

Coal Mine Brook  
Worcester, MA

Beals and Thomas, Inc.®  
April 2022

**TECHNICAL SPECIFICATIONS SITEWORK CONSTRUCTION**

**Coal Mine Brook  
616 Plantation Street  
Worcester, Massachusetts 01605**

*Prepared for:*

**The City of Worcester  
Department of Public Works and Parks  
50 Officer Manny Familia Way  
Worcester, Massachusetts 01605**

*Prepared by:*

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**Issue Date: 04/26/2022  
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**SITework CONSTRUCTION**

<u>Section No.</u>	<u>Title</u>
024120	SELECTIVE SITE DEMOLITION
033053	MISCELLANEOUS CAST-IN-PLACE CONCRETE
129300	SITE FURNISHINGS
260000	ELECTRICAL
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## SECTION 024120 - SELECTIVE SITE 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.
- B. Stormwater Pollution Prevention Plan and NPDES Construction General Permit.
- C. Order of Conditions for this project issued by the City of Worcester Conservation Commission.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Demolition and removal of selected site elements.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for site clearing and removal of above- and below-grade improvements not part of selective site demolition

#### 1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items 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, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

#### 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 PREINSTALLATION MEETINGS

- A. Predemolition Conference: Conduct conference at Project site.
  - 1. Inspect and discuss condition of construction to be selectively demolished.
  - 2. Review and finalize selective site demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 3. Review requirements of work performed by other trades that rely on substrates exposed by selective site demolition operations.
  - 4. Review areas where existing construction is to remain and requires protection.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Schedule of Selective Site Demolition Activities: Indicate the following:
  - 1. Detailed sequence of selective site demolition and removal work, with starting and ending dates for each activity.
  - 2. Interruption of utility services. Indicate how long utility services will be interrupted.
  - 3. Coordination for shutoff, capping, and continuation of utility services.
- B. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.
- B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

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## 1.8 FIELD CONDITIONS

- A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- B. Notify Landscape Architect of discrepancies between existing conditions and Drawings before proceeding with selective site demolition.
- C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - 1. 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.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective site demolition operations.
  - 1. Maintain fire-protection facilities in service during selective site demolition operations.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective site demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Survey existing conditions and correlate with requirements indicated to determine extent of selective site demolition required.

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- 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 or video.
  - 1. Before selective site demolition or removal of existing 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 ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
  - 1. Arrange to shut off utilities with utility companies.
  - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective site demolition and that maintain continuity of services/systems to other parts of site.

### 3.3 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Protect work that is to remain or that is exposed during selective site demolition operations.
- B. Temporary Shoring: Design, 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 site demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.4 SELECTIVE SITE 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 site demolition systematically, from higher to 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. 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 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. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective site demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. 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 until delivery to Owner.
  - 4. Transport items to Owner's storage area designated by Owner.
  - 5. Protect items from damage during transport and storage.
- D. 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.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective site demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective site demolition, cleaned and reinstalled in their original locations after selective site demolition operations are complete.

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### 3.5 SELECTIVE SITE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

- A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

### 3.6 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 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.
- B. Burning: Do not burn demolished materials.

### 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 site demolition operations began.

### 3.8 SELECTIVE SITE DEMOLITION SCHEDULE

- A. Remove: Dead or leaning trees, bituminous concrete pavement, cape cod berm, portion of encroaching fence, chain link fence, and specified trees beyond limit of clearing as indicated in Project Record Documents.
- B. Remove and Salvage:
- C. Remove and Reinstall: East-west trail sign to the east of the site as indicated in Project Record Documents.
- D. "Existing to Remain" Paragraph below may be used to inform Contractor of items that are to remain, such as those that occur in, or are adjacent to, construction being demolished, but are not being removed and reinstalled. Retain paragraph if required.
- E. Existing to Remain: Encroaching wood deck, hydrants, utility poles, water services, east-west trail sign to the west of the site, and sewer services as indicated in Project Record Documents.

END OF SECTION 024120



## SECTION 033053 - MISCELLANEOUS 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, labor and equipment, reinforcement, concrete materials, mixture design, placement procedures, and finishes for the following site improvements:
  - 1. Concrete mow-strip
  - 2. Precast concrete curb
  - 3. Concrete sidewalks
  - 4. Concrete pads
  - 5. Fence footings
  - 6. Site furnishings concrete pads and footings
- B. Related Sections:
  - 1. Section 312000 "Earth Moving" for drainage fill under slabs-on-grade.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Other Action Submittal:
  - 1. Design Mixtures: For each concrete mixture.

#### 1.4 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- B. Comply with the following sections of ACI 301, unless modified by requirements in the Contract Documents:

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1. "General Requirements."
  2. "Formwork and Formwork Accessories."
  3. "Reinforcement and Reinforcement Supports."
  4. "Concrete Mixtures."
  5. "Handling, Placing, and Constructing."
  6. "Lightweight Concrete."
- C. Comply with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

## PART 2 - PRODUCTS

### 2.1 FORMWORK

- A. Furnish formwork and formwork accessories according to ACI 301.

### 2.2 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- C. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

### 2.3 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 I.
- B. Normal-Weight Aggregate: ASTM C 33, graded, 1-1/2-inch nominal maximum aggregate size.
- C. Water: ASTM C 94/C 94M.

### 2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.

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- 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.

## 2.5 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

## 2.6 CONCRETE MIXTURES

- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:
1. Minimum Compressive Strength: 4000 psi at 28 days.
  2. Maximum Water-Cementitious Materials Ratio: 0.45.
  3. Slump Limit: 4 inches, plus or minus 1 inch.
  4. Air Content: Maintain within range permitted by ACI 301.

## 2.7 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 above 90 deg F, reduce mixing and delivery time to 60 minutes.
- 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, mix type, mix time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 FORMWORK

- A. Design, construct, erect, brace, and maintain formwork according to ACI 301.

### 3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

### 3.3 STEEL REINFORCEMENT

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

### 3.4 CONCRETE PLACEMENT

- A. Comply with ACI 301 for placing concrete.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Do not add water to concrete during delivery, at Project site, or during placement.
- D. Consolidate concrete with mechanical vibrating equipment.

### 3.5 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 with ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

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- C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure formed and unformed concrete for at least seven days:
  - 1. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests: Perform according to ACI 301.
  - 1. Testing Frequency: One composite sample shall be obtained for each day's pour of each concrete mix exceeding 5 cu. yd. but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.

### 3.7 REPAIRS

- A. Remove and replace concrete that does not comply with requirements in this Section.

END OF SECTION 033053

## SECTION 129300 - 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. Bike Racks
  - 2. Benches
  - 3. Picnic Tables

#### 1.3 GENERAL DESCRIPTION

- A. Furnish and deliver from the approved single-source manufacturer, all materials required to install the play equipment and structures as indicated on the drawings or as approved and specified herein. Delivery date shall be approved by City Representative and coordinated with contractor responsible for installation of equipment.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Bike Rack (3)
  - 2. Benches (6)
  - 3. Picnic Table ADA Accessible (3)
- B. Samples: For each exposed product and for each color and texture specified.
- C. Samples for Initial Selection: For units with factory-applied finishes.
- D. Shop Drawings: Shop drawings or manufacturer's specifications shall be submitted for all work furnished in this Section, in accordance with the provisions of the Special Conditions Section of the Contract Specifications.

1.5 CLOSEOUT SUBMITTALS

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

1.6 WARRANTY/GUARANTEE

- A. The Contractor/Manufacturer's Representative shall provide information on the equipment manufacturer's warranty/guarantee with bid.

1.7 SAFETY GUIDELINES AND STANDARDS

- A. All materials and playground equipment shall conform to the current issue of the "Handbook for Public Playground Safety" published by the Consumer Product Safety Commission (C.P.S.C.) and ASTM F1487-05. The manufacturer shall be responsible for correcting any product violations of the C.P.S.C. Guidelines and ASTM F1487-05, to the satisfaction of the Owner, should they be found after installation.
- B. ADA Accessibility Guidelines (ADAAG) Section 15.6 Play Areas.

1.8 QUALITY ASSURANCE

- A. The Contractor/Manufacturer's Representative furnishing the play equipment and structures must have a minimum of 10 years experience in the manufacturing of play equipment with the personnel, facilities, and equipment adequate for the products specified, and shall produce written proof of such.
- B. Certification by Manufacturer that the Installer is an approved playground equipment installer of the approved playground product and shall produce written proof of such.
- C. International Play Equipment Manufacturers Association (IPEMA) certified.
- D. The Contractor/Manufacturer's Representative shall provide inspection and written report from approved Certified Playground Safety Inspector (CPSI) as verification that materials and installation conforms to item 1.04 - Safety Guidelines and Standards.

PART 2 - PRODUCTS

2.1 HARDWARE AND FASTENERS:

- A. All hardware and fasteners shall be zinc-coated, except for reinforcing bars. Nuts and bolts shall be Grade A steel, hexagon-type. Washers shall be carbon steel.

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## 2.2 SITE FURNISHINGS

- A. Bike Racks: Three (3) shall be City standard model and to be installed by the Contractor as indicated on Drawings.
- B. Benches (Add. Alt.): Six (6) shall be City Standard surface-mounted model #58-60, manufactured by DuMor Site Furnishings, Inc., Mifflintown, PA (phone #800-598-4018), or approved equal.
- C. Picnic Table ADA Accessible (Add. Alt.): Three (3) shall be surface-mounted model #76-23PL, manufactured by DuMor Site Furnishings, Inc., Mifflintown, PA (phone #800-598-4018), or approved equal.

## 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.
- 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. Benches: Assemble furnishings in accordance with manufacturer's written instructions, and install in accordance with the Drawings.



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END OF SECTION 129300

SITE FURNISHINGS

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**SECTION 26 00 00**  
**ELECTRICAL**

**PART 1 - GENERAL**

**1.01 DESCRIPTION**

- A. The City of Worcester Bid Form, General Conditions, Supplementary Conditions, and applicable parts of the Special Conditions form a part of this Specification and the Contractor shall consult them in detail for instructions.
- B. The Contractor shall provide all labor, equipment, and materials; and perform all operations necessary to complete the work of this section as indicated on the Drawings and specified herein which shall include but is not limited to the following:
  - 1. Walkway, and parking area lighting
  - 2. Security lighting
  - 3. Security camera system
  - 4. All other work shown on the Drawings and included in these Specifications
- C. The Contractor shall furnish a complete, working finished product, which meets all applicable codes and standards, and the intent and specific requirements of the Drawings and specifications for this project. All materials and all work, which may be reasonably implied as being incidental to the work of this Section, shall be furnished at no extra cost to the Owner.

**1.02 RELATED WORK SPECIFIED IN OTHER SECTIONS**

- A. Section 32 12 16 – Bituminous Concrete
- B. Section 03 30 53 – Cast-in-Place Concrete

**1.03 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
- B. The Contractor must be familiar with all other Sections of this specifications and the associated Drawings, which affect the scope of work. The General Conditions, all Supplementary and Special Conditions, and all other sections of this specification shall be adhered to, as they apply to this Section. Where paragraphs of this Section conflict with similar paragraphs elsewhere, the more stringent requirements shall prevail.

**1.04 REFERENCE STANDARDS AND SPECIFICATIONS**

- A. Perform work strictly as required by rules, regulations, standards, codes, ordinances,

and laws of local, state, and federal government, and other authorities that have lawful jurisdiction.

- B. All materials and installations shall be in accordance with the latest edition of the Massachusetts Electrical Code, and all applicable local codes and ordinances. Materials and equipment shall be listed by Underwriters Laboratories (UL).
- C. Except as modified by governing codes and by the Contract Documents, the Contractor shall comply with applicable provisions and recommendations of the following:
  - 1. American National Standards Institute - ANSI
  - 2. American Society for Testing & Materials - ASTM
  - 3. Illuminating Engineering Society - IES
  - 4. Institute of Electrical & Electronics Engineers - IEEE
  - 5. Insulated Cable Engineers' Association - ICEA
  - 6. National Electrical Code - NEC
  - 7. National Electrical Manufacturer's Association - NEMA
  - 8. National Electrical Safety Code - NESC
  - 9. InterNational Electrical Testing Association - NETA
  - 10. National Fire Protection Association - NFPA
  - 11. Occupational Safety & Health Administration - OSHA
  - 12. Underwriter's Laboratories, Inc. - UL

The above listed codes and standards are referenced to establish minimum requirements and wherever this Section requires higher grades of materials and workmanship than required by the listed codes and standards, this Section shall apply. In the event a conflict occurs between the above listed codes and standards and this Section, the more stringent requirement shall govern.

#### **1.05 SITE VISIT**

- A. Each bidder shall visit the site of the proposed work and fully acquaint himself with the conditions there relating to construction and labor, and should fully inform himself as to the facilities involved, and the difficulties and restrictions attending the performance of the Contract.
- B. The Bidder shall thoroughly examine and familiarize himself with Drawings, Technical Specifications and all other Bid and Contract Documents. The Contractor, by the execution of the Contract, shall in no way be relieved of any obligation under it due to his failure to receive or examine any form or legal document or to visit the site and acquaint himself with the conditions there existing and the Owner will be justified in rejecting any claim thereof.

#### **1.06 AS-BUILT DRAWINGS:**

- A. After completion of the electrical installation, the Contractor shall furnish an "as-built" drawings showing all conduits, cables, cabinets, transformers, light poles, etc. to scale with dimensions where required. Instruction sheets and parts lists covering all operating equipment will be bound into a folder and furnished to the Owner in duplicate.

**1.07 INSTRUCTIONS:**

- A. Within 10 days, after completion and testing of the system, the Contractor shall instruct the Owner's personnel in the proper operations and maintenance of the system, in a 2 hour training session.
- B. The Contractor shall furnish at least two (2) complete sets of operating and instruction manuals for the equipment provided under this Contract. These manuals shall detail the operation, testing, and maintenance of the electrical equipment and systems. Manuals shall be provided upon Engineer's request or upon project completion, whichever comes first.

**1.08 GUARANTEE**

- A. Guarantee work of this Section in writing for one year from date of Owner's acceptance. Repair or replace defective materials, equipment, workmanship, and installation that develop within this period, promptly and to Owner's satisfaction and correct damage caused in making necessary repairs or replacements under guarantee with no extra cost to Owner. Contractor shall transfer all equipment warranties for lighting and other systems to Owner.

**1.09 SUBMITTALS**

- A. Within 10 days after Award of General Contract, submit shop drawings and product data on below listed items for approval. Submit copies as requested.
- B. Check, stamp and mark with project name shop drawings and product data before submitting for approval. Specifically indicate on shop drawing transmittal form or by separate letter any deviations from Contract Documents because of standard shop practice or other reason. Rectify with no extra cost to Owner, deviations which escape Engineer's scrutiny and have not been indicated on shop drawings.
- C. List of materials and equipment requiring shop drawings shall include:
  - 1. Conduits and Wiring
  - 2. Panelboards
  - 3. Service Cabinets and Equipment
  - 4. Transformer Foundations
  - 5. Meter Sockets
  - 6. Circuit Breakers
  - 7. Concrete Products and Light Bases
  - 8. Wiring Devices and Receptacles
  - 9. Pathway Lighting

## 10. Handholes

The Engineer's review shall be only for conformance with the design concept of the project and compliance with the specifications and Drawings. The responsibility of, and the necessity of, furnishing materials and workmanship required by the specifications and Drawings which may not be indicated on the shop drawings is included under the work of this Section.

### 1.10 INSPECTIONS AND FEES

- A. Obtain all necessary permits and licenses, file necessary plans and pay all fees for permits and inspections. Permit fees are the responsibility of the Contractor as part of his bid, as is all coordination with the municipality and the local utility National Grid.

### 1.11 INTERPRETATION OF DRAWINGS

- A. Drawings are diagrammatic and indicate general arrangement of systems and work included in Contract. Drawings are not intended to specify or show every offset, fitting or component; however, Contract Documents require components and materials whether or not indicated or specified as necessary to make installation complete and operational.
- B. Contractor is responsible for all work shown on both Contract Drawings and these written specifications, including work detailed in the specifications and not shown on the drawings and including work shown on the Drawings and not described in the specifications. All ancillary equipment necessary for a complete installation shall be included, even if not shown, detailed or described. For conflicts between the Contract Drawings, written specifications and other contract information, the more stringent requirement shall apply, and the Engineer may direct the Contractor as to what is the preferred option to be provided.
- C. Any work installed contrary to, or without review by, the Engineer shall be subject to change as directed by the Engineer, and no extra compensation will be allowed for making these changes.
- D. Circuit layouts are not intended to show the number of fittings, or other installation details. Additional circuits shall be installed wherever needed to conform to the specific requirements of the equipment or local codes.
- E. As work progresses and for duration of Contract, maintain complete and separate set of prints of Contract Drawings at job site at all times. Record work completed and all changes from original Contract Drawings clearly and accurately, including work installed as a modification or addition to the original design.

### 1.12 ELECTRIC UTILITY

- A. The Electric Utility for this project is National Grid (Massachusetts Electric Company). All

coordination with the Electric Utility is the responsibility of the Contractor, All work and materials for the electric service shall be in accordance with the requirements of the Electric Utility, and are to be met under this Section and included in the bid price of the Contractor, (removal of existing service).

## **PART 2 – MATERIALS & PRODUCTS**

### **2.01 GENERAL**

- A. Materials and products furnished shall be designed for the intended use, shall meet all requirements of the latest edition of the National Electric Code (NEC), and all local codes.
- B. Materials shall be manufactured in accordance with the standards indicated in this Section, and typical industry standards and codes for the products specified. Materials and equipment shall be Underwriter's Laboratory (UL) listed.
- C. The materials used shall be new, unused, and of the best quality for the intended use. All equipment shall have the manufacturer's name, address, model or type designation, serial number and all applicable ratings clearly marked thereon in a location which can be readily observed after installation. The required information should be marked on durable nameplates that are permanently fastened to the equipment.
- D. Electrical equipment shall at all times during construction be adequately protected against mechanical injury or damage by water. Electrical equipment shall not be stored outside exposed to the elements. If any equipment or apparatus is damaged, such damage shall be repaired at no additional cost, or replaced at no additional cost as directed by the Engineer.

### **2.02 RACEWAYS**

- A. Rigid Metallic Conduit: Listed to Underwriters Laboratories Safety Standard UL6 and ANSI 080.1.
- B. Electrical Metallic Tubing (EMT) Listed to Underwriters Laboratories Safety Standard UL 797 Manufactured in accordance with ANSI C80.3
- C. Flexible Metallic Conduit: UL I. Liquidtight flexible metal conduit shall be used in wet locations.
- D. Polyvinyl Chloride (PVC) Conduit, electrical, gray, Schedule 40 or Schedule 80 as specified, meeting the requirements of UL 651 and NEMA TC-2. If concrete encasement is required, a minimum of 3,000 psi concrete shall be used. All conduits placed under roadways, and subject to vehicular traffic, shall be concrete-encased Schedule 40 (or Schedule 80 as approved).
- E. Minimum size of conduit shall be 3/4". Unless indicated on Drawings, conduit sizes can

be sized in accordance with National Electric Code (NEC). Conduit bends shall not have kinks or flats, and shall not be less than standard radii.

- F. Rigid Galvanized Steel (RGS) conduit shall be used for all power, control signal, and instrumentation wiring, except where noted. Conduit shall be fully threaded at both ends and each length shall be furnished with one threaded coupling. All 90 degree conduit sweeps shall be RGS.
- G. Conduits shall be made electrically continuous at coupling and connections to boxes and cabinets by means of joining fasteners or copper bond wires. Conduit shall be connected to grounded structural steel or the ground network. After assembly all conduit locknuts, all EMT coupling fittings, and all bond wire screws shall be set up tight before installation of wiring. Insulated metallic bushings shall be used on all conduits entering panel cabinets, pull-boxes, and wiring gutters, except on branch lighting circuits.
- H. Expansion fittings shall be provided on all conduits as required by the 2020 National Electrical Code, and as required by local and state codes. This includes, but is not limited to, vertical conduit risers coming from below-grade.

## **2.03 WIRE AND CABLE**

- A. Unless otherwise noted, conductors for power, lighting, and grounding above grade shall be No. 12 through No. 8 AWG, NEC type THWN/THHN, meeting the requirements of UL 83. Conductors for power and lighting shall be no smaller than No. 12 AWG.
- B. Conductors for power, lighting, grounding, and control below grade (and in wet locations) shall be No. 2 AWG and larger, NEC type XHHW (or XHHW-2), meeting the requirements of NEMA WC7 and ICEA S-66-524.
- C. All conductors shall be annealed copper, 98% conductivity, Class B stranded, except conductors used for power and lighting circuits No. 10 AWG and smaller which may be solid. All conductors should be rated for 600 volts or less, with a thermal rating of 90° C.

## **2.04 WIRE AND CABLE CONNECTORS AND DEVICES**

- A. Wire and cable connectors and devices shall meet the requirements of UL 486. Connectors, including miscellaneous nuts, bolts, and washers shall be silicon bronze. Ferrous materials shall not be used.

## **2.05 BOXES**

- A. Outlet and Switch Boxes: NEMA OS 1.
- B. Pull Boxes, Junction Boxes, and Equipment Enclosures: NEMA ICS 6. Pull boxes, junction boxes, and equipment enclosures shall be of NEMA Type I construction for indoor use, and NEMA Type 3R construction for outdoor or wet location use, unless otherwise noted.

- C. Box sizes shall not be less than that required by the Massachusetts Electrical Code.

## **2.06 WARNING TAPE**

- A. Warning tape shall be six (6) inches wide, polyethylene not less than 3.5 mil thick with a minimum strength of 1,500 psi. Install 8 inches below final grade. Tape shall be red for electric conduit, and red or yellow for communication conduit. Tape shall have black lettering on two lines as indicated below:

- B. For Electric conduit:

**CAUTION CAUTION CAUTION  
BURIED ELECTRIC LINE BELOW**

- C. For Telephone, Fire Alarm and Communication conduit:

**CAUTION.CAUTION.CAUTION  
BURIED COMMUNICATION LINE BELOW**

## **2.07 PANELBOARDS**

- A. Panelboards: NEMA PBI, and UL 67. Panelboards shall be door-in-door construction with copper bus. Circuit breakers shall be molded case, thermal magnetic, bolt-on type rated as noted, and rated to match panelboard voltage and interrupting rating. Provide circuit breaker sizes as shown on panel schedules. Provide spare breakers in sizes as directed by Owner or Engineer to fill each panel with spare breakers, above those indicated on panel schedules.

- B. The Contractor shall provide the following panelboards:

Panelboard P-1 120/240V, 1-phase, 3-wire, 250A main circuit breaker, 22kA A1C 30 circuit panelboard, (NEMA 1 enclosure with the number and size of circuit breakers as listed on the panel schedules provided in the Contract Drawings.

## **2.08 ELECTRICAL ENCLOSURE & CABINETS**

- A. The Contractor shall provide outdoor NEMA 3R stainless steel, to contain 120/240V panelboards, receptacles, etc. for power, with space for future equipment.
- B. Contractor shall size cabinet to coordinate with sizes of panelboard and equipment to be installed within cabinets. Dimensions shown are typical and are for reference only. Cabinet shall be similar to cabinets installed at the recently renovated Parks (list provided upon request). Cabinet shall include all equipment shown or implied and all equipment shall be installed inside of cabinet without physical conflicts and per NEC, Cabinet shall be sized for all necessary conduits, whether active, spare or future as listed on panelboard schedules.



- C. Cabinets shall be manufactured from 11 gauge minimum stainless steel with 12 gauge steel panel, mounted inside. Cabinets to have integral keyed locking mechanism, keyed alike, with provision for pad-lock. Cabinets shall be ventilated type and factory painted black powder-coat. Cabinets shall have door hold-open latches.

## **2.09 ELECTRIC HANDHOLES**

- A. Electric Handholes shall be strong, precast concrete and provided in the dimensions as shown on the Contract Drawings. Electric Handholes shall be unaffected by moisture, freezing temperatures, soil, and sub-soil chemicals.
- B. Handholes shall be provided with skid-resistant surface covers, with an Electric or Communications label for power, audio, etc. Handholes and Covers shall be designed for street-rated, heavy duty applications, meeting the requirements of the either: AASHTO HS-20 or ANSI/SCTE 77-2002 Tier 15 loading, with a minimum design load of 15,000 lbs. for both the handhole box and cover. Covers shall include recessed stainless steel captive bolts of a penta-head design. The nuts for the bolts shall be self-centering and corrosion resistant. Handholes shall meet the requirements of the latest edition of the National Electric Code (2020 or later) with regards to structural integrity, installation methods, grounding of the cover and metallic parts, etc. Handholes shall be UL listed for the intended use.
- C. Handholes shall be installed flush with final grade.

## **2.10 CAST-IN-PLACE CONCRETE FOUNDATIONS**

- A. The Contractor shall provide the materials, labor, and equipment necessary for the installation of cast-in-place concrete foundations, in accordance with these Specifications, Contract Drawings, City requirements, and all applicable codes & regulations.

## **2.11 SECURITY CAMERA SYSTEM**

- A. The Contractor shall provide a security camera system in accordance with City Requirements.

## **PART 3 - EXECUTION**

### **3.01 GENERAL**

- A. This Section covers the requirements for installation of materials, proper workmanship, testing, cleaning, grounding, and work methods to be followed by the Contractor. This Section also includes specific instructions and to be used in conjunction with the contract Drawings.
- B. Contractor is responsible for coordinating work with other trades, Owner, and Architect's schedule. Work will be coordinated such that systems can be properly

located, and conflicts and delays are avoided. Contractor shall consider commencement of work acceptance of existing conditions.

### **3.02 MATERIALS AND WORKMANSHIP**

- A. Work shall be executed in workmanlike manner and shall present neat, rectilinear and mechanical appearance when completed. Do not run raceway exposed unless shown exposed on Drawings. Material and equipment shall be new and installed according to manufacturer's recommended best practice so that complete installation shall operate safely and efficiently.

### **3.03 TESTING, INSPECTION AND CLEANING**

- A. Test wiring and connections for continuity and grounds before fixtures are connected; demonstrate insulation resistance by megger test as required at not less than 500 volts. Insulation resistance between conductors and grounds for secondary distribution systems shall meet National Electrical Code (NEC) and InterNational Electrical Testing Association (NETA) requirements.
- B. Verify and correct as necessary: voltages, tap settings, trip settings and phasing on equipment from secondary distribution system to point of use. Test secondary voltages at transformers, bus in panelboards, and at other locations on distribution systems as necessary. Test secondary voltages under no-load and full-load conditions.
- C. Test lighting fixtures with specified lamps in place for 100 hours. Replace lamps that fail within 90 days after acceptance by Owner at no extra cost to Owner (no exceptions).
- D. Provide necessary testing equipment and testing services.
- E. Failures or defects in workmanship or materials revealed by tests or inspection shall be corrected promptly and retested. Replace defective Material.
- F. Clean panels and other equipment, Panelboard interiors shall be cleaned and vacuumed. Equipment with damage to painted finish shall be repaired to Engineer's or Architect's satisfaction. After completion of project, clean exterior surfaces of electrical equipment.

### **3.04 WIRING METHODS**

- A. Install wire and cables in approved raceways as specified and as approved by authorities that have jurisdiction.
- B. Follow homerun circuit numbers and/or notes as shown on drawings to connect circuits to panelboards. Where homerun circuit numbers are not shown on Drawings, divide similar types of connected leads among phase buses so that currents are approximately equal in normal usage.
- C. Run concealed conduit in as direct lines as possible with a minimum number of bends,

longest possible radius. Run exposed conduit parallel to or at right angles to building/field lines. Bends shall be free from dents or flattening. The exact locations and routing shall be determined by the Contractor subject to the approval of the Owner and Engineer.

- D. Polarity of all electrical connections shall be observed in order to preserve phase relationship in all feeders and equipment.
- E. Splices shall be made in neat, workmanlike manner using approved mechanical connectors. After splicing, insulation equal to that on the spliced wires shall be applied at each splice. Splices are permitted only in junction boxes, outlet boxes, or other permanently accessible locations. Splices installed in electric handholes shall be weather and waterproof, pre-molded polymer splices. Hand taping of splices below-grade is not acceptable.

### **3.05 GROUNDING**

- A. Bond and ground equipment and systems connected under this Section in accordance with standards of the NEC and other applicable regulations and codes.
- B. Conduit system shall be electrically continuous throughout, grounded at service entrance. Equipment frames, enclosures, boxes, etc. shall be grounded by use of green-jacketed (or bare copper) ground sized as per Table 250-95 oldie NEC.
- C. Copper fittings for ground connections shall conform to the requirements of ASTM B 30. All bolts, u-bolts, cap screws, nuts, and lock washers for copper fitting shall be of approved corrosion-resisting material. Compression connectors required for all below-grade grounding connections.
- D. Ground Rods shall be 5/8" diameter and 8' in length, copperweld as required by applicable codes (NEC, NESC). Bonding connections to ground rods shall be permanent, welded or crimped, with copper connectors. All wire used for grounding shall be no smaller than #4 Awg copper, stranded conductor.

### **3.06 INSTALLATION OF ELECTRICAL EQUIPMENT**

- A. Contractor shall furnish and install the following major electrical components, and all necessary minor and expected accessories.
- B. Provide, furnish and install all products and work outlined in Part 1 of this Specification Section.
- C. Provide new conduit system for lighting and electrical work, in locations as shown on Contract Drawings. Utilize existing empty conduits (installed by others) where possible and install new conduits for a complete and functional system. Provide all new cabling for all electrical equipment listed.
- D. Install all equipment in locations as shown on Contract Drawings. All deviations must be

approved, in advance by Owner, Architect, and Engineer.

- E. Install all equipment per manufacturer's instructions.
- F. Balance the lighting, receptacle, and electrical load evenly on all circuits and on all phases of each circuit.
- G. Clean-up excavated areas, and restore with new loam & seed, as directed by Owner.
- H. Provide complete "As-Built" drawings to Engineer & Owner.

**3.07 INSTALLATION OF SECURITY CAMERA SYSTEM**

- A. The security camera system shall be installed in accordance with City Requirements, and with the Drawings and this Section.

**3.08 GUARANTEE AND ACCEPTANCE**

- A. Any defective elements shall be replaced in part or whole by the Contractor at no cost to the Owner.

**END OF SECTION**

## 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.
- B. Storm Water Pollution Prevention Plan and NPDES Construction General Permit.
- C. Order of Conditions for this project issued by the City of Worcester Conservation Commission.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Protecting existing vegetation to remain.
  - 2. Removing existing vegetation.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Stripping and stockpiling rock.
  - 6. Removing above- and below-grade site improvements.
  - 7. Disconnecting, capping or sealing, and abandoning site utilities in place.
  - 8. Temporary erosion and sedimentation control.
- B. Construction runoff or dewatering effluent shall not be discharged directly or tributary to stormwater management infiltration systems without the specific approval of the Owner or Landscape Architect. Approval will require effluent water quality testing.

#### 1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "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; the zone where plant roots grow.

- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; 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 larger than 2 inches in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.
- E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 MATERIAL OWNERSHIP

- A. Except for 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.

#### 1.6 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 video recordings.
  - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

#### 1.7 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where directed.

#### SITE CLEARING

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- C. Utility Locator Service: Notify Dig Safe for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- E. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

## PART 2 - PRODUCTS

### 2.1 STRAW BALES

- A. Air-dried straw, seasoned before baling, free of noxious weeds, weed seeds, and other materials detrimental to plant life.
- B. Hardwood Stakes: 1-inch by 1-inch by 3 feet kiln dried hardwood stakes.

### 2.2 SILT FENCE

- A. Amoco 2130® Silt Fence or approved equal.
- B. Wood support posts: Minimum 1-inch by 1-inch by 4 feet kiln dried hardwood posts.

### 2.3 FILTER BAGS FOR CATCH BASINS

- A. Non-woven polypropylene filter bag manufactured specifically for controlling sediment flow into catch basins.
  - 1. Ultra-DrainGuard® Catch Basin Insert.
  - 2. Siltsack® Hi-Flow or equal.

### 2.4 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. Do not cut, remove, destroy or trim trees or other vegetation outside the designated areas without approval of the Owner.
  - 2. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Comply with the requirements of the Project's Storm Water Pollution Prevention Plan and the EPA's NPDES Construction General Permit.
- B. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- C. As construction progresses and seasonal conditions dictate, more erosion control facilities may be required. Address new conditions that may be created and provide additional facilities over the above minimum requirements as may be required.
- D. As a minimum, the following shall apply:
  - 1. Trees may be cut whenever desired, but brush and stumps shall not be removed until 1 week prior the start of construction in that area. The existing ground surface shall be disturbed as little as possible prior to the start of construction.
  - 2. Provide erosion control barriers as shown on the Drawings or as otherwise required to reduce the sediment content of the water. Other methods which reduce the sediment content to an equal or greater degree may be used as approved by the Architect.
  - 3. Ensure that all runoff leaving the site flows to water courses in such a manner to prevent erosion.
  - 4. Loam and seed or mulch disturbed areas as soon as practicable but not contrary to the requirements of other Sections.
- E. Siltation/Sedimentation Basins

## SITE CLEARING

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1. Install temporary siltation/sedimentation basins on site to desilt all storm water or water pumped from excavations.
2. If additional siltation control is required, place check dams or silt fences in ditches receiving storm water from areas disturbed by construction, upon approval of the Architect.
3. Construct siltation/sedimentation ponds in accordance with the requirements of the agencies having jurisdiction over facilities to receive discharge from siltation/sedimentation ponds.

F. Catch Basin Protection

1. Filter Bags
  - a. Install in accordance with manufacturer's recommendations.
  - b. Remove accumulated silt periodically as necessary to maintain effectiveness.
  - c. Dispose of accumulated silt off-site, or on-site as approved by the Architect.

G. Straw Bale/Silt Fence Barrier

1. Install as shown on Drawings to catch silt.
2. Install bales in conjunction with silt fence, unless otherwise indicated.
3. Entrench bales and silt fence into ground and stake in place as shown on Drawings.
4. Remove accumulated silt and replace hay bales and silt fence periodically as necessary to maintain effectiveness.
5. Dispose of accumulated silt off-site, or on-site as approved by the Architect.

H. Existing Drainage Facilities

1. Clean existing storm sewers, culverts, or other drainage facilities which become partially or totally blocked due to siltation from Contractor's operations. Make any necessary arrangements with the jurisdictional agency for the cleaning of the facility.

I. Temporary Drainage Diversion

1. Divert the surface runoff water around the site as may be required.
2. Restore drainage conditions to those existing prior to construction unless otherwise shown on the Drawings.

J. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

K. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

### 3.3 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Owner's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

### 3.4 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. Remove tree branches and dispose of off-site.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

### 3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
  - 1. Limit height of topsoil stockpiles to 72 inches.
  - 2. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity to be stockpiled for reuse.
  - 3. Stockpile surplus topsoil to allow for respreading deeper topsoil.

### 3.6 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.

### 3.7 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 312000 - EARTH MOVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Order of Conditions for this project issued by the City of Worcester Conservation Commission.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Excavating and filling for rough grading the Site.
  - 2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
  - 3. Subbase course for concrete walks and pavements.
  - 4. Subbase course and base course for asphalt paving.
  - 5. Subsurface drainage backfill for walls and trenches.
  - 6. Excavating and backfilling trenches for utilities and pits for buried utility structures.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
  - 2. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
  - 3. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
  - 4. Standard Specification: Massachusetts Department of Public Works Standard Specifications for Highways and Bridges, 1988 edition as amended.

#### 1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - 1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Landscape Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
  - 2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
  - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, will be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock:
  - 1. Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
    - a. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
    - b. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket.
- I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.
- J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

- K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct pre-excavation conference at Project site.
  - 1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
    - a. Personnel and equipment needed to make progress and avoid delays.
    - b. Coordination of Work with utility locator service.
    - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
    - d. Extent of trenching by hand or with air spade.
    - e. Field quality control.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
  - 1. Geotextiles.
  - 2. Controlled low-strength material, including design mixture.
  - 3. Warning tapes.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
  - 1. Classification according to ASTM D2487.
  - 2. Laboratory compaction curve according to ASTM D1557.
- C. Pre-excavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Utility Locator Service: Notify Dig Safe for area where Project is located before beginning earth-moving operations.
- C. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 311000 "Site Clearing" are in place.
- D. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- E. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Owner and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Owner not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Owner's written permission.
- F. 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.
- G. Geotechnical Report: A geotechnical report has been prepared for this Project and is available for information only. The report is not part of the Contract Documents. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of the subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor. The geotechnical report is included elsewhere in the Project Manual.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Ordinary Fill: Well graded, natural inorganic soil approved by the Architect, free of organic or other weak or compressible materials, or frozen materials, and of stones larger than one-half the lift thickness. It shall be of such nature and character that it can be compacted to the specified densities in a reasonable length of time. It shall be free of highly plastic clay, of all materials subject to decay, decomposition, or dissolution, and of cinders or other materials that will corrode piping or other metal. It shall have a minimum dry unit weight of not less than 115 pounds per cubic foot. Material from excavation on the site may be used as ordinary fill if it meets the above requirements.
- E. Processed Gravel: Sound, durable bank or crusher-run gravel and sand, practically free from loam, peat, clay, surface coatings and deleterious materials, well graded as follows:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
3 in.	100
1 ½ in.	70-100
¾ in.	50-85
No. 4	30-60
No. 200	0-10



- F. Crushed Stone or Drainage Fill: Clean crushed stone approved by the Architect and conforming to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
1 in.	100
¾ in.	90-100
½ in.	10-50
3/8 in.	0-20
No. 4	0-5

- G. Screened Gravel: Hard, durable, particles of proper size and gradation, free from sand, loam, clay, excess fines, and deleterious materials. Screened gravel shall meet the requirements of ASTM C33, stone size No. 67 and shall conform to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
1 in.	100
¾ in.	90-100
3/8 in.	20-55
No. 4	0-10
No. 8	0-5

- H. Structural Fill: Clean granular material free from ice, snow, roots, sod, rubbish, loam, peat, clay and other deleterious or organic matter conforming to the following gradation:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
¾ in.	100
No. 4	30-85
No. 40	5-50
No. 200	0-8

- I. Sand Borrow: Clean inert, hard durable grains of quartz or other hard durable rock, free from loam or clay, surface coatings and deleterious materials. The allowable amount of material passing a No. 200 sieve as determined by AASHTO-T11 shall not exceed 10 percent by weight. Maximum particle size shall be 3/8 inch.

- J. Riprap: Stone used for machine placed Riprap shall be hard, durable angular in shape, resistant to weathering and free from organic material and approved by the Architect. The width and thickness of each stone may not be less than one-third its length. Rounded stones or boulders are not acceptable. Shale and stones with shale seams are not acceptable. The minimum unit weight of the stone shall be 155 pounds per cubic foot (bulk-saturated, surface-dry basis AASTHO Test T-85).

1. Stone for Riprap shall meet the following gradation:

<u>Size of stone (lbs)</u>	<u>Percent of Total Weight Less</u>
200	100
120	80
50	50
4	not to exceed 10

2. Each load of Riprap shall be reasonably well graded. Spalls will not be permitted in an amount exceeding 10 percent by weight of each load.
3. Control of gradation will be by visual inspection. The Contractor shall provide at least a 1-ton sample meeting the gradation for frequent reference. The sample may be part of the finished Riprap covering.
4. Any difference of opinion between the Engineer and Contractor shall be resolved by checking two random truck loads of stone. Expenses and labor costs will be provided by the Contractor at no additional cost to the Owner.
5. Blast ledge excavated for the Site may be used as Riprap providing the rock meets the criteria listed above and the material is approved by the Architect.

- K. Controlled Density Fill: Flowable, self-consolidating, rigid setting low-density material conforming to Massachusetts Department of Public Works Standard Specifications for Highways and Bridges, 1988 edition as amended, subsection M4.08.0.
- L. Sand: ASTM C 33/C 33M; fine aggregate.

## 2.2 ACCESSORIES

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Red: Electric.
  2. Yellow: Gas, oil, steam, and dangerous materials.

3. Orange: Telephone and other communications.
  4. Blue: Water systems.
  5. Green: Sewer systems.
- B. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polypropylene with minimum elongation of 50 percent; complying with the following properties determined according to AASHTO M 288:
1. Survivability: Class 2.
  2. Apparent Opening Size: No. 70 sieve, maximum.
  3. Permittivity: 1.4 per second, minimum.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

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

#### 3.2 DEWATERING

- A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

### 3.3 EXPLOSIVES

- A. Explosives:
  - 1. Do not use explosives.
- B. Rock Removal: If rock is encountered during excavation, contact the Owner to establish a procedure for removal.
  - 1. Notify the Owner and other interested authorities at least 48 hours before any blasting is intended.
  - 2. Exercise all possible care in drilling and blasting operations to ensure the stability of the remaining rock and to keep overbreak to a minimum. Produce excavated surfaces that are as smooth and sound as the nature of the rock permits. It is the Contractor's responsibility to produce the most satisfactory surface by use of techniques best suited to job conditions.
  - 3. Presplitting: Form vertical and near vertical faces of excavation in rock by the blasting technique known as presplitting.
    - a. Use presplitting technique for rock cuts 10 feet or more in vertical height where design slope is 1 horizontal to 4 vertical or steeper.
    - b. Locate presplit holes so that the break will occur along the design lines shown on the Drawings.
    - c. Maintain alignment in the vertical plane of not more than 6 inches from the plane of specified slope.
    - d. Extend holes at least to the proposed bench levels and to the bottom of the proposed excavations.
    - e. Space presplit holes at intervals of not more than 24 in. center to center and no larger than 3 in. in diameter.
  - 4. Clean exposed surfaces of rock so that they are free of loose fragments of rock and decomposed rock.

### 3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    - a. 24 inches outside of concrete forms other than at footings.

- b. 12 inches outside of concrete forms at footings.
- c. 6 inches outside of minimum required dimensions of concrete cast against grade.
- d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
- e. 6 inches beneath bottom of concrete slabs-on-grade.
- f. 86 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

### 3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Excavation for Subsurface Infiltration Units, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

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

### 3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
  - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe. Remove all excavated materials not required or unsuitable for backfill and legally dispose of them off-site, or conduit unless provisions for on-site disposal have been approved by the Owner otherwise indicated.
  - 1. Clearance: As indicated.
- C. Trench Bottoms:

1. Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
  - a. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

### 3.8 SUBGRADE INSPECTION

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

### 3.9 UNAUTHORIZED EXCAVATION

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

### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.11 BACKFILL

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

### 3.12 UTILITY TRENCH BACKFILL

- A. Place backfill on subgrades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
  1. Screened Gravel bedding is required below all pipes unless otherwise shown on Drawings or specified herein. Place bedding to the full width of the trench and to mid-diameter of the pipe as indicated on the Drawings.
  2. After a pipe is bedded, fill the trench to the centerline of the pipe with the specified bedding. Carefully and thoroughly tamp bedding around the pipe.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."
- D. Backfill voids with satisfactory soil while removing shoring and bracing.
- E. Initial Backfill:
  1. Soil Backfill: Place and compact initial backfill of subbase material, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
  2. For non-plastic pipe or conduit, place and compact initial backfill of Ordinary Fill, free of particles larger than 1 inch to a height of 12 inches over the utility pipe or conduit.

- a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
3. Fill voids with approved backfill materials as shoring and bracing, and sheeting is removed.
4. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.
- F. Final Backfill:
  1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
  2. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.
- G. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  1. Under grass and planted areas, use satisfactory soil material.
  2. Under walks and pavements, use satisfactory soil material.
  3. Under steps and ramps, use engineered fill.
  4. Under footings and foundations, use engineered fill.
- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

### 3.14 RIPRAP

- A. Place stone for Riprap on the filter bed in a manner that will produce a reasonably well-graded mass of stone with the minimum practical percentage of voids. Distribute stones evenly. Uneven accumulations of large stones or smaller stones is not acceptable.
- B. Place the entire mass of stone in careful conformance with the lines, grades, and thickness shown on the Drawings. Place Riprap to its full course thickness at one operation and in such a manner as to avoid displacing the underlying material. Placing Riprap in layers or by dumping into chutes and similar methods likely to cause segregation is not permitted.



- C. Place Riprap with only sufficient lag to allow for proper stabilization of the embankment. Do not allow the mixing of embankment and Riprap materials.

### 3.15 SOIL MOISTURE CONTROL

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

### 3.16 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:
  - 1. Under structures, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

### 3.17 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch
  - 2. Walks: Plus or minus 1 inch
  - 3. Pavements (except walks): Plus or minus 1/2 inch

### 3.18 SUBSURFACE DRAINAGE

- A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
  - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.
- B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
  - 1. Compact each filter material layer [to 85 percent of maximum dry unit weight according to ASTM D698.
  - 2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

### 3.19 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

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

5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.
- C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

### 3.20 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will 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 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
  2. Retaining Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
  3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

### 3.21 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

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

END OF SECTION 312000

## SECTION 312319 - DEWATERING

### 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. Storm Water Pollution Prevention Plan and NPDES Construction General Permit.
- C. Order of Conditions for this project issued by the City of Worcester Conservation Commission.

#### 1.2 SUMMARY

- A. Section includes:
  - 1. Construction Dewatering.
- B. Construction runoff or dewatering effluent shall not be discharged directly or tributary to stormwater management infiltration systems without the specific approval of the Owner or Engineer. Approval will require effluent water quality testing.
- C. Related Requirements:
  - 1. Section 312000 "Earth Moving" for excavating, backfilling, site grading, and controlling surface-water runoff and ponding.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review condition of site to be dewatered including coordination with temporary erosion-control measures and temporary controls and protections.
  - 3. Review geotechnical report.
  - 4. Review proposed site clearing and excavations.
  - 5. Review existing utilities and subsurface conditions.
  - 6. Review observation and monitoring of dewatering system.

#### 1.4 ACTION SUBMITTALS

- A. Shop Drawings: For dewatering system, prepared by or under the supervision of a qualified professional engineer.
  - 1. Include plans, elevations, sections, and details.
  - 2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
  - 3. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
  - 4. Include written plan for dewatering operations including sequence of well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Submittals:
  - 1. Field quality-control reports.
- B. Qualification Statements: For Installer and professional engineer
- C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.
- D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

#### 1.6 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Installer: An experienced installer that has specialized in design of dewatering systems and dewatering work.

#### 1.7 FIELD CONDITIONS

- A. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of a geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by a geotechnical engineer. Owner is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering in accordance with to performance requirements.
2. The geotechnical report is included elsewhere in Project Manual.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.
  1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
  2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
  3. Prevent surface water from entering excavations by grading, dikes, or other means.
  4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  5. Remove dewatering system when no longer required for construction.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
  2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

## DEWATERING

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1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 311000 "Site Clearing," during dewatering operations.

### 3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  1. Space well points or wells at intervals required to provide sufficient dewatering.
  2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below groundwater level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- D. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

### 3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
  2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and



sediment in a manner that avoids inconvenience to others and in compliance with EPA requirements.

- D. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

### 3.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
  - 1. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.
  - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.
- C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- D. Prepare reports of observations.

### 3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

## SECTION 315000 - EXCAVATION SUPPORT AND PROTECTION

### 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 temporary excavation support and protection systems.
- B. Related Requirements:
  - 1. Section 312000 "Earth Moving" for excavating and backfilling, for controlling surface-water runoff and ponding, and for dewatering excavations.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review geotechnical report.
  - 2. Review existing utilities and subsurface conditions.
  - 3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
  - 4. Review proposed excavations.
  - 5. Review proposed equipment.
  - 6. Review monitoring of excavation support and protection system.
  - 7. Review abandonment or removal of excavation support and protection system.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.

## 1.5 CLOSEOUT SUBMITTALS

- A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

## 1.6 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
  - 2. Do not proceed with interruption of utility without Owner's written permission.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Provide materials that are either new or in serviceable condition.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
  - 1. Shore, support, and protect utilities encountered.

### 3.2 INSTALLATION - GENERAL

- A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.

## EXCAVATION SUPPORT AND PROTECTION

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- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

### 3.3 TRENCH BOXES

- A. Use caution when using a steel trench box to install underground piping or conduit to ensure that items already installed are not pulled apart when the trench box is moved ahead to install the next pipe. It may be necessary to prevent the bottom of the trench box not from extending below mid-diameter of the pipe or to pick the end of the trench box up above mid-diameter before moving it ahead.

### 3.4 MAINTENANCE

- A. Monitor and maintain excavation support and protection system.
- B. Prevent surface water from entering excavations by grading, dikes, or other means.
- C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

### 3.5 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks daily during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.
  - 1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
  - 2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.

- C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

### 3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.
  - 1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
  - 2. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction, and abandon remainder.
  - 3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."
  - 4. Repair or replace, as approved by City, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

## **SECTION 316200 - HELICAL PILE FOUNDATIONS**

### **1. Description**

The Contractor shall be responsible for designing and furnishing all work and materials for installation of helical piles (i.e. helical piles). Helical pile work includes but is not limited to the following:

- Furnish all labor, equipment, materials and incidentals required to design, deliver to the site, and install helical piles as shown on the Drawings and as specified herein. The helical piles shall be designed to provide the allowable capacities specified herein.
- Provide all equipment necessary for the installation of the helical piles at the locations indicated on the Drawings. Each helical pile shall be installed to the minimum length determined by the Contractor using installation torque indicative of the design allowable capacities.
- Provide equipment and materials for the protection of existing utilities, vehicles, pedestrians, and other facilities located within the work area.
- Install helical piles through whatever material is encountered to the required depth to achieve design capacity.
- Helical piles shall be cut-off, as needed, at the elevations required to enable connection of bracket assemblies to the platform floor beams or stringers as shown on the Drawings.
- Provide qualified personnel for design and onsite installation, inspection and record keeping as specified herein.

#### **1.1. Referenced Codes and Standards**

Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title, or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation. In case of conflict, the particular requirements of this specification shall prevail. The latest publication as of the issue of this specification shall govern, unless indicated otherwise.

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

ASTM A29/A29M Steel Bars, Carbon and Alloy, Hot-Wrought and Cold Finished. ASTM A36/A36M Structural Steel.

ASTM A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless. ASTM A153 Zinc Coating (Hot Dip) on Iron and Steel Hardware.

ASTM A252 Welded and Seamless Steel Pipe  
Piles. ASTM A775 Electrostatic Epoxy Coating

ASTM A193/A193M Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.

ASTM A320/A320M Alloy-Steel Bolting Materials for Low Temperature Service.

ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

ASTM A513 Standard Specification for Electric Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

ASTM A536 Standard Specifications for Ductile Iron Castings

ASTM A572 HSLA Columbium-Vanadium Steels of Structural Quality.

ASTM A618 Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing.

ASTM A656 Hot-Rolled Structural Steel, High-Strength Low-Alloy Plate with Improved Formability.

ASTM A958 Standard Specification for Steel Castings, Carbon, and Alloy, with Tensile Requirements, Chemical Requirements Similar to Wrought Grades.

ASTM A1018 Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.

ASTM D1143 Method of Testing Piles Under Static Axial Compressive Load.

ASTM D3689 Method of Testing Individual Piles Under Static Axial Tensile Load.

1.1.2. American Welding Society (AWS):

AWS D1.1 Structural Welding Code – Steel.

AWS D1.2 Structural Welding Code – Reinforcing Steel.

1.1.3. American Society of Civil Engineers (ASCE):

ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations.

1.1.4. Deep Foundations Institute (DFI):

Guide to Drafting a Specification for High Capacity Drilled and Grouted Micropiles for Structural Support, 1<sup>st</sup> Edition, Copyright 2001 by the Deep Foundation Institute (DFI).

1.1.5. Society of Automotive Engineers (SAE):

SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners.

**1.2. Quality Assurance**

The Helical Pile Contractor shall not sublet the whole or any part of the contract without the express written permission of the Owner.

- Helical piles and bracket assemblies shall be installed by a specialized helical pile contractor. The Helical Pile Contractor shall have a minimum of 7 years of experience in designing and installing Helical piles of the type specified herein, including experience with similar subsurface materials, groundwater conditions, helical pile sizes and techniques required.
- The Helical Pile Contractor shall be trained and certified by the helical pile manufacturer in the proper methods of design and installation of helical piles. The Contractor shall provide names of on-site personnel materially involved with the work, including those who carry documented certification from the manufacturer. At a minimum, these personnel shall include foreman, machine operator, and project engineer/manager.
- The Contractor shall employ an adequate number of skilled workers who are experienced in the necessary crafts and who are familiar with the specified requirements and methods needed for proper performance of the work of this specification.
- All Helical Piles shall be installed in the presence of a designated representative of the Owner unless said representative informs the Contractor otherwise. The designated representative shall have the right of access to any and all field installation records and test reports.
- Helical Pile components as specified therein shall be manufactured by a facility whose quality systems comply with ISO (International Organization of Standards) 9001 requirements. Certificates of Registration denoting ISO Standards Number shall be presented upon request to the Owner or their representative.
- The Helical Pile Contractor shall employ a professional engineer registered in the Commonwealth of Massachusetts to design the helical piles; monitor, record, and evaluate the torque test results; and certify that each helical pile has achieved the required capacity. The engineer shall have at least five (5) years of experience in helical pile design, installation and pile load test setup, monitoring, and analysis.



### 1.3. Submittals

Required submittals include Pre-construction Submittals, Post-construction Submittals, and Close-out Submittals.

#### 1.3.1. Pre-Construction Submittals

The Contractor shall prepare and submit to the Engineer, for review and acceptance, working drawings and design calculations for the Helical Piles intended for use at least 14 calendar days prior to planned start of construction. All submittals shall be signed and sealed by a Registered Professional Engineer currently licensed in the Commonwealth of Massachusetts.

Pre-construction Submittals shall include:

- A detailed description of the construction procedures and equipment proposed for installation of the helical piles. Include description of methods to maintain alignment of the piles during installation and the required angle for inclined piles. Procedures shall include a description of mitigating measures to be taken if the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required and if the helical pile is refused or deflected by a subsurface obstruction.
- Working drawings indicating:
  - Helical pile number, location and pattern by assigned identification number
  - Helical pile design load
  - Type and size of central steel shaft for helix segments and riser segments, including transition bars
  - Helix configuration (number and diameter of helix plates) on lead segment and extension segment(s), if required
  - Minimum effective installation torque
  - Minimum overall length
  - Inclination of helical pile
  - Cut-off elevation
  - Helical pile bracket assembly to platform deck beam, including thread bars (if used)
- Shop drawings for all helical pile components, including transition adapters, helical segments, riser segments, thread bar adapters, brackets, and bolt connections. Include identification of manufacturer's catalog numbers.

- Example field log to be used for recording installation details for each helical pile installation.
- Mill test reports for the central steel shaft for the materials delivered to the site. The ultimate strength, yield strength, % elongation, and chemistry composition shall be provided.
- Copies of calibration reports for each torque indicator or torque motor, and all load test equipment to be used on the project. The calibration tests shall have been performed within forty five (45) working days of the date submitted. Helical pile installation and testing shall not proceed until the Engineer has received the calibration reports. These calibration reports shall include, but are not limited to, the following information:
  - Name of project and Contractor
  - Name of testing agency
  - Identification (serial number) of device calibrated
  - Description of calibrated testing equipment
  - Date of calibration
  - Calibration data
- Qualifications of the helical pile contractor and qualifications of the Contractor's Engineer who will design the helical piles and design, monitor, evaluate and prepare report for pile load tests. Qualifications shall satisfy the requirements of Section 1.3 of these specifications.
- ISO9001 certificate for helical pile manufacturer or complete description of product testing and manufacturing quality assurance programs used to assess and maintain product quality.
- Work shall not begin until all the submittals have been received and accepted by the Engineer. The Contractor shall allow the Engineer a reasonable time to review, comment, and return the submittal package after a complete set has been received. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Contractor.

#### 1.3.2. Post-Installation Submittals

- The Contractor shall provide the Engineer copies of helical pile installation records within 24 hours after each installation is completed. Formal copies shall be submitted on a weekly basis. As a minimum, data shall include:
  - Name of project and Contractor
  - Name of Contractor's supervisor during installation

- Date and time of installation
- Name and model of installation equipment
- Type of torque indicator used
- Location of Helical Pile by assigned identification number
- Actual Helical pile type and configuration – including manufacturer's catalogue numbers for lead section (number and size of helix plates), number and type of extension sections, and associated hardware used to make shaft connections and bracket connections to deck
- Helical pile installation duration and observations
- Total length of installed helical pile
- Cut-off elevation
- Inclination of helical pile
- Installation torque at one-foot intervals for the final 10 feet
- Comments pertaining to interruptions, obstructions, or other relevant information
- Certified load capacities

#### 1.3.3. Closeout Submittals

- Submit Warranty documents as specified herein
- Submit, for Engineer's Acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights the Engineer may have under Contract Document.

### 1.4. Design Requirements

Design of the helical piles shall be based on Allowable Stress Design (ASD) and conform to the following minimum design criteria:

- Helical pile manufacturer shall furnish a guarantee for a period of ten (10) years from date of delivery against defects due to manufacturing of helical piles and bracket assemblies. Helical pile manufacturer must carry product liability insurance.
- Helical piles shall be designed to provide minimum allowable design capacities as shown in plans.
- Vertical and inclined helical piles will be located as indicated on the Contract Drawings.

- Piles shall be designed so that the helices derive support entirely in the inorganic soils underlying fill and organic soil strata.
- Minimum factor of safety shall be 2.0. The design loads shall be confirmed with pile load tests as specified herein.
- Design and installation of helical piles shall conform to the manufacturer's recommendations. In the event of a conflict between these specifications and manufacturer's recommendations, the more stringent shall govern.

#### **1.5. Allowable Tolerances**

- Centerline of Helical Piles shall not be more than 3 inches from indicated plan location.
- Vertical piles shall be within 2" of plumb.
- Inclined piles shall be within 5" of design alignment.
- Top elevation of Helical Pile shall be within +1 inch to -2 inches of the design vertical elevation.

#### **1.6. Project Conditions**

The Contractor shall visit the site to review all details of the work and working conditions, to verify dimensions in the field and to advise the Engineer of any discrepancy before performing any work.

The Contractor shall verify that all helical piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc. The Contractor shall consult the Contract Drawings and official records of existing utilities, both surface and subsurface, and their connections to be fully informed on all existing conditions and limitations as they apply to this work. Contractor shall repair or replace any construction induced damage to existing active utilities to the satisfaction of the governing utilityowner at the Contractor's expense.

Subsurface explorations (drive sample borings) were performed at each platform location. Locations of the borings are shown on the Contract Drawings, and Boring Logs are included in Appendix of the Geotechnical Report. Contractor shall review logs of these explorations and other pertinent data for the site as described in the Geotechnical Report. After obtaining Engineer's permission, take whatever additional explorations deemed necessary at no additional cost to the Owner or Engineer. It should be expected that conditions will vary between the explorations.

The aforementioned data is for general information and is accurate only at the particular locations and time the subsurface explorations were made. It is the Contractor's responsibility to make interpretations and draw conclusions on the character of the materials encountered and the impact on this work based on Contractor's expert knowledge of the area and helical pile installation techniques.

## 2. Materials

It is the helical pile installation contractor's responsibility to select the appropriate size and type of helical piles and bracket assemblies to support the loads stated in these specifications. These specifications provide minimum requirements to aid the contractor in making appropriate materials selections. The size and number of helical blades must be such that the helical piles achieve the appropriate torque and capacity in the soils at this site. Failure to achieve proper torque and capacity shall result in contractor replacing helical piles as appropriate to support the required loads. All installation procedures, materials, and replacements shall be acceptable to the Engineer.

### 2.1. Helical Piles

Contractor's design of the helical piles shall conform to the minimum material requirements stated below:

- Central steel shaft consisting of lead helical segments, helical extensions and welded adapter bars used to transition to 3-1/2 inch OD riser pipe: use hot rolled solid steel bars meeting dimensional and workmanship requirements of ASTM A29. The bar shall be at least 1.75 inches square and consist of high strength low alloy, low to medium carbon steel grade with improved strength due to fine grain size and shall have a minimum yield strength of 90 ksi and a torque strength rating of at least 11,000 ft-lb.
- Central steel shaft riser above lead helical segment or helical extension: use 3-1/2 inch OD structural steel pipe, seamless or straight-seam welded, per ASTM A500 or A513. Wall thickness is 0.300 inch (Schedule 80). Pipe shall have minimum yield strength of 50ksi and a torque strength rating of 13,000 ft-lb.
- Helix bearing plate shall be hot rolled carbon steel sheet, strip or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate material shall conform to ASTM A572, A1019, or A656 with minimum yield strength of 50 ksi. Plate thickness is 3/8 inch.
- Bolts used to connect the central steel shaft sections together shall be 3/4 inch diameter per ASTM A320 Grade L7 or ASTM A325.
- Coupling shall be formed as an integral part of the helical extension segment and riser segment as hot upset forged sockets.
- Walkway vertical and angled bracket assembly plates shall be rated for the design loads specified herein and the strength of the structure they support. The bracket assembly for vertical helical piles shall be bolted to the riser section to resist tension loading.
- Thread bars shall be used to form the connection between the riser section and angled brackets for inclined helical piles. Bolts for the bracket assembly are specified on the Contract Drawings.

## **2.2. General**

Helical pile shaft connections shall be in-line, straight and rigid and shall have a maximum tolerable slack of 1/16 inch or as otherwise accepted by the Engineer. All helical pile bolts shall be securely snug tightened.

All components of helical piles shall be hot-dipped galvanized in accordance with ASTM A123 and/or A153, as applicable, after fabrication.

The Contractor may be allowed to use materials that with structural capacities greater than or equal to those specified, based solely on the opinion of the Engineer.

Helical piles shall be designed for a Service Life of 50 years.

## **3. Construction Requirements**

Contractor shall be responsible for selecting installation equipment, tooling and procedures for installing helical piles. These specifications provide minimum requirements to aid the contractor in making appropriate selections.

### **3.1. Installation Equipment and Material Acceptance**

Loads specified in Article 1.5 are allowable design loads. A minimum factor of safety of 2.0 shall be used to determine the required ultimate tensile and compressive capacity of the helical piles with regard to their interaction with soil. Helical pile capacity in soil depends on the geometric configuration of the helical blades about the lead section and the subsurface conditions. The torque applied during installation provides an indirect verification of axial capacity. Manufacturer's recommendations should be followed regarding the torque and the tensile/bearing capacity relationship for the particular helical pile selected. The number and size of blades shall be determined by the Contractor so as to achieve the required torque and tensile/bearing capacity for the soil conditions at the site. However, the ratio of design allowable capacity to the total area of the helical blades shall not exceed the allowable subsurface material bearing capacity.

Helical piles shall be advanced into the ground until the required torque is achieved to accommodate the ultimate tensile and bearing capacity plus an additional distance to ensure proper embedment. For the helical piles, the embedment length shall be achieved by continuing advancement while maintaining or exceeding the required torque for the last three (3) feet of penetration.

### **3.2. Installation Equipment and Material Acceptance**

All drive tools and equipment shall comply with the manufacturer's written installation instructions.

All helical pile installation equipment and materials shall be acceptable to the Engineer prior to delivery to the site. Acceptance will be based upon submission of records and data, as discussed in the Specifications. Once accepted, changes in installation equipment and materials will not be permitted without additional review and acceptance, and will be considered only after Contractor has submitted any and all information requested by Engineer.

### **3.3. Installing Helical Piles**

Loads specified in Article 1.5 are allowable design loads. A minimum factor of safety of 2.0 shall be used to determine the required ultimate tensile and compressive capacity of the helical piles with regard to their interaction with soil. Helical pile capacity in soil depends on the geometric configuration of the helical blades about the lead section and the subsurface conditions. The torque applied during installation provides an indirect verification of axial capacity. Manufacturer's recommendations should be followed regarding the torque and the tensile/bearing capacity relationship for the particular helical pile selected. The number and size of blades shall be determined by the Contractor so as to achieve the required torque and tensile/bearing capacity for the soil conditions at the site. However, the ratio of design allowable capacity to the total area of the helical blades shall not exceed the allowable subsurface material bearing capacity.

Helical piles shall be advanced into the ground until the required torque is achieved to accommodate the ultimate tensile and bearing capacity plus an additional distance to ensure proper embedment. For the helical piles, the embedment length shall be achieved by continuing advancement while maintaining or exceeding the required torque for the last three (3) feet of penetration.

### **3.4. Installation Procedures**

- The Helical Pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project.
- The lead section shall be positioned at the locations shown on the working drawings. Battered Helical Piles can be positioned perpendicular to the ground to assist in initial advancement into the soil before the required batter angle is established. The Helical Pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 to 20 RPM's. Extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt(s) and nut torqued to 40 ft-lb.
- Sufficient down pressure shall be applied to uniformly advance the Helical Pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.

### **3.5. Termination Criteria**

- The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.

- The minimum installation torque and minimum overall length criteria as shown on the working drawings shall be satisfied prior to terminating the Helical Pile installation.
- If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum overall length required, the Contractor shall have the following options:
  - Terminate the installation at the depth obtained subject to the review and acceptance of the Owner, or:
  - Remove the existing Helical Pile and install a new one with fewer and/or smaller diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.
- If the minimum installation torque as shown on the working drawings is not achieved at the minimum overall length, and there is no maximum length constraint, the Contractor shall have the following options:
  - Install the Helical Pile deeper using additional extension sections, or:
  - Remove the existing Helical Pile and install a new one with additional and/or larger diameter helix plates. The new helix configuration shall be subject to review and acceptance of the Owner. If re-installing in the same location, the top-most helix of the new Helical Pile shall be terminated at least (3) three feet beyond the terminating depth of the original Helical Pile.
  - De-rate the load capacity of the Helical Pile and install additional Helical Pile(s). The de-rated capacity and additional Helical Pile location shall be subject to the review and acceptance of the Owner.
- If the Helical Pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the Helical Pile re-installed. If the obstruction can't be removed, the Helical Pile shall be installed at an adjacent location, subject to review and acceptance of the Owner.
- If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the final elevation, the Contractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Contractor may cut said extension shaft to the correct elevation. The Contractor shall not reverse (back-out) the Helical Pile to facilitate extension removal.
- The average torque for the last three feet of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings.



The average torque shall be defined as the average of the last three readings recorded at one-foot intervals.

### **3.6. Non-Conforming Helical piles**

Non-conforming helical piles include anchors that are not installed within tolerances as specified in these specifications, are damaged, are not installed to the required torque, or the helical pile is not installed in the specified bearing stratum. To mitigate and/or remedy nonconforming helical piles, the Contractor may be required to provide additional helical piles or supplement helical piles to meet specified requirements at no additional cost to the Owner. Mitigating measures shall be submitted for review and acceptance by the Engineer. Re-use of components of helical piles that had been previously installed and removed shall be at the acceptance by the Engineer.

### **3.7. Field Modifications**

Field welding, if required, shall be in accordance with the "Code for Welding in Building Construction" of the American Welding Society. Welding of galvanized steel can produce toxic gases and should be done in adequate ventilation and with appropriate gas detection, breathing gear, and other safety equipment per OSHA regulations. Modification of manufactured helical pile shaft, helical blades, bracket assemblies, and shaft connections is prohibited and shall not be performed without approval of product manufacturing company and acceptance by the Engineer.

### **3.8. Quality Assurance Observation**

Installation of helical piles shall be observed by the Engineer to verify the length, final installation torque, and load capacity tests. Contractor shall notify Engineer at least 24 hours prior to installation work.

## **4. Method of Measurement and Basis of Payment**

HELICAL PILE shall be measured by the lineal feet of helical pile placed, measured from the bottom of the timber deck beam to the bottom of the pile, complete in place. Payment for materials shown on the plans or specified herein as being part of the HELICAL PILE which may be incidental to their construction shall be included as part of the contract unit bid price. HELICAL PILE will be paid for at the contract unit bid price per lineal foot, which price shall include all labor, materials and incidental costs to complete the work.

## SECTION 321216 - ASPHALT PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Hot-mix asphalt paving.
  - 2. Precast concrete curbs.
  - 3. Asphalt surface treatments.
- B. Related Requirements:
  - 1. Section 024119 "Selective Demolition" for demolition and removal of existing asphalt pavement.
  - 2. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
  - 3. Section 321313 "Concrete Paving" for concrete pavement and for separate concrete curbs.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
    - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
    - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Include technical data and tested physical and performance properties.
  - 1. Herbicide.
  - 2. Joint sealant.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For paving-mix manufacturer.
- B. Material Certificates: For each paving material, from manufacturer.
  - 1. Aggregates.
  - 2. Asphalt binder.
  - 3. Tack coat.
- C. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
- B. Testing Agency Qualifications: Qualified in accordance with ASTM D3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the Commonwealth of Massachusetts Department of Transportation Standard Specifications for Highways and Bridges, 2021 edition as amended ("Standard Specification") for asphalt paving work.
  - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

#### 1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
  - 1. Prime Coat: Minimum surface temperature of 60 deg F
  - 2. Tack Coat: Minimum surface temperature of 60 deg F

3. Asphalt Base Course and Binder Course: Minimum surface temperature of 40 deg F and rising at time of placement.
4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

## PART 2 - PRODUCTS

### 2.1 AGGREGATES

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: Comply with section M3.11.04A of the Standard Specification.
- C. Fine Aggregate: Comply with section M3.11.04B of the Standard Specification.
- D. Mineral Filler: Comply with section M3.11.05 of the Standard Specification.

### 2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO MP 1, PG 64-28.
- B. Asphalt Cement: Comply with section M3.01.0 of the Standard Specification.
- C. Tack Coat: AASHTO M 140 emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- D. Water: Potable.
- E. Undersealing Asphalt: ASTM D3141/D3141M; pumping consistency.

### 2.3 AUXILIARY MATERIALS

- A. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.
- B. Sand: ASTM D1073, Grade No. 2 or No. 3.
- C. Joint Sealant: ASTM D6690, hot-applied, single-component, polymer-modified bituminous sealant.

## ASPHALT PAVING

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## 2.4 MIXES

- A. Hot-Mix Asphalt: Type I-1 conforming to the Standard Specifications, Sections 420 and 460, and M3.11.03 for binder course, top course and dense mix job mix formulas.
  - 1. Binder course: Conform to the Standard Specifications M3.01.01 for binder course hot mix asphalt in accordance with the job mix formula installed in one layer.
  - 2. Top course: Conform to the Standard Specifications M3.11.4 for top course hot mix asphalt in accordance with the job mix formula installed in one layer.

## 2.5 PRECAST CONCRETE CURBING

- A. Reinforced Concrete, minimum compressive strength of 4,000 psi at 28 days, and 5 to 7 percent entrained air.
- B. Treated with a protective coating of linseed anti-spalling compound consisting of a mixture of 50 percent boiled linseed oil conforming to ASTM D260, and 50 percent mineral spirits conforming to ASTM D235.
- C. Smooth Formed Finish:
  - 1. Use clean forms to provide smooth finish.
  - 2. Surfaces shall be substantially free of irregularities or voids.
  - 3. No concrete may be used to patch surface.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proceed with paving only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

## ASPHALT PAVING

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1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by City, and replace with compacted backfill or fill as directed.

### 3.3 SURFACE PREPARATION

- A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.
- B. Herbicide Treatment: Apply herbicide in accordance with manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
  1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..
  1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.4 HOT-MIX ASPHALT PLACEMENT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
  2. Place hot-mix asphalt surface course in single lift.
  3. Spread mix at a minimum temperature of 250 deg F.
  4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
  5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
  2. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.5 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
  2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
  3. Offset transverse joints, in successive courses, a minimum of 24 inches.
  4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
  5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  6. Compact asphalt at joints to a density within 2 percent of specified course density.

### 3.6 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density, Marshall Test Method: 96 percent of reference laboratory density in accordance with AASHTO T 245, but not less than 94 percent or greater than 100 percent.
  2. Average Density, Rice Test Method: 92 percent of reference maximum theoretical density in accordance with ASTM D2041/D2041M, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
- I.

### 3.7 INSTALLATION TOLERANCES

- A. Grade: Maximum grades of pavement shall meet the following requirements unless otherwise indicated:
1. Handicap Parking Area: 2 percent.
  2. Sidewalk, Transverse: 2 percent.
  3. Sidewalk, Longitudinal: 5 percent.
  4. Ramp, Transverse: 2 percent.
  5. Ramp, Longitudinal: 1:12 rise to run ratio.
- B. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:
1. Binder Course: Plus or minus 1/2 inch.
  2. Surface Course: Plus 1/4 inch, no minus.
- C. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:



1. Binder Course: 1/4 inch.
2. Surface Course: 1/8 inch.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/D3549M.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with AASHTO T 168.
  1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
  2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.
    - a. Field density of in-place compacted pavement may be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 321216

## SECTION 321723 - PAVEMENT MARKINGS

### 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. Painted markings applied to asphalt paving.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to marking asphalt paving or concrete surfaces including, but not limited to, the following:
    - a. Asphalt-paving or concrete-surface aging period before application of pavement markings.
    - b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Include technical data and tested physical and performance properties.
  - 1. Pavement-marking paint, alkyd.
- B. Shop Drawings:
  - 1. Indicate pavement markings, colors, lane separations, defined parking spaces, and dimensions to adjacent work.
- C. Samples: For each exposed product and for each color and texture specified; on rigid backing, 8 inches square.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain pavement-marking paints from single source from single manufacturer.

2.2 PAVEMENT-MARKING PAINT

- A. Pavement-Marking Paint, Alkyd: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N; colors complying with FS TT-P-1952F.
  - 1. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that pavement-marking substrate is dry and in suitable condition to begin pavement marking in accordance with manufacturer's written instructions.
- B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with City.
- B. Allow asphalt paving or concrete surfaces to age for a minimum of 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

PAVEMENT MARKINGS

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3.3 PROTECTING AND CLEANING

- A. Protect pavement markings from damage and wear during remainder of construction period.
- B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723

## SECTION 323223 - SEGMENTAL RETAINING WALLS

### 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. Segmental retaining walls.
- B. Related Requirements:
  - 1. Section 312000 "Earth Moving" for excavation for segmental retaining walls, base material, soil fill, fill placement and compaction, and field in-place density testing.

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Show sizes, profiles, coursing, and locations of retaining wall units; including backfill and leveling base materials.
  - 2. Show types, sizes, locations of soil reinforcing materials.
  - 3. Signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated Design Submittals: For segmental retaining walls, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of segmental retaining wall unit from manufacturer.
  - 1. Include test data for shear strength between segmental retaining wall units in accordance with ASTM D6916.
  - 2. Include test data for connection strength between segmental retaining wall units and soil reinforcement in accordance with ASTM D6638.
- B. Test and Evaluation Reports:
  - 1. Product Test Reports: For each type of segmental retaining wall unit for tests performed by qualified testing agency.
    - a. Include test data for shear strength between segmental retaining wall units in accordance with ASTM D6916.
    - b. Include test data for connection strength between segmental retaining wall units and soil reinforcement in accordance with ASTM D6638.
  - 2. Preconstruction Test Reports: For segmental retaining wall units.

## 1.6 QUALITY ASSURANCE

- A. Qualifications: Qualified in accordance with ASTM E329 for testing indicated.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
- B. Store geosynthetics in manufacturer's original packaging with labels intact. Store and handle geosynthetics to prevent deterioration or damage due to sunlight, chemicals, flames, temperatures above 160 deg F or below 32 deg F, and other conditions that might damage them. Verify identification of geosynthetics before use, and examine them for defects as material is placed.

## PART 2 - PRODUCTS

### 2.1 SEGMENTAL RETAINING WALL UNITS

- A. Concrete Units: ASTM C1372, Normal Weight, except that maximum water absorption shall not exceed 7 percent by weight and units shall not differ in height more than plus or minus 1/16 inch from specified dimension.

## SEGMENTAL RETAINING WALLS

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1. Provide units that comply with requirements in ASTM C1372 for freeze-thaw durability.
  2. Provide units that interlock with courses above and below by means of integral lugs, lips, or tongues and grooves.
- B. Color: As selected by City from manufacturer's full range.
- C. Shape and Texture:
1. Provide units with shaped exposed face with deeply beveled vertical edges.
    - a. Face Dimensions:
      - 1) 18 inches high by 46 inches long.
  2. Provide units matching basic shape, dimensions, and face texture of basis-of-design product.
  3. Provide units of any basic shape and dimensions that produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with shaped exposed face with deeply beveled vertical edges.
- D. Batter: Provide units that offset from course below to provide 1:20 batter.
- E. Cap Units: Provide cap units of same shape as other units with smooth, as-cast top surfaces without holes or lugs.
- F. Special Units: Provide corner units, end units, and other shapes as needed to produce segmental retaining walls of dimensions and profiles indicated and to provide texture on exposed surfaces matching face.

## 2.2 INSTALLATION MATERIALS

- A. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
- B. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
- C. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
- D. Leveling Base: Comply with requirements in Section 312000 "Earth Moving" for base course.
- E. Drainage Fill: Comply with requirements in Section 312000 "Earth Moving" for drainage course.

- F. Nonreinforced-Soil Fill: Comply with requirements in Section 312000 "Earth Moving" for satisfactory soils.
- G. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.
- H. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation of greater than 50 percent.
  - 1. Apparent Opening Size: No. 70 to 100 sieve, maximum; ASTM D4751.
  - 2. Minimum Grab Tensile Strength: 110 lb; ASTM D4632/D4632M.
  - 3. Minimum Weight: 4 oz./sq. yd..

## 2.3 SOURCE QUALITY CONTROL

- A. Factory test and inspect each roll of soil reinforcement for minimum average roll values for geosynthetic index property tests, including the following:
  - 1. Weight.
  - 2. Grab or single-rib strength.
  - 3. Aperture opening.
  - 4. Rib or yarn size.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF RETAINING WALLS

- A. General: Place units in accordance with NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
  - 1. Lay units in running bond.
  - 2. Form corners and ends by using special units or cutting units with motor-driven saw.
- B. Do not use units with chips, cracks, or other defects that are visible at a distance of 20 feet where such defects are exposed in the completed Work.

## SEGMENTAL RETAINING WALLS

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- C. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight in accordance with ASTM D698.
- D. First Course: Place first course of segmental retaining wall units for full length of wall. Place units in firm contact with each other, properly aligned and level.
  - 1. Tamp units into leveling base as necessary to bring tops of units into a level plane.
- E. Subsequent Courses: Remove excess fill and debris from tops of units in course below. Place units in firm contact, properly aligned, and directly on course below.
  - 1. For units with lugs designed to fit into holes in adjacent units, lay units so lugs are accurately aligned with holes, and bedding surfaces are firmly seated on beds of units below.
  - 2. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
  - 3. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
  - 4. For units with pins, install pins and align units.
  - 5. For units with clips, install clips and align units.
- F. Cap Units: Place cap units and secure with cap adhesive.

### 3.3 FILL PLACEMENT

- A. General: Comply with requirements in Section 312000 "Earth Moving," with NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
- B. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
- C. Place, spread, and compact drainage fill and soil fill in uniform lifts for full width and length of embankment as wall is laid. Place and compact fills without disturbing alignment of units. Where both sides of wall are indicated to be filled, place fills on both sides at same time. Begin at wall, and place and spread fills toward embankment.
  - 1. Use only hand-operated compaction equipment within 48 inches of wall or one-half of height above bottom of wall, whichever is greater.
  - 2. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight in accordance with ASTM D698.
    - a. In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight in accordance with ASTM D698.

- b. In areas where fill height exceeds 15 feet, compact reinforced-soil fill that will be more than 15 feet below finished grade to not less than 98 percent maximum dry unit weight in accordance with ASTM D698.
    - c. In areas where fill height exceeds 30 feet, compact reinforced-soil fill that will be more than 30 feet below finished grade to not less than 100 percent maximum dry unit weight in accordance with ASTM D698.
  - 3. Compact nonreinforced-soil fill to comply with Section 312000 "Earth Moving."
  - D. Place drainage geotextile against back of wall, and place layer of drainage fill at least 12 inches wide behind drainage geotextile to within 12 inches of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.
  - E. Place a layer of drainage fill at least 12 inches wide behind wall to within 12 inches of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
  - F. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.
  - G. Place impervious fill over top edge of drainage fill layer.
  - H. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at wall base away from wall. Provide uniform slopes that prevent ponding.
  - I. Place soil reinforcement in horizontal joints of retaining wall where indicated and in accordance with soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
    - 1. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
    - 2. Place geosynthetics with seams, if any, oriented perpendicularly to segmental retaining walls.
    - 3. Do not dump fill material directly from trucks onto geosynthetics.
    - 4. Place at least 6 inches of fill over reinforcement before compacting with tracked vehicles or 4 inches before compacting with rubber-tired vehicles.
    - 5. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.
- 3.4 CONSTRUCTION TOLERANCES
- A. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet, 3 inches maximum.

- B. Variation from Indicated Batter: For slope of wall face, do not vary from indicated slope by more than 1-1/4 inches in 10 feet.
- C. Variation from Indicated Wall Line: For walls indicated as straight, do not vary from straight line by more than 1-1/4 inches in 10 feet.
- D. Maximum Gap between Units: 1/8 inch.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Comply with requirements in Section 312000 "Earth Moving" for field quality control.
- C. Tests and Inspections:
  - 1. In each compacted backfill layer, perform at least one field in-place compaction test for each 24 inches of fill depth and each 50 feet or less of segmental retaining wall length.
  - 2. Segmental retaining wall system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### 3.6 ADJUSTING

- A. Remove and replace segmental retaining wall construction of the following descriptions:
  - 1. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if City approves methods and results.
  - 2. Segmental retaining walls that do not comply with other requirements indicated.
- B. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 323223

## SECTION 329200 - TURF AND GRASSES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Seeding.
  - 2. Hydroseeding.
- B. Related Requirements:
  - 1. Section 329300 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and mow strips.

#### 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. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include 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. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
  - 2. Experience: Three years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Pesticide Applicator: State licensed, commercial.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

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.
3. Accompany each delivery of bulk materials with appropriate certificates.

1.9 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion.

1. Spring Planting: May 1 to June 30.
2. Fall Planting: September 1 to November 30.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
2. Quality, Non-State Certified: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
3. Sun and Partial Shade, Cool-Season Grass: Proportioned by weight as follows:
  - a. 50 percent Kentucky bluegrass (*Poa pratensis*).
  - b. 30 percent chewings red fescue (*Festuca rubra* variety).
  - c. 10 percent perennial ryegrass (*Lolium perenne*).
  - d. 10 percent redtop (*Agrostis alba*).

## 2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition:
    - a. 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
    - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition:
    - a. 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
    - b. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

## 2.3 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- D. Asphalt Emulsion: ASTM D977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

## 2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## 2.5 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 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. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is 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 Architect and replace with new planting soil.

### 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
  - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.



### 3.3 TURF AREA PREPARATION

- A. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
- B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 PREPARATION FOR EROSION-CONTROL MATERIALS

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

### 3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft..
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

### 3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Mix slurry with fiber-mulch manufacturer's recommended tackifier.
  - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 1500-lb/acre dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

### 3.7 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow to a height of 1-1/2 to 2 inches.
- D. Turf Postfertilization: Apply commercial fertilizer after initial mowing and when grass is dry.

1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

### 3.8 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Architect:
  1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

### 3.9 PESTICIDE APPLICATION

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

### 3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

### 3.11 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately

after each area is planted and continue until acceptable turf is established, but for not less than the following periods:

1. Seeded Turf: 60 days from date of Substantial Completion.
  - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

END OF SECTION 329200

## SECTION 329300 - PLANTS

### 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. Plants.
  - 2. Tree stabilization.
- B. Related Requirements:
  - 1. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

#### 1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than sizes indicated; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- D. Finish Grade: Elevation of finished surface of planting soil.
- E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- F. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- G. Planting Area: Areas to be planted.
- H. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- I. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- J. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- K. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- L. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### 1.4 COORDINATION

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

#### 1.5 PREINSTALLATION MEETINGS

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

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- B. Samples for Verification: For each of the following:
  - 1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.

Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis of standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

#### 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
  - 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
  - 2. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.

#### 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- 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.
  3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
  1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.



1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

#### 1.11 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
  1. Spring Planting: May 1 to June 30.
  2. Fall Planting: September 1 to November 30.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

#### 1.12 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures including plantings falling or blowing over.
    - c. Faulty performance of tree stabilization.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  2. Warranty Periods: From date of planting completion.
    - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
  3. Include the following remedial actions as a minimum:

- a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
- b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
- c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
- d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.
  2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to City, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

## 2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
  - 1. Size: 5-gram tablets.
  - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

## 2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Type: Ground or shredded bark.
  - 2. Size Range: 3 inch maximum, 1/2 inch minimum.
  - 3. Color: Natural.

## 2.4 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## 2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
  - 1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
  - 2. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
  - 3. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
  - 4. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.

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## 2.6 MISCELLANEOUS PRODUCTS

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

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  - 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. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. 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 City and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants 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.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain City's acceptance of layout before excavating or planting. Make minor adjustments as required.

### 3.3 PLANTING AREA ESTABLISHMENT

- A. Placing Planting Soil: Place manufactured planting soil over exposed subgrade.
- B. Before planting, obtain City's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
  - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  - 2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
  - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
  - 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  - 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  - 6. Maintain supervision of excavations during working hours.
  - 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
  - 8. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify City if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
  - 1. Hardpan Layer: Drill 6-inch-diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.
- D. Drainage: Notify City if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

### 3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
  - 1. Backfill: Planting soil
  - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: Two per plant.
  - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch above adjacent finish grades.
  - 1. Backfill: Planting soil.
  - 2. Carefully remove root ball from container without damaging root ball or plant.
  - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: Two per plant.
  - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.

- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

### 3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.

### 3.7 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:
  - 1. Upright Staking and Tying:
    - a. Stake trees of 2- through 5-inch caliper. Stake trees of less than 2-inch caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
    - b. Stake trees with two stakes for trees up to 12 feet high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 feet high and up to 4 inches in caliper. Space stakes equally around trees.
  - 2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
  - 3. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

### 3.8 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 30-inch radius around trunks or stems. Do not place mulch within 2 inches of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 2 inches of trunks or stems.

### 3.9 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### 3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### 3.11 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by City.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by City.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that City determines are incapable of restoring to normal growth pattern.
  - 1. Provide new trees of same size as those being replaced.
  - 2. Species of Replacement Trees: Same species being replaced.



### 3.12 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

### 3.13 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: 12 months from date of planting completion.

END OF SECTION 329300

## SECTION 330500 - COMMON WORK RESULTS FOR UTILITIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping joining materials.
  - 2. Transition fittings.
  - 3. Equipment installation common requirements.
  - 4. Concrete bases.

#### 1.3 DEFINITIONS

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

#### 1.4 DELIVERY, STORAGE, AND HANDLING

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

## 1.5 COORDINATION

- A. Coordinate installation of identifying devices after completing covering and painting if devices are applied to surfaces.
- B. Coordinate size and location of concrete bases. Formwork, reinforcement, and concrete requirements are specified in Section 033000 "Cast-in-Place Concrete."

## PART 2 - PRODUCTS

### 2.1 PIPING JOINING MATERIALS

- A. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- B. Solvent Cements for Joining Plastic Piping:
  - 1. ABS Piping: ASTM D2235.
  - 2. CPVC Piping: ASTM F493.
  - 3. PVC Piping: ASTM D2564. Include primer according to ASTM F656.
  - 4. PVC to ABS Piping Transition: ASTM D3138.

### 2.2 TRANSITION FITTINGS

- A. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
- B. Transition Couplings NPS 1-1/2 and Smaller:
  - 1. Underground Piping: Manufactured piping coupling or specified piping system fitting.
- C. AWWA Transition Couplings NPS 2 and Larger:
  - 1. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
- D. Plastic-to-Metal Transition Fittings:
  - 1. Description: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint or threaded end.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
  - 1. Description: ASTM C1173 with elastomeric sleeve ends same size as piping to be joined, and corrosion-resistant metal band on each end.

## PART 3 - EXECUTION

### 3.1 PIPED UTILITY DEMOLITION

- A. Refer to Section 024119 "Selective Demolition" for general demolition requirements and procedures.
- B. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 PIPING INSTALLATION

- A. Install piping according to the following requirements and utilities Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Drawings.
- C. Install piping at indicated slopes.
- D. Install piping free of sags and bends.
- E. Install fittings for changes in direction and branch connections.

### 3.3 PIPING JOINT CONSTRUCTION

- A. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D3212.
- B. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### 3.4 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.

## COMMON WORK RESULTS FOR UTILITIES

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3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

END OF SECTION 330500

## SECTION 331415 - SITE WATER DISTRIBUTION 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. Water-distribution piping and related components for domestic water service.

#### 1.3 DEFINITIONS

- A. CDA: Copper Development Association.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. PA: Polyamide (nylon) plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
  - 1. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: For piping and specialties including relation to other services in same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- B. Field Quality-Control Submittals:
  - 1. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product indicated.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare piping, valves, meters, backflow prevention devices, and fire hydrants according to the following:
  - 1. Ensure that piping, valves, meters, backflow prevention devices, and fire hydrants are dry and internally protected against rust and corrosion.
  - 2. Protect threaded ends and flange faces against damage.
  - 3. Set piping, valves, meters, backflow prevention devices, and fire hydrants in best position for handling and to prevent rattling.
- B. During Storage: Use precautions for piping, valves, meters, and backflow prevention devices, according to the following:
  - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
  - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle products if size requires handling by crane or lift. Rig products to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

## 1.8 PROJECT CONDITIONS

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

## 1.9 COORDINATION

- A. Coordinate connection to water main with municipal water department.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of municipal water department. Include tapping of water mains and backflow prevention.
- B. Comply with standards of authorities having jurisdiction for domestic water-service piping, including materials, installation, testing, and disinfection.
- C. Piping materials to bear label, stamp, or other markings of specified testing agency.
- D. All piping and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372 or are certified in compliance with NSF 61/NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

### 2.2 PIPING MATERIALS

- A. Comply with requirements in "Piping Applications" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and service sizes.



- B. Potable-water piping and components comply with NSF 14, NSF 61, and NSF 372.

## 2.3 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type K.
- B. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

## 2.4 PE PIPE AND FITTINGS

- A. PE, ASTM Pipe: ASTM D2239, SDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 200 psig.
  - 1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
  - 2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

## 2.5 PIPING JOINING MATERIALS

- A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series.
- B. Gaskets for Ferrous Piping and Copper-Alloy Tubing: ASME B16.21, asbestos free.
- C. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.6 PIPING SPECIALTIES

- A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
- B. Flexible Connectors:
  - 1. Nonferrous-Metal Piping: Bronze hose covered with bronze wire braid; with copper-tube, pressure-type, solder-joint ends or bronze flanged ends brazed to hose.
  - 2. Ferrous-Metal Piping: Stainless steel hose covered with stainless steel wire braid; with ASME B1.20.1, threaded steel pipe nipples or ASME B16.5, steel pipe flanges welded to hose.

## 2.7 GATE VALVES

- A. Gate Valves - AWWA, Cast Iron:
1. Source Limitations: Obtain gate valves - AWWA, cast iron, from single manufacturer.
  2. Gate Valves - Nonrising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
    - a. Standards: AWWA C509 or AWWA C515.
    - b. Minimum Pressure Rating: 200 psig.
    - c. End Connections: Mechanical joint, flanged, threaded, or push on.
    - d. Interior Coating: Complying with AWWA C550.
  3. Gate Valves - OS&Y, Rising Stem, Resilient Seated: Cast- or ductile-iron body and bonnet, with bronze or cast- or ductile-iron gate, resilient seats, and bronze stem.
    - a. Standard: AWWA C509 or AWWA C515.
    - b. Minimum Pressure Rating: 200 psig.
    - c. End Connections: Mechanical joint, flanged, threaded, or push on.

## 2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

- A. Tapping-Sleeve Assemblies: Sleeve and valve compatible with drilling machine.
1. Source Limitations: Obtain tapping-sleeve assemblies from single manufacturer.
  2. Standard: MSS SP-60.
  3. Tapping Sleeve: Cast- or ductile-iron or stainless steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
  4. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.
- B. 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, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches in diameter.
1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
- C. Indicator Posts: UL 789, FM Global approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

## 2.9 WATER METERS

- A. Water Meters - Displacement Type:
1. Source Limitations: Obtain water meters - displacement type, from single manufacturer.
  2. Standard: AWWA C700.
  3. Pressure Rating: 150 psig working pressure.
  4. Body Design: Nutating disc; totalization meter.
  5. Registration: Flow in gal. as required by utility company.
  6. Case: Bronze.
  7. End Connections: Threaded or flanged.

## 2.10 WATER METER BOXES

- A. Water Meter Boxes:
1. Cast-iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.
    - a. Option: Base section may be cast-iron, PVC, clay, or other pipe.
  2. Cast-iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.
  3. Water Meter Boxes: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping. Include vertical and lateral design loadings of 15,000 lb minimum over 10 by 10 inches square.

## 2.11 BACKFLOW PREVENTERS

- A. Backflow Preventers - Reduced-Pressure Principle:
1. Source Limitations: Obtain backflow preventers - reduced-pressure principle, from single manufacturer.
  2. Standard: AWWA C511.
  3. Operation: Continuous-pressure applications.
  4. Pressure Loss: 12 psig maximum, through middle one-third of flow range.
  5. Size: TBD
  6. Design Flow Rate: TBD.
  7. Selected Unit Flow Range Limits: TBD.
  8. Pressure Loss at Design Flow Rate: TBD for NPS 2 and smaller.
  9. Body: Bronze for NPS 2 and smaller.
  10. End Connections: Threaded for NPS 2 and smaller.
  11. Configuration: Designed for horizontal, straight through flow.

12. Accessories:

- a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
- b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.

2.12 PROTECTIVE ENCLOSURES

- A. Expanded-Metal Enclosures: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.
  - 1. Source Limitations: Obtain expanded-metal enclosures from single manufacturer.
  - 2. Standard: ASTM F1267.
  - 3. Material: Expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
  - 4. Type: II, expanded and flattened.
  - 5. Class: 3, corrosion-resistant steel.
  - 6. Finish: Manufacturer's enamel paint.
  - 7. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
  - 8. Locking device.
  - 9. Lugs or devices for securing enclosure to base.
- B. Enclosure Bases: 4-inch-minimum thickness precast concrete, of dimensions required to extend at least 6 inches beyond edges of enclosure housings. Include openings for piping.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with excavating, trenching, and backfilling requirements in Section 312000 "Earth Moving."

3.2 PIPING APPLICATIONS

- A. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.
- B. Do not use flanges or unions for underground piping.
- C. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

D. Underground water-service piping NPS 3/4 to NPS 3 to be the following:

1. Soft copper tube, ASTM B88, Type K; and brazed joints.
2. PE, ASTM pipe; and clamped joints.

### 3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FM Global, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 and smaller installation.

### 3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Comply with Section 330500 "Common Work Results for Utilities" for piping-system common requirements.
- B. Provide a continuous bare copper or aluminum tracer wire not less than 0.10 inch in diameter in sufficient length over each separate run of nonmetallic pipe.

### 3.5 INSTALLATION OF PIPING

A. Water-Main Connection:

1. Arrange with utility company for tap of size and in location indicated in water main.
2. Tap water main in accordance with requirements of water utility company and of size and in location indicated.

B. Make connections NPS 2 and smaller with drilling machine according to the following:

1. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
2. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
3. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
4. Install corporation valves into service-saddle assemblies.
5. Install curb valve in water-service piping with head pointing up and with service box.

### 3.6 JOINT CONSTRUCTION

- A. Comply with Section 330500 "Common Work Results for Utilities" for basic piping joint construction.
- B. Make pipe joints according to the following:
  - 1. Copper-Tubing, Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools and procedures recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
  - 2. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners in accordance with fitting manufacturer's written instructions.

### 3.7 INSTALLATION OF VALVES

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL-Listed or FM Global-Approved Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL-Listed or FM Global-Approved Valves Other Than Gate Valves: Comply with NFPA 24.
- E. MSS Valves: Install as component of connected piping system.
- F. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves.
- G. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.
- H. Comply with requirements for concrete piers in Section 033000 "Cast-in-Place Concrete" for support of valves and piping not direct buried.

### 3.8 INSTALLATION OF WATER METERS

- A. Install water meters, piping, and specialties in accordance with utility company's written instructions.
- B. Water Meters:
  - 1. Install displacement-type water meters, NPS 2 and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

### 3.9 INSTALLATION OF BACKFLOW PREVENTERS

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install in accordance with requirements of plumbing and health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

### 3.10 INSTALLATION OF PROTECTIVE ENCLOSURES

- A. Install concrete base level and with top approximately 2 inches above grade.
- B. Install protective enclosure over valves and equipment.
- C. Anchor protective enclosure to concrete base.

### 3.11 CONNECTIONS

- A. See Section 330500 "Common Work Results for Utilities" for piping connections to valves and equipment.
- B. Connect water-distribution piping to existing water main. Use tapping sleeve and tapping valve.

### 3.12 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests before joints are covered and after concrete 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: Test at not less than one-and-one-half times working pressure for two hours.
  - 1. Increase pressure in 50 psig increments and inspect each joint between increments. Hold at test pressure for one hour; decrease to 0 psig. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour

per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

- C. Prepare reports of testing activities.

### 3.13 IDENTIFICATION

- A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."
- B. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Section 330500 "Common Work Results for Utilities" for identifying devices.

### 3.14 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 authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
    - 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 three 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.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331415



## SECTION 334200 - STORMWATER CONVEYANCE

### 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. Storm Water Pollution Prevention Plan and NPDES Construction General Permit.
- C. Order of Conditions for this project issued by the City of Worcester Conservation Commission.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. PE pipe and fittings.
  - 2. Non-pressure transition couplings.
  - 3. Manholes.
  - 4. Catch basins.
  - 5. Stormwater detention structures.
  - 6. Pipe outlets.
  - 7. Water Quality Inlets
- B. Construction and permanent runoff or dewatering effluent shall not be discharged directly or tributary to stormwater management infiltration systems without the specific approval of the Owner or Engineer. Approval will require effluent water quality testing.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Manholes: Include plans, elevations, sections, details, frames, and covers.
  - 2. Catch basins. Include plans, elevations, sections, details, frames, covers, and grates.
  - 3. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.
  - 4. Water Quality Inlets: Include plans, elevations, sections, details, frames, covers, and grates.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from storm drainage system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
- B. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- C. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
- D. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

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

### PART 2 - PRODUCTS

#### 2.1 CORRUGATED-PE PIPE AND FITTINGS

- A. Source Limitations: Obtain corrugated-PE pipe and fittings from single manufacturer.
- B. Corrugated-PE Drainage Pipe and Fittings NPS 3 to NPS 10: AASHTO M 252, Type S, with smooth waterway for coupling joints.
- C. Corrugated-PE Pipe and Fittings NPS 12 to NPS 60: AASHTO M 294, Type S, with smooth waterway for coupling joints.

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- D. Corrugated-PE Silttight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.

## 2.2 MANHOLES

### A. Standard Precast Concrete Manholes:

1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
2. Diameter: 48 inches minimum unless otherwise indicated.
3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
9. Steps: Individual FRP steps or FRP ladder, wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings with level or sloped edge in thickness and diameter matching manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.

### B. Manhole Frames and Covers:

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch-minimum width flange and 26-inch-diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60-40-18 ductile iron unless otherwise indicated.

## 2.3 CONCRETE

- A. General: Cast-in-place concrete in accordance with ACI 318, ACI 350, and the following:

1. Cement: ASTM C150/C150M, Type II.
  2. Fine Aggregate: ASTM C33/C33M, sand.
  3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
  4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
  2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.
- C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
1. Reinforcing Fabric: ASTM A1064/A1064M, steel, welded wire fabric, plain.
  2. Reinforcing Bars: ASTM A615/A615M, Grade 60 (420 MPa) deformed steel.

## 2.4 CATCH BASINS

- A. Standard Precast Concrete Catch Basins:
1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  2. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
  3. Riser Sections: 4-inch minimum thickness, 48-inch diameter, and lengths to provide depth indicated.
  4. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  5. Joint Sealant: ASTM C990, bitumen or butyl rubber.
  6. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and shape matching catch basin frame and grate. Include sealant recommended by ring manufacturer.
  7. Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch total thickness, that match 24-inch-diameter frame and grate.
  8. Pipe Connectors: ASTM C923, resilient, of size required, for each pipe connecting to base section.
- B. Frames and Grates: ASTM A536, Grade 60-40-18, ductile iron designed for A-16 (AASHTO HS20-44), structural loading. Include flat grate with small square or short-slotted drainage openings.
1. Size: 24 by 24 inches minimum unless otherwise indicated.
  2. Grate Free Area: Approximately 50 percent unless otherwise indicated.

## 2.5 WATER QUALITY INLETS

- A. The water quality inlet shall be as indicated on the Contract Drawings and is a Contech CDS1515-3-C.
- B. Other acceptable equivalent models may be used if the following requirements are met and approval is received from the City.
  - 1. Calculations stamped by a Professional Engineer shall be supplied to demonstrate that the alternate water quality structures will accept the design flow rates without causing a backwater condition.
  - 2. The water quality structure shall have a proven record of having the capability to remove a minimum of 80% total suspended solids load from the low-flow storm conditions from the total catchment area of the drainage system. The structure must be capable of removing clay size particles. The water quality structure shall be installed underground as part of the stormwater system.
  - 3. All precast concrete components shall be designed and manufactured to a minimum live load of AASHTO HS-20 truck loading or greater based on local regulatory specifications.
  - 4. Water quality structure shall be equipped with high flow bypass that regulates the flow rate into the treatment chamber and conveys high flows directly to the outlet such that scour and/or re-suspension of material previously collected in the interceptor does not occur. The bypass area shall be physically separated from the separation area to prevent mixing.
  - 5. The structure shall be maintainable from the surface via access points without requiring entry into the interceptor.
  - 6. The structure shall be able to be installed to the invert elevations of the drainage system as detailed on the Contract Drawings.
  - 7. The water quality structure shall be capable of containing spills of floatable substances such as oil and gasoline within the structure without the use of floatable additives.
  - 8. The water quality structure shall not be compromised by backwater conditions i.e., trapped pollutants should not be re-suspended and scoured from the interceptor during backwater conditions.
  - 9. The concrete joints shall be water-tight and meet the design criteria according to ASTM C- 443. Mastic sealants or butyl tape are not an acceptable alternative.
  - 10. The frame and cover shall include an indented top design with lettering of the unit's name cast into the cover to allow for easy identification in the field.
    - a. Grates on structures in plaza areas or subject to direct pedestrian traffic shall be fully compliant with the applicable ADA/MAAB regulations and standards.
  - 11. All precast concrete sections shall be inspected to ensure that dimensions, appearance and quality of the product meet local specifications and ASTM C 478

## 2.6 STORMWATER DISPOSAL SYSTEMS

- A. Chamber Systems:
  - 1. Source Limitations: Obtain chamber systems from single manufacturer.
  - 2. Storage and Leaching Chambers: Molded PE with perforated sides and open bottom. Include number of chambers, distribution piping, end plates, and other standard components as required for system total capacity.
  - 3. Filtering Material: ASTM D448, Size No. 24, 3/4- to 2-1/2-inch washed, crushed stone or gravel.
  - 4. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd..

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section 312000 "Earth Moving."

### 3.2 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Install gravity-flow, nonpressure drainage piping in accordance with the following:
  - 1. Install piping pitched down in direction of flow.
  - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
  - 3. Install piping with 36-inch-minimum cover.

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4. Install PE corrugated sewer piping in accordance with ASTM D2321.

### 3.3 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping in accordance with the following:
  1. Join corrugated-PE piping in accordance with ASTM D3212 for push-on joints.

### 3.4 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants in accordance with ASTM C891.
- C. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

### 3.5 CATCH BASIN INSTALLATION

- A. Construct catch basins to sizes and shapes indicated.
- B. Set frames and grates to elevations indicated.

### 3.6 WATER QUALITY INLET INSTALLATION

- A. General: Install water quality inlets according to water quality inlet manufacturer's written instructions.
- B. Install water quality inlets, complete with appurtenances and accessories indicated.
- C. Install precast concrete sections with sealants according to ASTM C 891.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements.

### 3.7 CONCRETE PLACEMENT

- A. Place cast-in-place concrete in accordance with ACI 318.

### 3.8 STORMWATER DISPOSAL SYSTEM INSTALLATION

- A. Chamber Systems: Excavate trenches of width and depth, and install system and backfill in accordance with chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

### 3.9 CONNECTIONS

- A. Make connections to existing piping and underground manholes.
  - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
  - 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
  - 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
    - a. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
    - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- B. Connect to sediment interceptors specified in Section 221323 "Sanitary Waste Interceptors."
- C. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.



### 3.10 IDENTIFICATION

- A. Materials and their installation are specified in Section 312000 "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

### 3.11 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
  - 1. Submit separate reports for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.
  - 2. Test completed piping systems in accordance with requirements of authorities having jurisdiction.
  - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - 4. Submit separate report for each test.
  - 5. Gravity-Flow Storm Drainage Piping: Test in accordance with requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    - b. Option: Test plastic piping in accordance with ASTM F1417.
- C. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.12 CLEANING

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

END OF SECTION 334200