degrees or in otherwise unsatisfactory weather conditions.
  - a. Plant between March 1 and June 15 and August 15 until the ground freezes.
  - b. Plant trees known to be fall digging hazards only in the Spring.
2. Chemical Spraying Program: no spraying of herbicides, insecticides, fungicides, nematicides, fumigants or other chemicals shall be done without first submitting a spray program to the owner / owner's representative.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Packaged materials: Deliver packaged materials in clearly marked containers showing net weight, guaranteed analysis and name of manufacturer. Specified requirements for packaged materials apply to bulk shipments. Protect materials from deterioration during delivery and during storage at site.
  1. Deliver fertilizer in waterproof bags.
  2. All seed shall be labeled to show compliance with requirements of governmental agencies having jurisdiction. All bag tags of seed used shall be retained and if requested, submitted to the Owner / Owner's representative. Seed shall be kept in dry storage away from contaminants, insects and rodents.
- B. Plants: Notify Owner's representative seven (7) days in advance of any delivery of plants to site.
  1. Dig and handle trees with care to prevent injury to trunks, branches and roots. Do not prune prior to delivery. Do not bend or bind-tie trees in such manner as to damage bark, break branches or destroy natural shape. Pack and ship to ensure arrival at site in good condition. Provide protective covering during delivery. Plants with cracked or broken root balls shall not be accepted.
  2. Deliver plants after preparation of planting areas has been completed and approved, install plants immediately.
    - a. If planting is delayed more than eight (8) hours after delivery, set balled and burlapped plants on the ground well protected with soil, wet mulch or other acceptable material. Protect balls and roots, and container grown material from freezing, sun, drying winds and/or mechanical damage. Water as necessary until planted.
    - b. Do not heel in plants for more than five business days.
  3. Immediately remove rejected plants from site.

1.8 INSPECTION FOR SUBSTANTIAL COMPLETION

- A. Plants:
  1. All plants shall be alive, healthy and installed to be accepted.

2. Guarantee Period for plants shall not begin until all items have been completed or corrected.

#### 1.9 GUARANTEE / ESTABLISHMENT PERIOD FOR PLANTS

- A. Contractor shall not be held responsible for acts of vandalism occurring after the beginning of Guarantee Period, nor shall Contractor be held responsible for deleterious effects caused by maintenance procedures performed by Owner without concurrence of Contractor.
- B. Replace at no additional cost for a period of two growing seasons after the beginning date of Guarantee Period, any plants that have died or that are, in the opinion of Owner's representative, in unhealthy or unsightly condition, or that have lost their natural shape due to dead branches, excessive pruning, excessive defoliation.
  1. A growing season is defined as the period during which plant growth takes place from last killing frost of Spring to the first killing frost of Autumn.
  2. Replace unacceptable plants no later than the next succeeding planting season. All replacements shall have a guarantee of one planting season from date of replacement.
    - a. Replace unacceptable plants in accordance with original Specification. Cost is considered to be included in the Bid and Contract Price.

### PART 2 PRODUCTS

#### 2.1 PLANTS

- A. Provide freshly dug plants nursery grown in accordance with good horticultural practice.
  1. Sound, healthy and vigorous, well-branched and fully foliated when in leaf, free from disease, insect pests, eggs or larvae with healthy well-developed root systems.
- B. Conform to measurements specified on Plant List. Plants shall be measured before pruning, with branches in normal position. Any necessary pruning shall be done at time of planting. Requirements for the measurement, branching, grading, quality, balling, and burlapping of plants shall be in accordance with standards specified in ASNS and conform to ANSI Z.60.1.
- C. Provide B&B stock with a compact natural ball of earth, firmly wrapped and tied in burlap so that upon delivery the soil in the ball is still firm and compact about the small feeding roots. Root ball sizes shall be in accordance with standards specified in ASNS.
- D. Furnish trees with rootballs measured from top of rootball which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before trees are dug to ensure proper rootball depth.
- E. Plants shall be measured before pruning, with branches in normal position. Any necessary pruning shall be done at time of planting. Requirements for the measurement, branching, grading, quality, balling, and burlapping of plants shall be in accordance with standards specified in ASNS.

#### 2.2 STAKING AND GUYING MATERIALS

- A. Tree Stakes: 2" x 2" x 8' long wood posts, minimum 2 per tree, if required.
- B. Guys: Nylon straps shall be used wrapped loosely around tree trunks and securely fastened to stakes.

2.3 LIMESTONE

- A. In accordance with soil test recommendations, provide ground, high magnesium limestone containing not less than 85% total carbonates, 95% passing a 20 mesh sieve, 40% passing a 60 mesh sieve and a minimum of 30% percent passing a 100 mesh sieve.

2.4 MULCH

- A. Double shredded hardwood bark. To be natural in color, free of dye.

2.5 WATER

- A. Potable, clean fresh and free from harmful materials.

2.6 HERBICIDES

- A. Herbicides, fungicides, and pesticides: Approved before use for type and rate of application by Owner / owner's representative and local, state and/or federal agencies with jurisdiction. Spraying of all herbicides shall be done in accordance with the Chemical Spraying Program.
  - 1. Non-selective herbicide shall be Round-Up as manufactured by Monsanto or approved equal.
- B. A standard complete slow release fertilizer. At least 50% by weight of the nitrogen content of the fertilizer shall be derived from organic materials with the remainder in urea form or equivalent. Fertilizer shall contain percent nitrogen, phosphorous, and potash by weight of ingredients dictated by the topsoil test results.
  - 1. Fertilizer shall be in bags showing weight, analysis, and manufacturer's name.

2.7. PROTECTION MATERIALS

- A. Wood stakes, suitable in length so that 30" minimally is exposed above ground.
- B. Durable twine with fluorescent flagging.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that previously installed protection measures are in place.
- B. Verify that excavation and grading is complete.
- C. Do not begin planting and lawn work until all other work is complete. Planting areas shall be free of waste and debris generated by other construction activities.
- D. Beginning installation means acceptance of existing conditions.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees from damage caused by seeding operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Planting Pits:
  - 1. Verify by testing that planting areas are free draining. If planting areas are not free draining notify Owner / owner's representative and submit alternative method of drainage for approval.
  - 2. Stake out location of trees.
    - a. Completely layout planting areas before seeking approval by Landscape Architect and Owner / owner's representative.
  - 3. Planting pits in plant beds shall be excavated to the depth of the rootball and trees shall be planted on undisturbed soil.
    - a. Tree pit excavations shall be circular with vertical sides.
    - b. Install sand, as minimally required, to create a leveling bed under root balls of trees.
    - c. Install planting soil continuously at depths indicated on Drawings.
  - 4. Remove all existing materials from tree pits and scarify bottom and sides of planting pits and beds.
  - 5. If an impervious hard plan layer exists in the bottom of the pit after excavation, the pits shall be excavated to the depth of the hardpan or 36 inches below the bottom of the ball. Pit shall then receive a 6 inch layer of AASHTO 57 stone, covered with straw or similar material. Remainder of pit shall be backfilled with topsoil as specified.

### 3.3 PLANT INSTALLATION

- A. Planting:
  - 1. Do not plant until trees and planting pits have been approved by Owner's representative and Landscape Architect.
  - 2. Plant trees to a depth such that the bottom of the trunk flare is 1" above finished grade.
  - 3. Plant upright and plumb and faced to give the best appearance or relationship to adjacent plants and structures.
  - 4. Do not pull burlap out from under balls. Remove platforms, wire and surplus binding to the greatest extent possible. Remove burlap from the top and sides of the rootball to the greatest extent possible. Cleanly cut off all broken or frayed roots.
  - 6. Remove all non-biodegradable materials from the planting area.
  - 7. Carefully place planting soil in six (6) inch lifts to avoid injury to roots and to fill all voids. Firmly tamp each lift to prevent settlement.
  - 8. When the planting area is nearly filled, water and allow to soak away. If planting soil settles after watering, add more planting soil to bring to required level.
  - 9. Upon completion of planting operations, water plants thoroughly over the entire planting bed until fully saturated.
    - a. Apply water slowly to ensure penetration into the entire root system.
  - 10. Mulch within two (2) days of planting. Install two (2) inches of mulch over tree rootballs, and continuously over entire planting beds. Keep mulch at least 2 inches away from tree trunk.
  - 11. Staking and guying shall be done immediately after trees are planted. Trees shall stand plumb after staking.
    - a. Provide a minimum of two (2) stakes per tree.



12. Neatly prune trees to remove broken or badly bruised branches with a clean cut in accordance with NAA standards, and at the time designated by, and to the satisfaction of Owner / owner's representative.
  - a. Preserve the plant's natural character,
  - b. Perform pruning with clean, sharp tools.

### 3.4 PLANT MAINTENANCE PRIOR TO SUBSTANTIAL COMPLETION

- A. Begin maintenance immediately after each planting area is installed.
  1. Provide all care necessary to keep trees healthy including but not limited to: watering, mulching, weeding, fertilizing, pruning and spraying.
  2. During periods of inadequate rainfall, as determined by the Owner's representative / landscape architect, all plants shall be watered to maintain a constant suitable moisture level for good plant growth. Contractor shall provide all watering hoses and devices. Owner will provide water source.
  3. Weed control shall be by mechanical or hand weeding.
  4. Use of herbicides, insecticides, fungicides, nematicides, fumigants or other chemicals are only acceptable upon approval by the Owner / owner's representative.
- B. Prior to inspection for Substantial Completion remove all excess soil and debris from site and repair damage resulting from planting operations.

### 3.5 PLANT GUARANTEE / ESTABLISHMENT PERIOD

- A. The Establishment Period will begin upon notice of substantial completion by the Owner / owner's representative.
- B. Contractor shall guarantee the plants against defects including death and unsatisfactory growth. Guarantee shall include the purchase of the plants, the rental of any required special equipment necessary to place the plants and the installation of the plants. Contractor shall not be liable for vandalism out of Contractor's control.
- C. New plants installed during the Establishment Period shall carry a new establishment period guarantee equal to the original that begins at the time of acceptance of the replacements plant(s). Replacement and repair work shall be re-inspected by the Owner / owner's representative.
- D. At the end of the Plant Establishment Period, Owner / owner's representative shall make an inspection to determine that all plants are living and healthy. Any replacement of plants at this time shall be made according to the specifications for that type of plant. New plants installed as part of the original two-year guarantee, shall carry a new one-year guarantee period that begins at the time of acceptance of the replacement plant(s). Any replacement and repair work that is required shall be re-inspected by the Owner / owner's representative.

### 3.6 PLANT MAINTENANCE DURING ESTABLISHMENT PERIOD

- A. General: Perform procedures set forth in the submitted and approved maintenance program for the duration of Guarantee Period.
  1. Inspect all plants at least once a month to locate any disease or pest infestations. If infestation is present, submit a proposed method of control to Owner / owner's representative for approval prior to application of control measures.

2. Remove dead plants within five (5) business days of notification by Owner / owner's representative or the Owner will remove the plants and bill the Contractor accordingly.
  - a. Replacement plants may be installed during the next appropriate planting season.
  - b. Replacement plants shall be of the same species and size as specified in the Plant List unless determined otherwise by the Landscape Architect.
3. Perform all maintenance procedures, including but not limited to: fertilizing, watering, weeding, and mulching.
  - a. Prune, as necessary, to remove dead, diseased and damaged branches.
  - b. During periods of inadequate rainfall, all plants shall be watered to maintain a constant suitable moisture level for adequate plant growth. Apply water slowly so as to penetrate the entire root zone. Contractor shall provide water hoses. The Owner shall provide the water source.
  - c. Completely remove, by hand pulling, all weeds within mulch areas. Under no circumstances are weeds to attain more than two (2) inches of growth. Herbicide use is acceptable with Owner / owner's representative approval.
  - d. Restore mulch around trees as necessary to preserve their appearance and to control weed growth.
  - e. If re-fertilizing of trees is required, apply Ra-Pid-Gro at manufacturer's suggested rate.
  - f. If any tree settles from its proper elevation, raise it to the proper level.
  - g. If spraying to control insects, fungus, and other diseases is required seek approval from Owner / owner's representative before spraying. Furnish a spray program and product information on all sprays to be used to Owner / owner's representative for approval. After approval, application will only be permitted by licensed applicators. Applicators shall follow Notification requirements and report any Chemical Hypersensitivity Registries for the area.

### 3.7 FINAL ACCEPTANCE

- A. At end of Establishment Period, submit a written request to the Owner / owner's representative for Inspection for Final Acceptance at least two (2) weeks prior to the day on which inspection is requested.
- B. At the end of the Establishment Period, Owner / owner's representative and Contractor shall make an inspection to determine that all plants are living and healthy. Any plant that is dead or not in satisfactory condition, as determined by the Owner / owner's representative, shall be removed from the site and replaced in accordance with the specifications.

END OF SECTION 32 93 00

SECTION 33 14 16

SITE WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section includes water-distribution piping and related appurtenances for site work to be picked up by the general site contractor 5' from the face of all buildings.
- B. All work shall conform to the requirements of Philadelphia Water, Philadelphia Fire Marshall, and any other regulatory authorities having jurisdiction.
- C. All water main work and water service connections under this contract shall be governed by and done in accordance with the most recent revision or amendment to the Standard Specifications and Standard Details of the Philadelphia Water Department.
- D. All work on water service connections shall be done by, or under the direction of, a licensed Master Plumber.
- E. Section Includes:
  - 1. Pipe and fittings for Site water line, including domestic water line and fire water line.
  - 2. Tapping sleeves and valves.
  - 3. Valves and boxes.
  - 4. Fire hydrants and yard hydrants.
  - 5. Reduced-pressure backflow preventers.
  - 6. Pipe support systems.
  - 7. Bedding and cover materials.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Requirements:
  - 1. Section 033053 – Site Cast-in-Place Concrete: Concrete for thrust restraints.
  - 2. Section 310000 – Earthwork.
  - 3. Section 312316.13 – Trenching: Execution requirements for trenching.
  - 4. Section 331419 – Valves and Hydrants for Water Utility Service.

1.3 REFERENCES

- A. Philadelphia Water Department (PWD)
  - 1. Standard Details
  - 2. Standard Specifications
- B. Factory Mutual (FM)

1. Approval Guide
- C. Underwriters Laboratories (UL)
  1. Fire Protection Equipment Directory
  2. UL 1285 - Pipe and Couplings, Polyvinyl Chloride (PVC), for Underground Fire Service
  3. UL 262 - Gate Valves for Fire-Protection Service
  4. UL 246 - Hydrants for Fire-Protection Service
- D. National Sanitation Foundation (NSF)
  1. NSF 14 - Plastics Piping System Components and Related Materials
  2. NSF 61 - Drinking Water System Components - Health Effects
- E. National Fire Protection Association (NFPA)
  1. NFPA 70 - National Electrical Code
  2. NFPA 24 - Hydraulic Fluid Power Systems - Methods to Improve Sealing Reliability (new standard)
  3. NFPA 1963 - Screw Threads and Gaskets for Fire Hose Connections (revision of ANSI/NFPA 1963-1993)
- F. American Water Works Association (AWWA)
  1. C151 Ductile-Iron Pipe, Centrifugally Cast, for Water (revision of ANSI/AWWA C151/A21.51-91)
  2. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
  3. C150 - Thickness Design of Ductile-Iron Pipe
  4. C110 - Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in (75 mm through 1200 mm), for Water and Other Liquids
  5. C153 - Ductile-Iron Compact Fittings, 3 in. through 24 in. (76 mm Through 610 mm) and 54 in. through 64 in. (1,400 mm Through 1,600 mm), for Water Service
  6. C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 Inch through 12 Inch for Water Distribution
  7. C500 - Gate Valves for Water and Sewage Systems
  8. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
  9. C550 - Protective Epoxy Interior Coatings for Valves and Hydrants
  10. C509 - Resilient-Seated Gate Valves for Water Supply Service
  11. C800 - Underground Service Line Valves and Fittings
  12. C702 - Cold Water Meters - Compound Type
  13. C502 - Hydrants, Dry Barrel Fire
  14. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances
  15. C605 - Water Treatment - Underground Installation of Polyvinyl Chloride PVC Pressure Pipe and Fittings for Water
  16. C651 - Disinfecting Water Mains
- G. American Society for Testing and Materials (ASTM)
  1. B88 - Standard Specification for Seamless Copper Water Tube
  2. B813 - Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube
  3. B32 - Standard Specification for Solder Metal
  4. D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
  5. D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

6. F645 - Standard Guide for Selection, Design, and Installation of Thermoplastic Water Pressure Piping Systems

H. American Society of Mechanical Engineers (ASME)

1. B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings R(1994)
2. B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

I. Manufacturer's Standardization Society (MSS)

1.4 SUBMITTALS

A. Product Data for the following:

1. Valves, Corporation Stops, Curb Boxes, Curb Stops, Valve Boxes
2. Backflow preventers and assemblies, including enclosure
3. Meter Pits
4. Fire Hydrants

B. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data for the following:

1. Valves;
2. Backflow preventers;
3. Protective enclosures; and,

1.5 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of the regulatory authorities having jurisdiction; including tapping of water mains, backflow prevention, installation, testing, and disinfection. Comply with standards of the regulatory authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: UL listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to the regulatory authorities having jurisdiction and marked for intended use.

D. Comply with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

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

F. NSF Compliance: Comply with NSF 14 for plastic potable-water-service piping. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

G. Suppliers of materials must be pre-qualified in accordance with Water Department Quality Certification Standards QC-1 for Precast Concrete Products, QC-2 for Gray/Ductile Iron

Castings, QC-3 for Ready-Mixed Concrete, QC-4 for Welded Steel Inlet Frames and Grates, QC-5 for Standard Pressure Fire Hydrants, QC-6 for Reinforced Concrete Pipe, QC-7 for Filter Media Products, QC-8 for Ductile Iron Pipe and Fittings, QC-9 for Vitrified Clay Pipe and Fittings, QC-10 for Standard Pressure Gate valves (3" to 12") & (16" & Larger), QC-11 for Standard Pressure Butterfly Valves (3" to 20") & (24" & Larger), QC-12 for Resilient-Seated Gates Valves (3" to 12" Dia. & 16" Dia. to 48"), and QC-13 for Thermoplastic Pipe and Fittings.

## 1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify the engineer and the Owner not less than 2 days in advance of proposed utility interruptions; and,
  - 2. Do not proceed with utility interruptions without written permission from the engineer or the Owner.

## 1.7 COORDINATION & FEES

- A. The Contractor shall be responsible for obtaining and payment of all tap and construction permit fees associated with this section.
- B. The Contractor shall install water lines and appurtenances as shown on the drawings. Including, but not limited to, any taps, vault, and backflow prevention. The Contractor shall install plugging and marking apparatus as necessary to protect his work. Water meters are furnished and installed by the Philadelphia Water Department. The cost is covered in the fee charged for a water permit. Contractor is to coordinate with Philadelphia Water for meter installation.

## PART 2 - PRODUCTS

### 2.1 PIPE AND FITTINGS, APPLICATION

- A. Ductile-Iron Pipe
  - 1. Ductile iron pipe shall conform to the requirements of AWWA C151, class 350, and shall have a cement-mortar lining of standard thickness in accordance with AWWA C104; pipe thickness shall be in accordance with AWWA C150; pipe shall have push-on joints in accordance with AWWA C110. Additional fittings shall be mechanical-joint ductile-iron compact fittings in accordance with AWWA C153 or standard size in accordance with AWWA C110.
  - 2. Cast into, stamp or paint on each pipe: the manufacturer's mark; casting number; year of cast; "DI"; class of pipe. Markings shall be clear and legible.
- B. Copper Tubing
  - 1. Comply with ASTM B88.
  - 2. Type: K, annealed.
  - 3. Fitting: Cast copper; ASME B16.18
  - 4. Joints: Compression connection.

## 2.2 VALVES

### A. Cast-Iron, Gate Valves:

1. Nonrising-Stem, Metal-Seated Gate Valves: AWWA C500, UL 262, FM-approved, gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
  - a. Minimum Working Pressure: 200 psi (1380 kPa).
  - b. End Connections: Mechanical joint, per (AWWA C 111).
  - c. Interior Coating: Complying with AWWA C550.
  - d. Nut: 2 inches square, complying with AWWA C500.
2. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, UL 262, FM-approved, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
  - a. Minimum Working Pressure: 200 psig (1380 kPa).
  - b. End Connections: Mechanical joint, per ANSI A21.11 (AWWA C111).
  - c. Interior Coating: Complying with AWWA C550.
  - d. Nut: 2-inch square, complying with AWWA C500.

B. Tapping-Sleeve Assemblies: Conform to the requirements of MSS SP-60. Tapping sleeves may be cast-iron, ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection.

C. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, lid with lettering "WATER," bottom section with base of size to fit over valve, and approximately 5-inch diameter barrel.

D. Operating Wrenches: Steel tee-handle, stem of length to operate deepest buried valve, and 2-inch square socket matching valve operating nut, placed in sprinkler room.

## 2.3 WATER SERVICE CONNECTIONS

A. Service-Saddle Assemblies: Comply with AWWA C800.

B. Corporation Valve: Comply with AWWA C800, bronze body, threaded inlet and outlet matching service piping material.

C. Buffalo type curb boxes or approved equal

D. Curb Stops: Comply with AWWA C800, bronze body, with inlet and outlet matching service piping material.

E. Copper service pipe in accordance with ASTM B 88, Type K, annealed (temper O50 or O60).

## 2.4 METER PIT

A. Meter pits and accessories shall be tested and registered with the quality certification staff in accordance with the quality certification standard QC-1 for precast concrete products.

B. Meter pit shall be designed for H-20 loading.

- C. All precast segments shall be keyed and their joints watertight.
- D. Precast Concrete Meter Pit:
  - 1. Precast manufacturers shall be certified in accordance with QC-1 by the Department Quality Certification Staff.
  - 2. Concrete shall consist of Portland Cement which conforms to ASTM C150 and aggregates which conform to C33. The minimum compressive strength shall be 4,000 psi.
  - 3. Reinforcing steel shall conform to ASTM A615 grade 60 for bars or ASTM A185 for welded wire fabric.

2.5 BACKFLOW-PREVENTION DEVICES

- A. Comply with regulatory authorities having jurisdiction requirements and as shown on the Drawings.
- B. Enclosure:
  - 1. Provide manufactured backflow prevention assembly enclosure meeting the requirements of the backflow preventer and ASSE 1060.
  - 2. Enclosure shall be installed on a Concrete Pad meeting the manufacturer's instructions and meeting the requirements of Section 321600, Concrete Curbs, Sidewalks, and Pavement.

2.6 FIRE HYDRANTS

- A. Manufacturer:
  - 1. Furnish center compression locks manufactured by the Center Compression Lock Co. Inc., PO Box 3609, 2502 Edgemont Street, Philadelphia, PA 19125, (215) 739-1727, or approved equal.
  - 2. Furnish materials according to City of Philadelphia standards.
- B. Furnish standard pressure fire hydrant in accordance with Philadelphia Standard Specification W-14 for furnishing Philadelphia Standard Fire Hydrants and the Philadelphia Standard Details for Water Mains. Furnish retainer glands for all joints.
- C. The bonnets of hydrants shall be color coded as follows:

<u>Main Size</u>	<u>Hydrant Bonnet Color</u>
6" - 8"	Orange
10" - 12"	Green
16" & Larger	Red

- D. The hydrant bonnets shall be painted with Rust-Oleum 7600 series of VOC industrial enamels. The following is a list of Rust-Oleum's color name and number for each color:

<u>Color</u>	<u>Rust-Oleum Color Name</u>	<u>Number</u>
Orange	Equipment Orange	7656
Green	Safety Green	7633
Red	Fire Hydrant Red	7665



## PART 3 - EXECUTION

### 3.1 TRENCHING

- A. Comply with requirements of Section 312316.13, Trenching.

### 3.2 VALVES

- A. General Application: Use mechanical joint valves for NPS 2-inch and larger underground installation. Use threaded or flanged-end valves for installation in vaults.
- B. Set Valve boxes to grade, true and plumb with valve operating nut centered in box.

### 3.3 PIPE AND FITTING INSTALLATION

- A. Water-Main Connection: Verify with regulatory authorities having jurisdiction that size of tap and location shown on drawings is acceptable. Make tap conforming to requirements of regulatory authorities having jurisdiction and Manufacturers Standardization Society (MSS) standards.
- B. Install each service pipe with the material specified, or as directed by the Project Manager.
- C. Comply with NFPA 24 for fire-service-main piping materials and installation.
- D. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- E. All piping shall be installed with a minimum of 4 feet of cover, or 12 inches below level of max frost penetration, or as required by regulatory authorities having jurisdiction, whichever is deeper. If pipe is installed in a cut section prior to completion of grading operations, pipe shall be installed so that minimum required cover will exist upon completion of grading operations.
- F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- G. Pipe Bedding: Pipe bedding material shall be installed if required by regulatory authorities having jurisdiction water authority or engineer. No pipe shall be laid resting on a rock, blocking or unyielding objects.
- H. Location with Sewers: Separate trenches shall be provided for water lines and sewer lines, with lines separated by a minimum of 10 feet horizontally. Water mains that cross sewers shall have a minimum vertical separation of 18 inches).
- I. Tap water main for installation of ferrule. Use a single piece of service pipe between ferrule or swing joint and curb stop. Connect new service to water distribution pipe. Where adapter is required between curb stop and water distribution pipe, length of adapter may not exceed two feet without written approval from Project Manager for each such connection.

### 3.4 ANCHORAGE INSTALLATION

- A. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - 1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600;
  - 2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23;
  - 3. Fire-Service-Main Piping: According to NFPA 24; and,
  - 4. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

### 3.5 BACKFLOW-PREVENTER INSTALLATION

- A. Comply with regulatory authorities having jurisdiction, including water authority requirements.
- B. Do not install bypass piping around backflow preventers.

### 3.6 QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests:
  - 1. The Contractor shall test all pipelines and appurtenances with water at test pressure of 150 psi or 1.5 times working pressure, whichever is greater. Test pressure must be maintained for at least 2 hours. All leakage apparent after testing must be repaired immediately. a. The work will not be finally accepted until leakage shall prove to be less than 10 gallons per 24 hours per mile of pipe at test pressure; and,
  - 2. Fire Water System tests shall be in full conformity with the requirements of all applicable codes, NFPA standards, and other authorities having jurisdiction.
    - a. All new underground mains and lead-ins shall be flushed thoroughly before connection is made to internal system piping. The site utility subcontractor shall be responsible for disposal of the test water drained from the test outlets.
    - b. The trench shall be backfilled between joints before testing to prevent movement of pipe.
    - c. Test shall be made by the site utility subcontractor in the presence of the regulatory authority having jurisdiction and/or the Owner's representative.
    - d. The site utility subcontractor shall prepare reports of testing activities and submit 2 copies to the General Contractor.

### 3.7 IDENTIFICATION

- A. Install continuous underground detectable warning tape in accordance with Section 312000 – Earth Moving, or a 14-gauge solid copper tracer wire prior to backfilling of trench for underground PVC water-service piping. Locate below finished grade, directly over piping.

3.8 CLEANING

- A. Clean and disinfect water-distribution piping as follows:
1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use;
  2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet;
  3. Use purging and disinfecting procedure prescribed by regulatory authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or as described below; and,
    - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
    - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination
  4. The site utility subcontractor shall prepare reports of purging and disinfecting activities and submit 2 copies to the General Contractor.

END OF SECTION 331416

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SECTION 33 31 00

SANITARY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Sanitary sewerage piping.
  - 2. Bedding and cover materials.
- B. Related Requirements:
  - 1. Section 310000 - Earthwork.
  - 2. Section 312316.13 - Trenching: Requirements for trenching as required by this Section.
  - 3. Section 330561 - Concrete Manholes: Manholes for sanitary sewerage piping.

1.2 DEFINITIONS

- A. Bedding: Fill placed under, beside, and directly over pipe, prior to subsequent backfill operations.

1.3 REFERENCE STANDARDS

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. American Water Works Association:
  - 1. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
  - 2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
  - 3. AWWA C110 - Ductile-Iron and Gray-Iron Fittings.
  - 4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
  - 6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
  - 7. AWWA C153 - Ductile-Iron Compact Fittings.
- C. ASTM International:
  - 1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
  - 2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  - 3. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
  - 4. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
  - 5. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.

6. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>).
7. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

#### 1.4 COORDINATION

- A. Coordinate Work of this Section with termination of sanitary sewer connection outside building, connection to municipal sewer utility service, and trenching.

#### 1.5 PREINSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing Work of this Section.

#### 1.6 SUBMITTALS

- A. Product Data: Submit manufacturer information indicating pipe material to be used and pipe accessories.
- B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- C. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- D. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- E. Qualifications Statement:
  1. Submit qualifications for manufacturer and installer.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record finished locations of pipe runs, connections, manholes, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

#### 1.8 QUALITY ASSURANCE

- A. Perform Work according to City of Philadelphia standards.
- B. Maintain one copy of each standard affecting Work of this Section on Site.

#### 1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

- B. Installer: Company specializing in performing Work of this Section with minimum three years' documented experience and approved by manufacturer.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Storage:
  - 1. Store materials according to manufacturer instructions.
  - 2. Store valves in shipping containers with labeling in place.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Block individual and stockpiled pipe lengths to prevent moving.
  - 3. Provide additional protection according to manufacturer instructions.

#### 1.11 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

### PART 2 - PRODUCTS

#### 2.1 SANITARY SEWERAGE PIPING

- A. Ductile-Iron Pipe:
  - 1. Comply with AWWA C151.
  - 2. Minimum Special Thickness Class: 56 for pipes 12" in diameter and smaller and 54 for pipe larger than 12" in diameter.
  - 3. End Connections: Bell and spigot.
  - 4. Outside Coating:
    - a. Type: Asphaltic.
    - b. Minimum Uniform Thickness: 1/8 inch for pipe sizes 3 inches in diameter to 12 inches in diameter, inclusive.
    - c. Comply with AWWA C151.
  - 5. Lining:
    - a. Type: Asphaltic sealcoat.
    - b. Minimum Uniform Thickness: 1/8 inch for pipe sizes 3 inches in diameter to 12 inches in diameter, inclusive.
    - c. Comply with AWWA C104.
  - 6. PE Encasement: Comply with AWWA C105.
  - 7. Fittings:
    - a. Material: Ductile iron, Class 56 or greater.
    - b. Comply with AWWA C153.

- c. Lining: Cement-mortar lined according to AWWA C104.
- 8. Joints:
  - a. Rubber gasket joint devices.
  - b. Comply with AWWA C111.

## 2.2 MANHOLES

- A. As specified in Section 330561 - Concrete Manholes.

## 2.3 MATERIALS

- A. Bedding and Cover:
  - 1. Bedding: Course aggregate, Type C or better, in accordance with PennDOT Publication 408, Section 703.2.
  - 2. Cover: Course aggregate, Type C or better, in accordance with PennDOT Publication 408, Section 703.2.
  - 3. Soil Backfill from Above Pipe to Finish Grade:
    - a. On-Site Fill, as specified in Section 310000 - Earthwork.
    - b. Subsoil with no rocks more than 6 inches in diameter, frozen earth, or foreign matter.

## 2.4 MIXES

- A. Grout: As specified in PennDOT Publication 408, Section 1001.2(d).

## 2.5 ACCESSORIES

- A. Detectable Underground Tape
  - 1. Detectable Warning Tape shall be six inches wide (6”), 5-mil thickness, with aluminum foil core. Tape shall be printed with an appropriate legend (“Caution: Buried Sanitary Sewer Below” or as approved) and shall conform to the color standards of the APWA for buried utilities (green for sewer).

## 2.6 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of pipe.
- B. Certificate of Compliance:
  - 1. If manufacturer is approved by authorities having jurisdiction, submit certificate of compliance indicating Work performed at manufacturer's facility conforms to Contract Documents.
  - 2. Specified shop tests are not required for Work performed by approved manufacturer.



## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that trench cut is ready to receive Work of this Section.
- B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

### 3.2 PREPARATION

- A. Correct over-excavation with coarse aggregate.
- B. Remove large stones or other hard materials that could damage pipe or impede consistent backfilling or compaction.
- C. Protect and support existing sewer lines, utilities, and appurtenances.
- D. Utilities:
  - 1. Maintain profiles of utilities.
  - 2. Coordinate with other utilities to eliminate interference.
  - 3. Notify Architect/Engineer if crossing conflicts occur.

### 3.3 INSTALLATION

- A. Bedding:
  - 1. Excavate pipe trench as specified in Section 312316.13 - Trenching.
  - 2. Place bedding material at trench bottom.
  - 3. Level materials in continuous layer not exceeding 6 inches.
  - 4. Maintain optimum moisture content of bedding material to attain required compaction density.
- B. Piping:
  - 1. Install pipe, fittings, and accessories according to ASTM D2321, and seal joints watertight.
  - 2. Lay pipe to slope gradients as indicated on Drawings.
  - 3. Begin at downstream end of system and progress upstream.
  - 4. Bedding: Install at sides and over top of pipe, to minimum compacted thickness of 12 inches.
  - 5. Lay bell-and-spigot pipe with bells upstream.
  - 6. Backfill and compact as specified in Section 312316.13 - Trenching.
  - 7. Do not displace or damage pipe when compacting.
  - 8. Connect to building sanitary sewer outlet and municipal sewer system.
  - 9. Pipe Markers:
    - a. Continuous buried 6 inches below finish grade, above piping.
    - b. If multiple pipes occur in common trench, locate tape above centerline of trench.
    - c. Coordinate with trench Work as specified in Section 312316.13 - Trenching.

10. Install Site sanitary sewage system piping to within 5 feet of building, and connect to building sanitary waste system as specified in Section 221300 - Facility Sanitary Sewerage.

C. Manholes: As specified in Section 330561 - Concrete Manholes.

D. Backfilling:

1. Backfill around sides and to top of pipe with cover fill in minimum lifts of 6 inches.
2. Tamp fill in place, and compact to 95 percent of maximum density.
3. Place and compact material immediately adjacent to pipes to avoid damage to pipe and prevent pipe misalignment.
4. Maintain optimum moisture content of bedding material as required to attain specified compaction density.

### 3.4 TOLERANCES

A. Maximum Variation from Indicated Slope: 1/8 inch in 10 feet.

### 3.5 FIELD QUALITY CONTROL

A. Request inspection by Architect/Engineer prior to and immediately after placing bedding.

B. Testing:

1. If tests indicate that Work does not meet specified requirements, remove Work, replace, and retest.
2. Perform testing on Site sanitary sewage system according to local code and City of Philadelphia standards.
3. Compaction Testing:
  - a. Comply with ASTM D1557.

### 3.6 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

B. Cap open ends of piping during periods of Work stoppage.

END OF DOCUMENT 333100

SECTION 33 40 09

CONNECTIONS TO EXISTING STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY OF WORK

- A. The Work described in this Section shall include all materials, labor, equipment and incidentals required to make connections to structures from stormwater conduit piping as shown on the drawings. All orifice, underdrain, distribution, or other piping that connects to a structure shall have the connection constructed per these Specifications.

1.2 REFERENCES

- A. ASTM C 109, Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50 mm Cube Specimens).
- B. ASTM D 638, Test Method for Tensile Properties of Plastics.
- C. ASTM D 695, Test Method for Compressive Properties of Rigid Plastics.

1.3 SUBMITTALS

- A. Before starting this work, submit for approval of Owner/Authorized Representative, manufacturer's literature describing Epoxy Mortar Gel and Epoxy Bonding Agent. Literature must address each requirement (e.g. Compressive Strength per ASTM C109) as specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. The following products are acceptable as Epoxy Mortar Gel, provided they continue to meet all requirements:
  - 1. Meta Bond HM Gel, as manufactured by American Meta Seal Company, 509 Washington Avenue, Carlstadt, NJ 07072.
  - 2. Sikadur 31 Hi-Mod Gel, as manufactured by Sika Corporation, Box 297, Lyndhurst, NJ 07071.
  - 3. Thermal-Chem Mortar Resin Gel (Product No. 304), as manufactured by Thermal-Chem, Inc., 1400 Louis Avenue, Elk Grove, IL 60007.
  - 4. Approved equivalent product.
- B. The following products are acceptable as Epoxy Bonding Agent, provided they continue to meet all requirements:
  - 1. Meta Bond HM, or Meta Bond HM Gel, as manufactured by American Meta Seal Company.
  - 2. Sikastix 370, Sikadur Hi-Mod, or Sikadur 31 Hi-Mod Gel, as manufactured by Sika Corporation.

3. Thermal-Chem Mortar Resin (Product No. 3), or Thermal-Chem Mortar Resin Gel (Product No. 34), as manufactured by Thermal-Chem, Inc.
4. Approved equivalent product.

## 2.2 MATERIALS

- A. Epoxy Mortar Gel shall:
  1. Be a 100% solids formulation.
  2. Have a Tensile Strength per ASTM D 638 not less than 3000 psi after 7 days at 73°F.
  3. Have a Tensile Elongation per ASTM D 638 not over 7%.
  4. Have a Compressive Strength per ASTM D 695 not less than 3000 psi after 24 hours at 73 degrees F, and not less than 6000 psi after 7 days at 73 degrees F.
- B. Sand shall:
  1. Be oven-dry silica sand.
  2. Have at least 70% by weight pass #20 sieve.
  3. Have not over 35% by weight pass #40 sieve.
- C. Epoxy Bonding Agent shall meet the requirements for Epoxy Mortar Gel.

## 2.3 MIXES

- A. Epoxy Mortar shall consist of Epoxy Mortar Gel and Sand mixed at a 1:1 ratio by loose volume.

## PART 3 - EXECUTION

### 3.1 MAKING CONNECTION

- A. Make hole(s) in existing structure as necessary to permit connection. Core through existing concrete structures and cut reinforcing as necessary. Remove all dirt, laitance, and other loose or undesirable material from mating surfaces. Check hole(s) for fit.
- B. Comply fully with manufacturer's instructions. Coat mating surfaces with Epoxy Bonding Agent and set pipe. Seal all openings with Epoxy Mortar. Support pipe securely to prevent movement and protect for at least 24 hours.

END OF SECTION 334009

SECTION 33 42 00

STORMWATER CONVEYANCE

PART 1 - GENERAL

1.1 SUMMARY OF WORK

A. Section Includes:

1. Stormwater drainage piping.
2. Inlets and catch basins.
3. Cleanouts
4. Bedding and cover materials.

B. Related Requirements:

1. Section 310000 – Earthwork.
2. Section 315000 – Excavation Support and Protection
3. Section 334600 – Stormwater Management.
4. Section 334616 – Outlet Structures for Stormwater Ponds.

1.2 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials (AASHTO)

1. AASHTO M252 - Standard Specification for Corrugated Polyethylene Pipe (4-in to 10-in)
2. AASHTO M294 - Standard Specification for Corrugated Polyethylene Pipe (12-in to 36-in)

B. American Society for Testing and Materials (ASTM)

1. ASTM A746 - Standard Specification for Ductile Iron Gravity Sewer Pipe.
2. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
3. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>).
4. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>).
5. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Application.
6. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
7. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
8. ASTM F477 – Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
9. ASTM F667/F667M - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.

C. American Water Works Association (AWWA)

1. AWWA C150-08 – Thickness Design of Ductile-Iron pipe.
2. AWWA C151-09 – Ductile-Iron Pipe, centrifugally cast.

3. AWWA C111/A21.11-17 – Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
  - D. Philadelphia Water Department Quality Certification Standards (QC)
    1. QC-2 Standards for Gray/Ductile Iron Castings
    2. QC-13 Standards for Thermoplastic Pipe and Fittings
  - E. Commonwealth of Pennsylvania, Department of Transportation Specifications, Publication 408 (most recent edition).
    1. Bulletin 15, General Index of Approved Product Suppliers.
    2. Section 735 – Geotextiles
  - F. Where reference is made to one of the above standards the revision in effect at the time of bid opening shall apply.
- 1.3 COORDINATION
- A. Coordinate Work of this Section with termination of storm sewer connection outside building, trenching, connection to foundation drainage system, and municipal sewer utility service.
- 1.4 SUBMITTALS
- A. Product Data: Submit manufacturer information describing pipe, pipe accessories, manholes, inlets, catch basins and cleanouts.
  - B. Submit shop drawings showing details of pipe, fittings, joints and construction methods.
  - C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
  - D. Manufacturer Instructions: Submit special procedures required to install specified products.
  - E. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
  - F. Qualifications Statement:
    1. Submit qualifications for manufacturer
- 1.5 CLOSEOUT SUBMITTALS
- A. Project Record Documents: Record actual locations of pipe runs, connections, catch basins, inlets, cleanouts, and invert elevations.
  - B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.
- 1.6 QUALITY ASSURANCE
- A. HDPE pipe shall be furnished by a manufacturer / facility that is certified by the National Transportation Product Evaluation Program (NTPEP). The pipe shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with this Section.

- B. PP pipe shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the HDPE/PP pipe. The pipe shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with this Section.
- C. All gray iron pipe shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacture of the gray iron pipe. The pipe shall be designed, constructed, and installed in accordance with the best practices and methods and shall comply with this Section.
- D. All pipe, fittings, cleanout covers, domed riser covers, and other products shall be installed to ensure a minimum loading capacity in accordance with H-20 loading, as required by Philadelphia Department of Streets. Any deviation from manufacturer's specifications for product installation (without approval by manufacturer or signed and sealed statement of adequacy by Professional Engineer) is prohibited.
- E. Maintain one (1) copy of each standard affecting Work of this Section on Site.

#### 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' documented experience.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Store materials according to manufacturer instructions.
- C. Protection:
  - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
  - 2. Provide additional protection according to manufacturer instructions.

#### 1.9 EXISTING CONDITIONS

- A. Field Measurements:
  - 1. Verify field measurements prior to fabrication.
  - 2. Indicate field measurements on Shop Drawings.

### PART 2 - PRODUCTS

#### 2.1 CORRUGATED PE PIPING

- A. Pipe:
  - 1. Comply with ASTM F405.
    - a. Type: Smooth interior.
    - b. Inside Nominal Diameter: As Shown on the Drawings.
- B. Fittings: PE.
- C. Joints: Comply with ASTM F405.

2.2 GRAY (CAST) IRON DRAINAGE PIPE AND FITTINGS

A. Pipe:

1. Comply with ASTM A74.
2. Type: Service.
3. Inside Nominal Diameter: As Shown on the Drawings.

B. Fittings: Gray Iron

C. Joints:

1. Comply with ASTM A74.
2. Joint Devices: Rubber gasket.

2.3 RUBBER SADDLES

1. Rubber Saddles for Lateral Connections to RC Pipe Sewers shall be manufactured from a blend of rubber that is laboratory tested and appropriate for sewer applications
2. Pipe clamps and expansion rings shall be Type 304 Stainless Steel.
3. Rubber Saddles shall provide a watertight connection and be compatible with ASTM C-923.

2.4 CATCH BASINS AND INLETS

A. Catch Basin:

1. Polyvinyl Chloride (PVC) Catch Basin.
2. Provide catch basin manufactured by Nyloplast and as shown on the contract drawings.
3. PVC Riser section, as needed, manufactured by Nyloplast.

B. Inlet Frames:

1. Ductile Iron meeting ASTM A536, Grade 70-50-05
2. Manufactured by Nyloplast and as shown on the contract drawings.

C. Road and Highway Grates:

1. Ductile Iron meeting ASTM A536, Grade 70-50-05
2. Locking
3. Meeting H-20 Load Rating
4. Manufactured by Nyloplast and as shown on the contract drawings.

2.5 INLET TRAP/INLET HOOD

1. Nyloplast EnviroHood meeting the size of the size of the catch basin as shown on the contract drawings.

2.6 CLEANOUTS

A. Shaft and Top Section:

1. Material: Same material as horizontal pipe section.
2. Joints: Lipped male/female.
3. Nominal Shaft Diameter: Same as horizontal pipe section, 6 inches maximum.
4. Top Section: Concentric cone.



B. Cleanout Lids and Frames:

1. Materials: Cast iron.
2. Lid:
  - a. Hinged
  - b. Lockable
  - c. Design: Stamped "CLEANOUT"
3. Nominal Lid and Frame Size: 6 inch diameter.

C. Base Pad:

1. Material: Cast-in-Place concrete as specified in Section 033053 – Site Cast-in-Place Concrete.

2.7 DETECTABLE UNDERGROUND TAPE

- A. Detectable Warning Tape shall be six inches wide (6"), 5-mil thickness, with aluminum foil core. Tape shall be printed with an appropriate legend ("Caution: Buried Storm Sewer Below" or as approved) and shall conform to the color standards of the APWA for buried utilities (green for sewer).

PART 3 - EXECUTION

3.1 CONSTRUCTION CERTIFICATION FORM

- A. The contractor will be required to fill out and complete the Philadelphia Water Department SMP Construction Certification Form, as part of the Construction Certification Package (CCP). The contractor will be required to make, record, and document all measurements, required photos, and provide required documents, reports, and certifications outlined in the CCP.
- B. The CCP shall be completed and signed by one of the following:
1. Professional Engineer
  2. Registered Architect
  3. Landscape Architect
  4. Professional Land Surveyor
  5. Professional Geologist
  6. Licensed Contractor
- C. The contractor shall contact the project's assigned PWD Inspector at least three (3) days prior to the start of construction of any SMP, including excavation and soil testing, if applicable. The SMP installation must be observed by the PWD inspector.
- D. Provide the PWD Inspector an estimated schedule for placement of any of the following:
1. Piping
  2. Soil
  3. Other SMP-related devices or appurtenances.

3.2 EXAMINATION

- A. Verify that trench cut is ready to receive Work of this Section.

- B. Verify that excavations, dimensions, and elevations are as indicated on the Drawings.

### 3.3 PREPARATION

- A. Correct over-excavation with coarse aggregate.
- B. Remove large stones and other hard matter that could damage piping or impede consistent backfilling or compaction.

### 3.4 INSTALLATION OF PIPE

- A. Excavate trench to 12 inches below pipe invert, and as specified in Section 315000 – Excavation Support and Protection.
- B. Hand trim excavation for accurate placement of piping to indicated elevations.
- C. No single piece of pipe shall be laid unless it is straight. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than one-sixteenth of an inch (1/16”) per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site.
- D. All pipe shall be examined before laying and no piece shall be installed which is found to be defective.
- E. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required. HDPE pipe and fittings shall be installed in accordance with ASTM D2321 and the requirements of the manufacturer (see “Corrugated HDPE Pipe Installation Guide” from ADS), or as otherwise provided herein or on the Drawings.
- F. After the excavation is complete to normal grade of the bottom of the trench and bottom preparation according to the Drawings and Specifications is completed, crushed stone bedding shall be placed, compacted and graded to provide firm, uniform and continuous support for the pipe. The pipe shall be laid accurately to the lines and grades indicated on the Drawings. Blocking under the pipe will not be permitted. Bedding shall be placed evenly on each side of the pipe to mid diameter and hand tools shall be used to force the bedding where needed to give firm continuous support for the pipe. AASHTO #57 aggregate shall then be placed to twelve inches (12”) above the top of the pipe. Detectable underground utility marking tape shall be installed over all pipe not otherwise marked. The initial three feet (3’) of backfill above the bedding shall be placed in one-foot (1’) layers and carefully compacted. Generally the compaction shall be done evenly on each side of the pipe and compaction equipment shall not be operated directly over the pipe until sufficient backfill has been placed to ensure that such compaction equipment will not have a damaging effect on the pipe. Equipment used in compacting the initial three feet (3’) of backfill shall be approved by the pipe manufacturer's representative prior to use.
- G. All piping shall be sound and clean before installation. When installation is not in progress for any length of time, the open ends of the pipe shall be closed by watertight plug or other approved means. Good alignment shall be preserved during installation. The deflection at joints shall not exceed that recommended by manufacturer.

- H. Before any joint is made, the pipe shall be checked to assure that a close joint with the next adjoining pipe has been maintained and that the inverts are matched and conform to the required grade. The pipe shall not be driven down to grade by striking it.
- I. Precautions shall be taken to prevent flotation of the pipe in the trench.
- J. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below the top of the pipe. As trench boxes, moveable sheeting, shoring or plates are moved, crushed stone shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.
- K. The use of ninety-degree (90°) bend pipe fittings is not permitted in the installation of piping. The Contractor shall use minimum-angle fittings to construct the pipe layout diagrammatically shown in the Drawings. The maximum fitting angle approved for use is forty-five-degrees (45°), and fittings of lesser angles (22½° or 11¼°) are preferred for use where practical.

### 3.5 BACKFILLING AND COMPACTING PIPES

- A. Do not place backfill around any structure requiring time to gain strength (e.g., masonry or concrete), until so directed by Owner/Authorized Representative.
- B. Place Ordinary Backfill up to three feet (3') below subgrade elevation in all sewer trenches and sewer manholes to be abandoned. Place Select Backfill Material-2RC for three feet (3') below subgrade elevation in all sewer trenches and sewer manholes to be abandoned.
- C. Compact backfill around and to a depth of six inches (6") over pipes and fittings by hand tamping. Compact all other backfill in eight-inch (8") layers by mechanical tamping. Puddling is prohibited.
- D. When backfill has been placed to three feet (3') below street surface or finish grade, cut off and remove sheathing and shoring (including soldier beams) two feet (2') below street surface or finish grade. All sheathing and shoring shall be removed in its entirety from excavations for infiltration facilities (tree trenches, basins, etc.).

### 3.6 INSTALLATION OF INLETS AND CATCH BASINS

- A. Install inlet in accordance with PennDOT Publication 408, Section 605.3.

### 3.7 TOLERANCES

- A. Maximum Variation from Indicated Pipe Slope: 1/8 inch 10 feet.

### 3.8 FIELD QUALITY CONTROL

- A. Request inspection by Engineer prior to and immediately after placing aggregate cover over pipe.
- B. If inspection indicates that Work does not meet specified requirements, remove Work and replace at no additional cost to the Owner.

3.9 CLEANING PIPELINES

- A. As pipe laying progresses and at the conclusion of the work thoroughly clean all new pipelines by flushing with water or other means to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period. If, after this cleaning, obstructions remain, they shall be removed prior to approval and acceptance of the pipe by Owner/Authorized Representative.

END OF DOCUMENT 334200

SECTION 33 46 00

STORMWATER MANAGEMENT

PART 1 - GENERAL

1.1 SCOPE DESCRIPTION

- A. The work to be done under this section consists of construction activities pertaining to stormwater management, including but not limited to earthwork and excavation; protection of existing features; preparation of subgrade; check dam construction; grading; sheathing and shoring; placement and compaction of clean stone; construction of stone and/or modular stormwater storage structures; installation of geotextiles, impermeable liners, and rolled erosion control products; installation of velocity dissipators; connection of distribution and drainage piping; backfilling; and any incidental and related operations.
- B. The installation of the Modular storage units shall include any necessary bedding or subgrade preparation not otherwise accounted for, any observation or maintenance ports integral to the modular system, all interfaces required for piping, waterstops, geogrid and geotextile installation, onsite assembly of modular units, and furnishing and installing any additional fittings or appurtenant materials necessary to complete installation of the modular stormwater storage system.

1.2 REFERENCE STANDARDS

- A. The following apply to work in this section:
  - 1. ASTM: Specifications of the American Society for Testing and Materials latest editions. Modifications specified herein shall govern where conflicts with ASTM standards occur.
  - 2. PennDOT: Publication 408 current edition of the Commonwealth of Pennsylvania Department of Transportation Specifications.
  - 3. AASHTO: American Association of State Highway and Transportation Officials, current published standards.
  - 4. PTM: Pennsylvania Test Methods, current published standards.
  - 5. APWA: American Public Works Association, Uniform Color Code.
  - 6. PWD: Philadelphia Water Department Stormwater Management Guidance Manual, latest version
- B. Commonwealth of Pennsylvania, Department of Transportation (PennDOT)
  - 1. Bulletin No. 15: Approved Construction Materials

1.3 SUBMITTALS

- A. Submit a list of materials to be provided for work under this Section including the name and address of the materials producer and the location from which the materials are to be obtained.

- B. Submit certificates, signed by the materials producer, stating that materials meet or exceed the specified requirements. In addition, submit the following:
  - 1. Aggregate:
    - a. Sieve Analysis
    - b. Samples of loose material in sealed bag labeled with the name of the material and manufacturer to be submitted upon request for analysis by the Owner/Authorized Representative. Quantity of sample by weight shall be in accordance with ASTM standards and may be confirmed by the Philadelphia Water's Bureau of Laboratory Services (BLS) directly at (215) 685-1430.
    - c. Report demonstrating that the stone was washed per AASHTO T-11 Standards for less than 0.5% wash loss.
  - 2. Non-woven geotextile: product manufacturer and specification sheets
  - 3. Impermeable liner (if required): product manufacturer and specification sheets
  - 4. Modular stormwater storage units: product manufacturer and specification sheets, installation instructions and maintenance guidelines.
  - 5. Infiltration Testing Report, if required.
- C. Stormwater Storage Modules:
  - 1. Provide a single unit, height as specified in the contract drawings to be reviewed and retained by owner.

#### 1.4 QUALITY ASSURANCE

- A. All materials, methods of construction, and workmanship shall conform to applicable requirements of ASTM, PTM, PennDOT Standard Specifications and AASHTO Standards, unless otherwise specified.
- B. Upon completion of relevant excavation work, and prior to placement of geotextile and aggregate, subgrade soil shall be inspected by owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished subgrade elevation in accordance with the construction plans.
- C. Upon completion of placement of subgrade storage (stone fill or as otherwise specified) and geotextile, and prior to backfilling or surface restoration, the structure shall be inspected by owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished elevation(s) of the subsurface stormwater trench in accordance with the construction plans.
- D. Upon completion of placement of surface stormwater features, and prior to backfilling or surface restoration, the structure shall be inspected by Owner or authorized representative. Survey or acceptable measurement by the Contractor shall verify the finished elevation(s) of all features in accordance with the construction plans.

#### 1.5 DELIVERY STORAGE AND HANDLING

- A. Deliver, store, and handle all materials to ensure protection from damage.
- B. Bagged materials such as fertilizer, lime, etc. shall be delivered to the site, mixed as specified, in the original unopened standard size bags showing weight, analysis and name of manufacturer and indication of conformance with state and federal laws, as applicable. Containers shall bear the

manufacturer's certificate of compliance covering analysis shall be furnished to Owner/Authorized Representative. Store bagged materials in a weatherproof place and in such a manner that it will be kept dry and its effectiveness will not be impaired.

- C. If stored for an extended period of time, additional measures should be taken to prevent UV and weather damage
- D. Stored components should be checked at least once a week. A check of the stored area should be done to make any minor repairs to the cover or to restack any components that could have fallen over.

**PART 2 - PRODUCTS**

**2.1 AGGREGATE**

- A. Coarse aggregates shall meet the following requirements:
  - 1. Maximum wash loss of 0.5% by mass when tested per AASHTO T-11 wash loss test.
  - 2. Minimum Durability Index of 35 (ASTM D3744)
  - 3. Maximum abrasion of 10% for 100 revolutions and maximum of 50% for 500 revolutions
  - 4. All aggregate shall be uniformly graded, clean, and thoroughly washed.
  - 5. Aggregate shall be 100% crushed material.
- B. Unless otherwise approved by PWD, coarse aggregate for the stormwater trenches shall be uniformly graded as defined in Standard Sizes of Coarse Aggregate, Table 4, AASHTO Specifications, Part I, 19th Ed., 1998, or latest edition, unless otherwise specified.

1. Grading Requirements for AASHTO No. 57

U.S. Standard Sieve Size	Percent Passing
1½" (37.5 mm)	100
1" (25 mm)	95-100
½" (12.5 mm)	25-60
No. 4 (4.75 mm)	0-10
No. 8 (2.36 mm)	0-5

2. Grading Requirements for AASHTO No. 3

U.S. Standard Sieve Size	Percent Passing
2½" (63 mm)	100
2" (50 mm)	90-100
1½" (37.5 mm)	35-70
1" (25 mm)	0-15
½" (12.5 mm)	0-5

- C. Crushed concrete shall not be an acceptable substitute for coarse aggregate.

2.2 SAND

- A. Sand if used or required by the modular manufacture to line the bottom of stormwater trenches shall be AASHTO M-43 No. 9 or 10.
- B. Sand shall not be an acceptable substitute for coarse aggregate
  - 1. Grading Requirements for AASHTO No 9

U.S. Standard Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	85-100
No. 8 (2.36 mm)	10-40
No. 16 (1.18 mm)	0-10
No. 50 (300 μm)	0-5

- 2. Grading Requirements for AASHTO No 10

U.S. Standard Sieve Size	Percent Passing
3/8" (9.5 mm)	100
No. 4 (4.75 mm)	85-100
No. 100 (150 μm)	10-30

2.3 GEOTEXTILES

- A. Non-woven geotextile (drainage filter fabric) consisting of polypropylene fibers
  - 1. Meeting AASHTO Class 1 or Class 2 Geotextile
  - 2. Minimum flow rate: 95 gal/min/ft<sup>2</sup> (ASTM D-4491)
  - 3. Minimum grab tensile strength: 120 lbs (ASTM D-4632)
  - 4. Minimum Mullen Burst Strength: 225 psi (ASTM D-3786)
  - 5. Minimum puncture strength (2-in flat-end rod): 660 lbs (ASTM D-6241)
  - 6. Minimum Trapezoid Tear Strength: 95 lbs (machine direction) and 75 lbs (cross machine direction) (ASTM D-4533)
  - 7. Minimum UV resistance: 70% retained strength after 500 hrs (ASTM D-4355)
  - 8. Heat-set or heat-calendared fabrics are not permitted.
- B. Impermeable liner if used shall be 40 mil thick high density polyethylene geomembrane designed specifically for flexible geomembrane applications. Geomembrane liner shall be GSE Lining Technology product # HDE 040A000 or approved equivalent.
  - 1. Minimum average thickness 40 mil (mm) (ASTM D 5199)
  - 2. Density 0.94 g/cm<sup>3</sup> (ASTM D 1505)
  - 3. Strength at break 152 lb/in-width
  - 4. Strength at yield 84 lb/in-width



5. Elongation at break 700%
6. Elongation at yield 12%
7. Tear resistance 28 lb (ASTM D 1004)
8. Puncture resistance 72 lb (ASTM D 4833)
9. Carbon black content 2% (ASTM D 5596)
10. Notched constant tensile load 300 hr (ASTM D 5397, Appendix)

- C. Geotextiles and geogrids associated with modular stormwater systems shall be as specified by the manufacturer.

## 2.4 BACKFILL MATERIALS

- A. Ordinary Backfill Material may include all material excavated from the trench and free of objectionable matter, unless rejected by Owner or authorized representative. The Contractor shall furnish any deficiency of Ordinary Backfill Material.
- B. Select Backfill Material shall be furnished where specified in accordance with PennDOT Publication 408 Specifications, Section 703.3, Select Granular Material-2RC (as amended). The use of slag as Select Backfill Material is hereby prohibited.

## 2.5 WATERSTOPS (ANTI-SEEP COLLARS)

- A. Waterstops (or antiseep collars), if required, shall be quarter-inch ( $\frac{1}{4}$ " ) HDPE sheets cut to the dimensions indicated and installed per the Drawings. All metal fittings or attachments used shall be nylon or stainless steel (Grade 304 or better). Plastic sealant for weld shall be as suggested by manufacturer.

## 2.6 DETECTABLE UNDERGROUND TAPE

- A. Detectable Underground Utility Warning Tape shall be six inches wide (6"), 5-mil thickness, with aluminum foil core. Tape shall be printed with an appropriate legend ("Caution: Buried Storm Sewer Below" or as approved) and shall conform to the color standards of the APWA for buried utilities (green for sewer).

## 2.7 OBSERVATION WELLS

- A. Observation wells shall be four-inch (4") inside diameter rigid Schedule 40 PVC pipe in upper section, with solid cap.
- B. Slotted sections shall be four-inch (4") PVC slotted well with 0.01 slots and attached plug. Atlantic Screen and Manufacturing Item # OE540400 or approved equivalent.
- C. Covers for observation wells shall be lockable ductile iron with gray iron frames, East Jordan Ironworks product #00157024R or approved equivalent. Cover and/or frame shall be stamped "OBS WELL".
- D. Aggregate fill around observation wells shall be consistent with surrounding aggregate.

## 2.8 MODULAR STORMWATER STORAGE SYSTEMS

- A. Modular Stormwater Storage Systems shall be as indicated on the Drawings. Fittings, installation, and appurtenant materials (geogrids, geotextiles, etc) shall be as specified by the manufacturer.
  - 1. ACO Stormbrixx SD as supplied by ACO, Inc.
  - 2. Brentwood Module 20 Series StormTank
  - 3. or Approved equal
- B. The sub-surface stormwater storage system modules under the requires 2.0 ft. cover must withstand, at a minimum live loading consisting of the design truck (HS-20) loading in accordance with AASHTO LRFD Bridge Design Requirements, without geogrid.
- C. The Modular storage units must have a minimum 95% void space.

## 2.9 MANUFACTURED WATER QUALITY TREATMENT DEVICE

- A. Manufactured treatment devices shall be as indicated on the Drawings. Fittings, installation, and appurtenant materials (geogrids, geotextiles, etc) shall be as specified by the manufacturer
  - 1. TBD

## PART 3 - EXECUTION

### 3.1 GENERAL CONDITIONS

- A. Coordinate the installation with the product distributor, to have the distributor on-site during product installation.
- B. Review manufacture's installation procedures and coordinate Sub-surface stormwater storage system installation with other work affected, such as grading, excavation, utilities, construction access, erosion control, etc.
- C. Cold weather installation or assembly of modules should not be undertaken when temperatures are below 40°F, without utilization of a heated facility.
- D. Assembled modules may be walked on, but vehicle traffic if prohibited until properly backfilled and covered per Manufacturer's recommendations. Protect personnel and the installation against damage with highly visible construction tape, fencing or other means until construction is complete.

### 3.2 CONSTRUCTION CERTIFICATION FORM

- A. The contractor will be required to fill out and complete the Philadelphia Water Department SMP Construction Certification Form, as part of the Construction Certification Package (CCP). The contractor will be required to make, record, and document all measurements, required photos, and provide required documents, reports, and certifications outlined in the CCP.

- B. The CCP shall be completed and signed by one of the following:
  - 1. Professional Engineer
  - 2. Registered Architect
  - 3. Landscape Architect
  - 4. Professional Land Surveyor
  - 5. Professional Geologist
  - 6. Licensed Contractor
  
- C. The contractor shall contact the project's assigned PWD Inspector at least three (3) days prior to the start of construction of any SMP, including excavation and soil testing, if applicable. The SMP installation must be observed by the PWD inspector.
  
- D. Provide the PWD Inspector an estimated schedule for placement of any of the following:
  - 1. Geotextile
  - 2. Stone
  - 3. Storage media
  - 4. Piping
  - 5. Soil
  - 6. Other SMP-related devices or appurtenances.

### 3.3 EXCAVATION BELOW GRADE

- A. Subgrade shall be unfrozen, firm, and stable with no standing water, mud, or muck. If the Contractor fails to maintain the subgrade properly, the Contractor shall remove the unsuitable material at no additional cost to owner. If the bottom of any excavation is taken out below the limits shown on the Drawings, it shall be restored at the Contractor's expense with six inch (6") layers of AASHTO #57 aggregate to the elevations shown in the Drawings. Compacted earthen fill is not acceptable.
  
- B. If in the opinion of owner or authorized representative the undisturbed natural subgrade, at or below the normal grade of the excavation as indicated on the Drawings, is unsuitable for construction, it shall be removed to such depth and width as owner or authorized representative may direct and be replaced with suitable material as directed. These activities shall be included in the appropriate lump sum price bid for the related construction activities by location.
  
- C. Excavation of trenches required for the installation of all pipes and structures shall be made to the depths and widths indicated on the Drawings. The Contractor shall render the bottom of the excavations firm and dry and in all respects acceptable to owner or authorized representative. Pavement, when encountered, shall be sawcut along straight lines before excavating.
  
- D. Excavation shall be performed in the dry and shall be accomplished by methods which preserve the undisturbed state of subgrade soils. The existing subgrade shall not be compacted or subject to excessive construction equipment prior to placement of geotextile and crushed stone. If it is essential that equipment be used in the excavated area of infiltration facilities, all equipment must be approved by PWD or authorized representative. Use of equipment with narrow tracks or tires, rubber tires with large lugs, or high pressure tires that will cause excessive compaction shall not be permitted within the excavation.

### 3.4 EXCAVATION SUPPORT

- A. Furnish, install, monitor and maintain excavation support (e.g., shoring, sheeting, bracing, trench boxes, etc) as required by Federal, State or local laws, ordinances, regulations and safety requirements. Support the sides of excavation, to prevent any movement which could in any way reduce the width of the excavation below that necessary for proper construction and protect adjacent structures from undermining, settlement or other damage.
- B. The Contractor shall take care to prevent the formation of voids outside of sheeting. If voids occur behind sheeting, immediately backfill and compact the voids with AASHTO #57 aggregate. Voids in locations that cannot be properly compacted upon backfilling shall be filled with lean concrete.
- C. All excavation supports shall be carefully removed in such manner so as not to endanger the Work or other adjacent structures, utilities, or property. All voids left or caused by withdrawal of supports shall be immediately filled with crushed stone and compacted. No sheeting shall be left in the trench following installation of improvements.
- D. No payment will be given for sheeting, bracing, etc, during the progress of the work. All payment for installing, maintaining, and removing sheathing and shoring or any other required excavation support shall be included in the appropriate lump sum price bid for the related construction activities by location.

### 3.5 SUBGRADE PREPARATION AND GRADING

- A. Subgrade of infiltration beds shall be level: Plus or minus one-half inch (+/- 1/2") over ten feet is acceptable as level.
- B. Grading shall be performed to the lines and grades shown on the Drawings. All objectionable material encountered within the limits indicated shall be removed and disposed of by the Contractor.
- C. In excavation faces, all loose or protruding rocks shall be barred loose or otherwise removed to line or finished grade of slope. All cut and fill slopes shall be uniformly dressed to the slope, cross section, and alignment shown on the Drawings or as directed by PWD or authorized representative.
- D. Prior to backfill for stone stormwater systems, Double Ring Infiltrometer Testing shall be conducted in one location for each system in accordance with ASTM Standard D 3385: Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer. Test holes shall be located within the limits of the proposed trench excavation and results of the testing shall be submitted to PWD or an authorized representative.
- E. In locations where subsurface stone storage underlies the stormwater surface feature, all work to prepare the stone storage layer shall be completed prior to installation of surface features (see Section 334005). Subsurface stone storage shall be approved by Owner/Authorized Representative prior to installation of surface structures. Appropriate stone foundation shall be utilized in all locations for precast and cast-in-place concrete surrounds and curbing (stone storage may be considered as foundation if compacted stone extends completely under the concrete surrounds).

- F. As-built information of subsurface stone storage and infrastructure below finished grade shall be accurately collected and recorded per PWD and PADEP latest requirements and approved Engineer prior to backfilling.

### 3.6 DISPOSAL OF UNSUITABLE OR SURPLUS MATERIAL

- A. Excavated materials that will not be reused shall be removed from the site of the work and disposed of by the Contractor. Disposal of excavated materials shall be included in the appropriate lump sum price bid for the related construction activities by location, and no additional payment shall be made for disposal of excavated materials regardless of class or condition.
- B. Excavated material shall be stacked without excessive surcharge on the trench bank and without obstructing free access to utilities, private drives and public rights-of-way. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified or shown on the Drawings, and protected.

### 3.7 BACKFILL

- A. Backfill other than planting soil or aggregate as described elsewhere in the Specifications (such as ordinary or select backfill used to fill over-excavation outside installed structures) shall be brought up evenly on all sides in 8-inch maximum lifts (sand layer shall be placed in a single six-inch (6") lift). Each layer of backfill material shall be compacted by rolling, tamping, or vibrating with mechanical compacting equipment or hand tamping. If rolling is employed, it shall be by use of a suitable roller or tractor, being careful to compact the fill throughout the full width of the trench. Use a pad foot roller for cohesive fill (silts and clay) and a smooth drum roller or vibrating plate for coarse grained fill (sands and gravels). If material is compacted by hand tamping, there must be at least one laborer tamping for each laborer shoveling material into the trench.
- B. Where pipes are laid in off-street easements, the remainder of the trench (one foot (1') or more above the top of the pipe) shall be filled with common fill in layers not to exceed eight inches (8") and compacted by rolling, tamping or vibrating with mechanical compacting equipment. Wherever a loam or gravel surface exists prior to excavations, it shall be removed, conserved and replaced to the full original depth as part of the work unless specified or shown otherwise. In some areas it may be necessary to remove excess material during the clean up process, so that the ground may be restored to its original level and condition. If the Contractor prefers not to store loam, gravel, or topsoil it shall be replaced with material as specified herein.
- C. Where pipes are laid in PennDOT or local roadways or rights-of-way, the remainder of the trench above the crushed stone backfill and up to the bottom of the specified paving or surface restoration shall be backfilled with fill materials as specified on the Drawings. Lifts shall at no time exceed eight inches (8") loose, and compaction shall be in accordance with these specifications. Preparation and paving shall be performed as shown on the Drawings or as specified herein.

### 3.8 INSTALLATION OF SUBSURFACE STONE

- A. Impermeable liner, non-woven geotextile, and/or sand layer shall be placed immediately after approval of subgrade preparation (to include infiltration testing). Subgrades shall not be subject to compaction during excavation or during installation of geotextile and aggregates. Subgrades shall be hand-raked to scarify bottoms of infiltration systems prior to geotextile and aggregate

placement. Any accumulation of debris or sediment which has taken place after approval of subgrade shall be removed prior to installation of non-woven geotextile at no extra cost to owner.

- B. Geotextile shall be placed in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater. Secure non-woven geotextile at least four feet (4') outside of trench and take steps necessary to prevent any runoff or sediment from entering the trench.
- C. Install coarse aggregate in eight inch (8") maximum lifts. Lightly compact each layer with equipment, keeping equipment movement on storage bed subgrades to a minimum. Install aggregate to grades indicated on the drawings. Install detectable underground utility warning tape at the perimeter of the subsurface stone storage trench on all sides. Once aggregate is backfilled and compacted to grades indicated on the Drawings, geotextile shall be folded over and overlapped on top of the bed to prevent soil intrusion into the aggregate bed.
- D. Impermeable liner shall be placed in accordance with manufacturer's instructions and as indicated in the Drawings. All seams and openings in the liner shall be sealed according to manufacturer's recommendations and specifications. Adjacent strips of impermeable liner shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater.
- E. Where an existing utility lateral or branch main intersects the stone stormwater storage system, a pass-through conduit (utility sleeve) shall be constructed to convey the existing utility. Owner's Representative shall review and approve any pass-through conduits for utility lines not indicated on the Drawings, and any utility laterals that may be reconstructed such that a pass-through conduit is not necessary shall be so reconstructed.
  - 1. Pass-through conduits shall be constructed of Schedule 40 PVC pipe of adequate diameter to convey the utility lateral within.
  - 2. Waterstops shall be installed at either end of the pass-through conduit, outside the geotextile wrap of the stone stormwater storage.
  - 3. The conduit shall be of watertight construction, and shall be sealed at either end around the existing pipe with non-shrink grout or sealant.
  - 4. Any pass-through conduits for utilities not indicated on the Drawings found to be necessary upon excavation will be paid at a contingency price.
  - 5. The Contractor shall coordinate sleeving of all existing and intersecting utility lines with the owners representative / design consultant of said utility lines.
  - 6. Split Pipe Conduit shall be P6F as manufactured by Conduit Repair Systems or approved equal.

### 3.9 INSTALLATION OF MODULAR SUBSURFACE STORMWATER STORAGE

- A. Installation procedure as follows shall be followed by the Contractor. The Contractor shall also reference the manufacturer's installation guidelines, and where any discrepancy exists owner reserves the right to preempt the manufacturer's installation guidelines as specified herein.
  - 1. Impermeable liner, non-woven geotextile, and/or sand layer shall be placed immediately after approval of subgrade preparation (to include infiltration testing). Subgrades shall not be subject to compaction during excavation or during installation of geotextile and aggregates. Subgrades shall be hand-raked to scarify bottoms prior to geotextile and aggregate placement. Any accumulation of debris or sediment which has taken place after

approval of subgrade shall be removed prior to installation of non-woven geotextile at no extra cost to owner.

2. Geotextile shall be placed in accordance with manufacturer's standards and recommendations. Geotextile and other liners shall be placed such that seaming shall be minimized. Additional material to be utilized for wrapping above the structure shall be protected from damage until use. Geotextile used shall be in accordance with modular stormwater unit manufacturer's specifications. Adjacent strips of geotextile shall overlap a minimum of eighteen inches (18") or per manufacturer specifications, whichever is greater. Secure non-woven geotextile at least four feet (4') outside of trench and take steps necessary to prevent any runoff or sediment from entering the trench.
3. After installation of geotextile as specified above, install base layer of minimum six inches (6") of AASHTO #57 stone across footprint of modular structure. Compact stone to 75-80% relative density per ASTM D4253, and level as necessary to produce a consistent surface. Subgrade shall be visually inspected and approved prior to continuing installation.
4. Utilize a soluble paint to outline the footprint of the modular units to be placed. Care should be taken to note any connections, observation or maintenance ports, or other irregular units to be placed.
5. Install modules by placing side-by-side, attaching per manufacturer's instructions. Use caution to avoid debris or soil intrusion to the system components.
6. Attach all pipe connections, observation or maintenance ports, pass-through conduits, or other intrusions to the system. No penetrations other than manufacturer approved ports shall be placed in top or bottom panels of the system. Support pipe in trenches and during backfill operations to prevent damage. Pipe Connections should extend into the modular system a minimum of 6".
7. Upon completion of the layer course, wrap geotextile or impermeable liner as specified and backfill around the structure with AASHTO #57 to a minimum of twelve inches (12") width. Side backfill shall be laid in maximum twelve-inch (12") depth lifts and compacted to 75-80% relative density per ASTM D4253. Use caution to avoid damage to the geotextile and other components.
8. Repeat steps 5-7 as necessary to complete the full modular stormwater system.
9. Install a twelve inch (12") lift of AASHTO #57 stone over the modular system. Compact to a 75-80% Proctor using vibrating plates or walk-behind non-vibratory rollers (do not use drivable rolling compactors).
10. Complete geotextile or liner wrap of system. Add any port connections to surface, ensuring a proper seal with geotextile or liner wrap.
11. Install detectable underground utility marking tape around perimeter of system to mark the area for future utility detection.
12. Prior to final backfilling and surface restoration, the structure shall be inspected by owner or authorized representative. Survey or acceptable measurement shall verify the finished elevations of the storage structure in accordance with the construction plans.
13. Install remaining cover to a minimum finished cover depth of twenty-four inches (24") as indicated on the plans. Maximum overall depth from surface to invert of system is eleven feet (11'). Complete surface restoration as indicated on the Drawings and as described in Related Work Sections of these specifications.

### 3.10 INSTALLATION OF ANTISEEP COLLARS (WATERSTOPS)

- A. Antiseep collars shall be installed at transitions between stormwater storage areas and surrounding substances as depicted on the Drawings, or as directed by owner/authorized representative. Geotextile or impermeable liners in place at the interface shall be minimally cut to allow for the pass-through section and then sealed within the solid external sheets of the

antiseep collar. All fittings and seals shall be installed to manufacturer's specifications for a watertight seal.

- B. All antiseep collars shall be placed continuously to form a watertight joint. All bends, corners, and splicing shall be made by standard rubber waterstop fittings or by vulcanizing. All collars projecting from the side of the joint shall be protected from damage during construction and be free from defects when the concrete on the adjacent side of the joint is poured in place. All waterstops shall be placed in the center of the joint, with 1/2 of the waterstop on each side of the joint.
- C. All waterstops shall be placed strictly in accordance with the manufacturer's specifications and requirements.

### 3.11 CLEANING

- A. Perform cleaning during the installation of work and upon completion of the work.
- B. Remove from the site all excess materials, debris, and equipment.

END OF DOCUMENT 33460



SECTION 33 46 16

OUTLET STRUCTURES FOR STORMWATER PONDS

PART 1 - GENERAL

1.1 SUMMARY

- A. The work of this Section consists of the construction of the outflow control structures for stormwater management basins.
- B. All materials shall be manufactured, supplied, stored and placed according to the latest referenced standards and as outlined herein.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections:
  - 1. Section 334600 – Stormwater Management

1.3 SUBMITTALS

- A. Submit complete shop drawings and product information for all items to be furnished under this Section upon receipt of notice to proceed and prior to construction.
- B. Certificates of Compliance: Before installation of any Precast Concrete Products, submit an acceptable Certificate of Compliance to Owner/Authorized Representative
- C. Submit a list of materials to be provided for work under this Section including the name and address of the materials producer and the location from which the materials are to be obtained.
- D. Submit certificates, signed by the materials producer, stating that materials meet or exceed the specified ASTM and ACI requirements.
- E. Submit detailed diagrams of all outflow structure depicting dimensions and materials used to construct the entire structure. Indicate knockout elevations and size for all pipe entering manhole structures or other concrete structures.

1.4 QUALITY ASSURANCE

- A. All materials, methods of construction, and workmanship shall conform to applicable requirements of ASTM, PTM, PennDOT Standard Specifications and AASHTO Standards, unless otherwise specified.

## PART 2 - PRODUCTS

### 2.1 OUTLET CONTROL STRUCTURE

#### A. Concrete Inlet Box

1. In accordance with PennDOT Publication 408, Section 605.2(d).
2. Internal weir wall to meet same design requirements of the inlet side wall. Extend weir wall reinforcement into the inlet box bottom and side walls. Weir wall shall be poured monolithically with the inlet walls.

#### B. Inlet Grate and Frame

1. In accordance with PennDOT Publication 408, Section 605.2(a).

#### C. Manhole Steps

1. In accordance with PennDOT Publication 408, Section 605.2(c).

#### D. Precast Top Unit

1. In accordance with PennDOT Publication 408, Section 605.2(d).

#### E. Inlet Trap/Hood

1. Catch Basin Trap Number R-3711 manufactured by Neenah Foundry Inc. or approved alternative.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF OUTLET CONTROL STRUCTURES

- A. Install in accordance with PennDOT Publication 408, Section 605.3.

### 3.2 CONSTRUCTION CERTIFICATION FORM

- A. The contractor will be required to fill out and complete the Philadelphia Water Department SMP Construction Certification Form, as part of the Construction Certification Package (CCP). The contractor will be required to make, record, and document all measurements, required photos, and provide required documents, reports, and certifications outlined in the CCP.
- B. The CCP shall be completed and signed by one of the following:
  1. Professional Engineer
  2. Registered Architect
  3. Landscape Architect
  4. Professional Land Surveyor
  5. Professional Geologist
  6. Licensed Contractor
- C. The contractor shall contact the project's assigned PWD Inspector at least three (3) days prior to the start of construction of any SMP, including excavation and soil testing, if applicable. The SMP installation must be observed by the PWD inspector.

- D. Provide the PWD Inspector an estimated schedule for placement of any of the following:
1. Geotextile
  2. Stone
  3. Storage media
  4. Piping
  5. Soil
  6. Other SMP-related devices or appurtenances.

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