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**County of Ventura  
Annual Road Rehabilitation  
Job Order Contract**

**Project #50492  
Specification #RD12-08**

**Technical Specifications**

**CSI SECTIONS 01000 - 03000**

**March 2012**

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**SECTION 01204 - NO SPECIFICATION REQUIRED**

1.1 GENERAL

- A. A separate specification is not required for this item. The description given in the line item of the Construction Task Catalog completely defines the item.

1.2 PRODUCTS - (Not Used)

1.3 EXECUTION - (Not Used)

END OF SECTION 01204



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
01352	01204	No Specification Required

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## SECTION 01510 - CONSTRUCTION WASTE MANAGEMENT

### 1.1 GENERAL

#### A. Summary

1. This Section includes administrative and procedural requirements for the following:
  - a. Salvaging nonhazardous demolition and construction waste.
  - b. Recycling nonhazardous demolition and construction waste.
  - c. Disposing of nonhazardous demolition and construction waste.

#### B. Definitions

1. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
2. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
3. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.
4. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.
5. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.
6. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

#### C. Performance Goals **OR** Requirements, **as directed**

1. General: Develop waste management plan that results in end-of-Project rates for salvage/recycling of 50 **OR** 75, **as directed**, percent by weight of total waste generated by the Work.
2. Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible including the following materials:

##### **OR**

Salvage/Recycle Goals **OR** Requirements, **as directed**: Owner's goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible. Owner has established minimum goals for the following materials:

- a. Demolition Waste:
  - 1) Asphaltic concrete paving.
  - 2) Concrete.
  - 3) Concrete reinforcing steel.
  - 4) Brick.
  - 5) Concrete masonry units.
  - 6) Wood studs.
  - 7) Wood joists.
  - 8) Plywood and oriented strand board.
  - 9) Wood paneling.
  - 10) Wood trim.
  - 11) Structural and miscellaneous steel.
  - 12) Rough hardware.
  - 13) Roofing.
  - 14) Insulation.
  - 15) Doors and frames.
  - 16) Door hardware.
  - 17) Windows.





- 18) Glazing.
- 19) Metal studs.
- 20) Gypsum board.
- 21) Acoustical tile and panels.
- 22) Carpet.
- 23) Carpet pad.
- 24) Demountable partitions.
- 25) Equipment.
- 26) Cabinets.
- 27) Plumbing fixtures.
- 28) Piping.
- 29) Supports and hangers.
- 30) Valves.
- 31) Sprinklers.
- 32) Mechanical equipment.
- 33) Refrigerants.
- 34) Electrical conduit.
- 35) Copper wiring.
- 36) Lighting fixtures.
- 37) Lamps.
- 38) Ballasts.
- 39) Electrical devices.
- 40) Switchgear and panelboards.
- 41) Transformers.
- b. Construction Waste:
  - 1) Site-clearing waste.
  - 2) Masonry and CMU.
  - 3) Lumber.
  - 4) Wood sheet materials.
  - 5) Wood trim.
  - 6) Metals.
  - 7) Roofing.
  - 8) Insulation.
  - 9) Carpet and pad.
  - 10) Gypsum board.
  - 11) Piping.
  - 12) Electrical conduit.
  - 13) Packaging: Regardless of salvage/recycle goal indicated above, salvage or recycle 100 percent of the following uncontaminated packaging materials:
    - a) Paper.
    - b) Cardboard.
    - c) Boxes.
    - d) Plastic sheet and film.
    - e) Polystyrene packaging.
    - f) Wood crates.
    - g) Plastic pails.

#### D. Submittals

1. Waste Management Plan: Submit 3 copies of plan within 7 **OR** 30, **as directed**, days of date established for commencement of the Work **OR** the Notice to Proceed **OR** the Notice of Award, **as directed**.
2. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit three copies of report. Include separate reports for demolition and construction waste, **as directed**. Include the following information:
  - a. Material category.



- b. Generation point of waste.
  - c. Total quantity of waste in tons (tonnes).
  - d. Quantity of waste salvaged, both estimated and actual in tons (tonnes).
  - e. Quantity of waste recycled, both estimated and actual in tons (tonnes).
  - f. Total quantity of waste recovered (salvaged plus recycled) in tons (tonnes).
  - g. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.
3. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.
  4. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.
  5. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.
  6. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
  7. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.
  8. LEED Submittal: LEED letter template for Credit MR 2.1 and 2.2, **as directed**, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.
  9. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.
  10. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.
- E. Quality Assurance
1. Waste Management Coordinator Qualifications: LEED Accredited Professional by U.S. Green Building Council. Waste management coordinator may also serve as LEED coordinator.
  2. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
  3. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.
  4. Waste Management Conference: Conduct conference at Project site. Review methods and procedures related to waste management including, but not limited to, the following:
    - a. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
    - b. Review requirements for documenting quantities of each type of waste and its disposition.
    - c. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
    - d. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
    - e. Review waste management requirements for each trade.
- F. Waste Management Plan
1. General: Develop plan consisting of waste identification, waste reduction work plan, and cost/revenue analysis. Include separate sections in plan for demolition and construction waste if Project requires selective demolition or building demolition. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.
  2. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.
  3. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.



- a. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
  - b. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
  - c. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
  - d. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
  - e. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
  - f. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.
4. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include the following:
- a. Total quantity of waste.
  - b. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
  - c. Total cost of disposal (with no waste management).
  - d. Revenue from salvaged materials.
  - e. Revenue from recycled materials.
  - f. Savings in hauling and tipping fees by donating materials.
  - g. Savings in hauling and tipping fees that are avoided.
  - h. Handling and transportation costs. Include cost of collection containers for each type of waste.
  - i. Net additional cost or net savings from waste management plan.

## 1.2 PRODUCTS (Not Used)

## 1.3 EXECUTION

### A. Plan Implementation

1. General: Implement waste management plan as approved by the Owner. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.
  - a. Comply with Division 01 Section "Temporary Facilities And Controls" for operation, termination, and removal requirements.
2. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.
3. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.
  - a. Distribute waste management plan to everyone concerned within three days of submittal return.
  - b. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.
4. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - a. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.



- b. Comply with Division 01 Section "Temporary Facilities And Controls" for controlling dust and dirt, environmental protection, and noise control.
- B. Salvaging Demolition Waste
  - 1. Salvaged Items for Reuse in the Work:
    - a. Clean salvaged items.
    - b. Pack or crate items after cleaning. Identify contents of containers.
    - c. Store items in a secure area until installation.
    - d. Protect items from damage during transport and storage.
    - e. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.
  - 2. Salvaged Items for Sale and Donation: Permitted **OR** Not permitted, **as directed**, on Project site.
  - 3. Salvaged Items for Owner's Use:
    - a. Clean salvaged items.
    - b. Pack or crate items after cleaning. Identify contents of containers.
    - c. Store items in a secure area until delivery to Owner.
    - d. Transport items to Owner's storage area on-site **OR** off-site **OR** designated by Owner, **as directed**.
    - e. Protect items from damage during transport and storage.
  - 4. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.
- C. Recycling Demolition And Construction Waste, General
  - 1. General: Recycle paper and beverage containers used by on-site workers.
  - 2. Recycling Receivers and Processors: Refer to the Owner for available recycling receivers and processors.
  - 3. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Owner **OR** accrue to Contractor **OR** be shared equally by Owner and Contractor, **as directed**.
  - 4. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical.
    - a. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
      - 1) Inspect containers and bins for contamination and remove contaminated materials if found.
    - b. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
    - c. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
    - d. Store components off the ground and protect from the weather.
    - e. Remove recyclable waste off Owner's property and transport to recycling receiver or processor.
- D. Recycling Demolition Waste
  - 1. Asphaltic Concrete Paving: Grind asphalt to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
    - a. Crush asphaltic concrete paving and screen to comply with requirements in Division 02 Section "Earthwork" for use as general fill.
  - 2. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility.
  - 3. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.
    - a. Pulverize concrete to maximum 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
    - b. Crush concrete and screen to comply with requirements in Division 02 Section "Earthwork" for use as satisfactory soil for fill or subbase.



4. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.
  - a. Pulverize masonry to maximum 3/4-inch (19-mm) **OR** 1-inch (25-mm) **OR** 1-1/2-inch (38-mm) **OR** 4-inch (100-mm), **as directed**, size.
    - 1) Crush masonry and screen to comply with requirements in Division 02 Section "Earthwork" for use as general fill **OR** satisfactory soil for fill or subbase, **as directed**.
    - 2) Crush masonry and screen to comply with requirements in Division 02 Section "Exterior Plants" for use as mineral mulch.
  - b. Clean and stack undamaged, whole masonry units on wood pallets.
5. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.
6. Metals: Separate metals by type.
  - a. Structural Steel: Stack members according to size, type of member, and length.
  - b. Remove and dispose of bolts, nuts, washers, and other rough hardware.
7. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.
8. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.
9. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.
  - a. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.
10. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
  - a. Store clean, dry carpet and pad in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.
11. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.
12. Plumbing Fixtures: Separate by type and size.
13. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.
14. Lighting Fixtures: Separate lamps by type and protect from breakage.
15. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.
16. Conduit: Reduce conduit to straight lengths and store by type and size.

E. Recycling Construction Waste

1. Packaging:
  - a. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
  - b. Polystyrene Packaging: Separate and bag materials.
  - c. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
  - d. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.
2. Site-Clearing Wastes: Chip brush, branches, and trees on-site **OR** at landfill facility, **as directed**.
  - a. Comply with requirements in Division 02 Section "Exterior Plants" for use of chipped organic waste as organic mulch.
3. Wood Materials:
  - a. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
  - b. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.
    - 1) Comply with requirements in Division 02 Section "Exterior Plants" for use of clean sawdust as organic mulch.
4. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location.





- a. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
  - 1) Comply with requirements in Division 02 Section "Exterior Plants" for use of clean ground gypsum board as inorganic soil amendment.
- F. Disposal Of Waste
  - 1. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.
    - a. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
    - b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 2. Burning: Do not burn waste materials.  
**OR**  
Burning: Burning of waste materials is permitted only at designated areas on Owner's property, provided required permits are obtained. Provide full-time monitoring for burning materials until fires are extinguished.
  - 3. Disposal: Transport waste materials and dispose of at designated spoil areas on Owner's property.  
**OR**  
Disposal: Transport waste materials off Owner's property and legally dispose of them.

END OF SECTION 01510



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**SECTION 01520 - TEMPORARY FACILITIES AND CONTROLS****1.1 GENERAL****A. Summary**

1. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

**B. Definitions**

1. Permanent Enclosure: As determined by the Owner, permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and all openings are closed with permanent construction or substantial temporary closures.

**C. Use Charges**

1. General: Cost or use charges for temporary facilities shall be included in the Contract Sum. Allow other entities to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, the Owner, occupants of Project, testing agencies, and authorities having jurisdiction.
2. Water Service: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.
3. Electric Power Service: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

**D. Submittals**

1. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

**E. Quality Assurance**

1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
2. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

**F. Project Conditions**

1. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

**1.2 PRODUCTS****A. Materials**

1. Pavement: Comply with Division 02 Section(s) "Asphalt Paving" OR "Cement Concrete Pavement", **as directed**.
2. Chain-Link Fencing: Minimum 2-inch (50-mm), 0.148-inch- (3.76-mm-) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-mm-) OD top rails **OR** with galvanized barbed-wire top strand, **as directed**.
3. Portable Chain-Link Fencing: Minimum 2-inch (50-mm), 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 m) high with galvanized steel pipe posts; minimum 2-3/8-inch- (60-mm-) OD line posts and 2-7/8-inch- (73-mm-) OD corner and pull posts, with 1-5/8-inch- (42-



mm-) OD top and bottom rails. Provide concrete **OR** galvanized steel, **as directed**, bases for supporting posts.

4. Wood Enclosure Fence: Plywood, 6 feet (1.8 m) **OR** 8 feet (2.4 m), **as directed**, high, framed with four 2-by-4-inch (50-by-100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
5. Lumber and Plywood: Comply with requirements in Division 06 Section(s) "Rough Carpentry" **OR** "Miscellaneous Carpentry", **as directed**.
6. Gypsum Board: Minimum 1/2 inch (12.7 mm) thick by 48 inches (1219 mm) wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C 36/C 36M.
7. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
8. Paint: Comply with requirements in Division 09.

#### B. Temporary Facilities

1. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
2. Common-Use Field Office: Of sufficient size to accommodate needs of construction personnel. Keep office clean and orderly. Furnish and equip offices as follows:
  - a. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
  - b. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack board.
  - c. Drinking water and private toilet.
  - d. Coffee machine and supplies.
  - e. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
  - f. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.
3. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.
  - a. Store combustible materials apart from building.

#### C. Equipment

1. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.
2. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.
  - a. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  - b. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  - c. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return air grille in system and remove at end of construction.

### 1.3 EXECUTION

#### A. Installation, General

1. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.
  - a. For greenfield sites if reduced site disturbance is required for LEED-NC Credit SS 5.1: Locate facilities to limit site disturbance as specified in General Requirements.



2. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

B. Temporary Utility Installation

1. General: Install temporary service or connect to existing service.
  - a. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
2. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.
  - a. Connect temporary sewers to municipal system **OR** private system indicated, **as directed**, as directed by authorities having jurisdiction.
3. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.  
**OR**  
Water Service: Use of Owner's existing water service facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
  - a. Where installations below an outlet might be damaged by spillage or leakage, provide a drip pan of suitable size to minimize water damage. Drain accumulated water promptly from pans.
4. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
  - a. Toilets: Use of Owner's existing toilet facilities will be permitted, as long as facilities are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.
5. Heating **OR** Heating and Cooling, **as directed**: Provide temporary heating **OR** heating and cooling, **as directed**, required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.
6. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
7. Electric Power Service: Use of Owner's existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to Owner.  
**OR**  
Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.
  - a. Install electric power service overhead **OR** underground, **as directed**, unless otherwise indicated.
  - b. Connect temporary service to Owner's existing power source, as directed by Owner.
8. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - a. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
  - b. Install lighting for Project identification sign.
9. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line for each field office.
  - a. Provide additional telephone lines for the following:
    - 1) Provide a dedicated telephone line for each facsimile machine and computer in each field office.
  - b. At each telephone, post a list of important telephone numbers.
    - 1) Police and fire departments.
    - 2) Ambulance service.





- 3) Contractor's home office.
- 4) the Owner's office.
- 5) Owner's office.
- 6) Principal subcontractors' field and home offices.
- c. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.
- 10. Electronic Communication Service: Provide temporary electronic communication service, including electronic mail, in common-use facilities.
  - a. Provide DSL **OR** T-1 line, **as directed**, in primary field office.

#### C. Support Facilities Installation

- 1. General: Comply with the following:
  - a. Provide incombustible construction for offices, shops, and sheds located within construction area or within 30 feet (9 m) of building lines. Comply with NFPA 241.
  - b. Maintain support facilities until near Substantial Completion. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.
- 2. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated **OR** within construction limits indicated, **as directed**, on Drawings.
  - a. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.
- OR**
- 3. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
  - a. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
  - b. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 02 Section "Earthwork".
  - c. Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.
  - d. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course according to Division 02 Section "Asphalt Paving".
- 4. Traffic Controls: Comply with requirements of authorities having jurisdiction.
  - a. Protect existing site improvements to remain including curbs, pavement, and utilities.
  - b. Maintain access for fire-fighting equipment and access to fire hydrants.
- 5. Parking: Provide temporary **OR** Use designated areas of Owner's existing, **as directed**, parking areas for construction personnel.
- 6. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
  - a. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
  - b. Remove snow and ice as required to minimize accumulations.
- 7. Project Identification and Temporary Signs: Provide Project identification and other signs as indicated on Drawings, **OR as directed**. Install signs where indicated to inform public and individuals seeking entrance to Project. Unauthorized signs are not permitted.
  - a. Provide temporary, directional signs for construction personnel and visitors.
  - b. Maintain and touchup signs so they are legible at all times.
- 8. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with General Requirements for progress cleaning requirements.
- 9. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.



- a. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
  10. Temporary Elevator Use: Refer to Division 14 for temporary use of new elevators.
  11. Existing Elevator Use: Use of Owner's existing elevators will be permitted, as long as elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.
    - a. Do not load elevators beyond their rated weight capacity.
    - b. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.
  12. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
  13. Existing Stair Usage: Use of Owner's existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
    - a. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If, despite such protection, stairs become damaged, restore damaged areas so no evidence remains of correction work.
  14. Temporary Use of Permanent Stairs: Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.
- D. Security And Protection Facilities Installation
1. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
  2. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.
    - a. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
  3. Stormwater Control: Comply with authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
  4. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.
  5. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Obtain extended warranty for Owner. Perform control operations lawfully, using environmentally safe materials.
  6. Site Enclosure Fence: Before construction operations begin **OR** When excavation begins, **as directed**, furnish and install site enclosure fence in a manner that will prevent people and animals from easily entering site except by entrance gates.
    - a. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations **OR** As indicated on Drawings, **as directed**.
    - b. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Owner with one set of keys, **as directed**.
  7. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.



8. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.
9. Covered Walkway: Erect structurally adequate, protective, covered walkway for passage of individuals along adjacent public street(s). Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawings, **OR as directed**.
  - a. Construct covered walkways using scaffold or shoring framing.
  - b. Provide wood-plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
  - c. Extend back wall beyond the structure to complete enclosure fence.
  - d. Paint and maintain in a manner approved by Owner and the Owner.
10. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.
  - a. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.
11. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Owner and tenants from fumes and noise.
  - a. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
  - b. If containment of airborne particles and dust generated by construction activities is critical to occupants of other spaces in building, e.g., occupied healthcare facilities: Construct dustproof partitions with 2 layers of 3-mil (0.07-mm) polyethylene sheet on each side. Cover floor with 2 layers of 3-mil (0.07-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant plywood.
    - 1) Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1219 mm) between doors. Maintain water-dampened foot mats in vestibule.
  - c. Insulate partitions to provide noise protection to occupied areas.
  - d. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
  - e. Protect air-handling equipment.
  - f. Weather strip openings.
  - g. Provide walk-off mats at each entrance through temporary partition.
12. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.
  - a. Prohibit smoking in hazardous fire-exposure **OR** construction, **as directed**, areas.
  - b. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
  - c. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
  - d. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

#### E. Operation, Termination, And Removal

1. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
2. Maintenance: Maintain facilities in good operating condition until removal.
  - a. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.



3. Operate Project-identification-sign lighting daily from dusk until 12:00 midnight.
4. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.
5. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - a. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  - b. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
  - c. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in General Requirements

END OF SECTION 01520



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
01520	01204	No Specification Required
01550	01204	No Specification Required
01560	01204	No Specification Required
01580	01204	No Specification Required
01590	01204	No Specification Required



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**SECTION 01720 - CUTTING AND PATCHING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for cutting and patching. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. This Section includes procedural requirements for cutting and patching.

**C. Definitions**

1. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
2. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

**D. Submittals**

1. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:
  - a. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
  - b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
  - c. Products: List products to be used and firms or entities that will perform the Work.
  - d. Dates: Indicate when cutting and patching will be performed.
  - e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
  - f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
  - g. the Owner's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

**E. Quality Assurance**

1. LEED Requirements for Building Reuse:
  - a. Credit MR 1.1 and 1.2, **as directed**: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be removed; do not cut such existing construction beyond indicated limits.
  - b. Credit MR 1.3: Maintain existing interior nonstructural elements (interior walls, doors, floor coverings, and ceiling systems) not indicated to be removed; do not cut such existing construction beyond indicated limits.
  - c. Credit MR 1.2 and 1.3, **as directed**: Maintain existing nonshell, nonstructural components (walls, flooring, and ceilings) not indicated to be removed; do not cut such existing construction beyond indicated limits.



2. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
  - a. **Refer to the Owner for list of elements that might otherwise be overlooked as structural elements and that require Architect's or Construction Manager's approval of a cutting and patching proposal.**
3. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety. Operating elements include the following:
  - a. Primary operational systems and equipment.
  - b. Air or smoke barriers.
  - c. Fire-suppression systems.
  - d. Mechanical systems piping and ducts.
  - e. Control systems.
  - f. Communication systems.
  - g. Conveying systems.
  - h. Electrical wiring systems.
  - i. Operating systems of special construction in Division 13.
4. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Miscellaneous elements include the following:
  - a. Water, moisture, or vapor barriers.
  - b. Membranes and flashings.
  - c. Exterior curtain-wall construction.
  - d. Equipment supports.
  - e. Piping, ductwork, vessels, and equipment.
  - f. Noise- and vibration-control elements and systems.
5. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
6. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

F. Warranty

1. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

## 1.2 PRODUCTS

A. Materials

1. General: Comply with requirements specified in other Sections.
2. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - a. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.



### 1.3 EXECUTION

#### A. Preparation

1. Temporary Support: Provide temporary support of Work to be cut.
2. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
3. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
4. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize **OR** prevent, **as directed**, interruption to occupied areas.

#### B. Performance

1. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - a. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - a. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
  - b. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  - c. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  - d. Excavating and Backfilling: Comply with requirements in applicable Division 02 where required by cutting and patching operations.
  - e. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  - f. Proceed with patching after construction operations requiring cutting are complete.
3. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
  - a. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  - b. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - 1) Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - 2) Restore damaged pipe covering to its original condition.
  - c. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - 1) Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.



- d. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
- e. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- 4. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 01720

**SECTION 02011 - SUBSURFACE DRILLING, SAMPLING, AND TESTING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing of labor and equipment for drilling, sampling and testing for subsurface investigation of soils.

**B. System Description:** The purpose of the work specified herein is to determine the type, nature, and characteristics of subsurface materials and the extent and conditions of the various materials as they exist to the depths and at the locations specified. This is to be accomplished by means of auger borings, drive sample borings, undisturbed sample borings, core drilling, pressure testing, or test pits.

1. **Auger Borings and Sampling:** An auger boring is any boring made in unconsolidated soils with a conventional manually or power-driven earth auger for the purpose of obtaining samples of subsurface materials. Auger boring and sampling shall be performed in accordance with ASTM D 1452.
2. **Drive Sample Borings and Sampling:** A drive sample boring is a boring made through unconsolidated or partly consolidated sediments or decomposed rock by means of a mechanically driven sampler. The purpose of these borings is to obtain knowledge of the composition, the thickness, the depth, the sequence, the structure, and the pertinent physical properties of foundation or borrow materials. Drive sample boring and sampling shall be performed in accordance with ASTM D 1587. Standard Penetration Tests (SPT) shall be performed in accordance with ASTM D 1586.
3. **Undisturbed Sample Borings and Sampling:** An undisturbed sample boring is a boring made to obtain soil samples which, when tested, will show properties as close to the in situ (in place) properties as any sample which can be obtained. All undisturbed sampling shall be accomplished in accordance with ASTM D 1587.
4. **Core Drilling:** Drilling of cores shall be performed as per ASTM D 2113. The method used shall provide equally good recovery of cores from both hard and soft rocks.
5. **Pressure Testing (Hydraulic):** Hydraulic pressure testing is the process of forcing water under pressure into subsurface rock formations through pre-drilled holes for the purpose of determining the subsurface leakage conditions and possible grouting requirements.
6. **Test Pit Excavation and Sampling:** A test pit is any excavation in soil, hardpan, decomposed rock, or other unconsolidated or partially consolidated overburden materials which has an open cross-sectional area large enough to permit efficient excavation and shoring/lining, engineering and geological inspection and photographing of the subsurface soils and manual undisturbed sampling from within the test pit. All test pits shall be excavated, dewatered (if necessary), shored/lined and protected from surface water drainage in accordance with all applicable Federal, State, local, and OSHA safety regulations.
7. **Bearing Capacity:** ASTM D 1149.
8. **Soils Classification:** ASTM D 2487, ASTM D 2488, MIL-STD 619.

**C. Submittals**

1. **Permits, Certifications, and Licenses:** Comply with all Federal, State and local laws, regulations and ordinances relating to the performance of this work. The Contractor shall, at his own expense, procure all required permits, certifications and licenses required of him by Federal, State, and local law for the execution of this work. Furnish copies of all such documents to the Owner prior to starting work.
2. **Drilling, Sampling, and Testing Plan:** Prior to starting work, submit a plan for drilling, sampling, testing, and safety. The plan shall include, but not be limited to, the proposed method of drilling and sampling including a description of the equipment and sampling tools that will be used, a listing of any subcontractors to include a description of how the subcontractors will be used and a description of all methods and procedures that will be utilized to ensure a safe operation and to protect the environment. This submittal shall also include a statement of the prior experience, in



the type of work described in these specifications, of the person or persons designated to perform the work specified herein. No work shall be performed until this plan has been approved and no deviation from the approved plan will be permitted without prior approval by the Owner.

3. Drilling Log: Submit complete, legible copies of drilling log and records to the Owner within 5 days after a hole or test pit is completed.

#### D. Care And Delivery Of Samples

1. General: The Contractor shall be solely responsible for preserving all samples in good condition. Keep samples from freezing and from undue exposure to the weather, and shall keep all descriptive labels and designations on sample jars, tubes, and boxes clean and legible until final delivery of samples to, and acceptance by, the Owner. Except as otherwise specified, deliver samples to the Owner. Deliver samples within the time limits specified for each type of investigation or in accordance with schedules prepared by the Owner.
2. Undisturbed Samples: Take every precaution to avoid damage to samples as a result of careless handling and undue delay in shipping. Ship samples in containers approved by the Owner, of sufficient durability to protect the samples from any damage during shipment. Pack sample tubes in vermiculite or other equal material approved by the Owner to protect the samples against vibration. Avoid exposing sealed and crated samples to precipitation, direct sunlight, freezing and temperatures in excess of 100 degrees F (38 degrees C). Samples permitted to freeze, even partially, shall be replaced by the Contractor at his expense. In general, no undisturbed samples shall remain on the site of sampling for more than one week before shipment. Store and ship samples with the tube in a horizontal **OR** vertical, **as directed**, position in order to prevent consolidation and segregation or change of water content.

#### E. Project/Site Conditions

1. Environmental Requirements
  - a. In order to prevent and to provide for abatement and control of any environmental pollution arising from Contractor activities in the performance of this contract, the Contractor and his subcontractors shall comply with all applicable Federal, State, and local laws, regulations, and ordinances concerning environmental pollution control and abatement.
    - 1) The Contractor shall be responsible for keeping informed of all updates and changes in all applicable laws, regulations, and ordinances.
    - 2) The Contractor shall not pollute lakes, ditches, rivers, springs, canals, waterways, groundwaters, or reservoirs with drill fluids, fuels, oils, bitumens, calcium chloride, insecticides, herbicides, or other materials that may be harmful to the environment or a detriment to outdoor recreation.
2. Field Measurements: The approximate locations of drill holes or test pits shall be as directed. The actual locations will be established in the field by the Owner prior to the start of work. The elevations of the established locations will also be provided by the Owner prior to the start of work. The Contractor will provide access to the locations as he deems necessary for the prosecution of the work. Since no separate payment will be made for access construction, all costs associated with this shall be included in the cost of drilling or excavating.

#### F. Sequencing And Scheduling

1. Schedule of Drilling, Sampling and Testing: The schedule of Drilling, Sampling, and Testing is listed in the following schedule:

##### SCHEDULE OF DRILLING, SAMPLING AND TESTING

HOLE NO. or PIT NO.	METHOD	DEPTH FT(M)	VERTICAL or INCLINED	SPECIAL INSTRUCTIONS
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2. Order of Work: The order in which the work is to be accomplished will be determined in the field by the Owner.





## 1.2 PRODUCTS

- A. Containers: Furnish jars, tubes, and boxes that meet the following requirements. All such containers will become the property of the Owner and the cost thereof shall be included in the contract price for the applicable item for which payment is provided.
1. Sample Jars: Sample jars shall be 1 pint (0.5 L) **OR** 1 quart (1.0 L), **as directed**, capacity, wide-mouth over 2-1/4 inches (57 mm) in diameter, glass **OR** plastic, **as directed**, jars with moisture-tight screw tops.
  2. Shipping Boxes: Boxes for shipping sample jars shall be corrugated cardboard **OR** wooden, **as directed**, boxes that have the capacity to hold no more than 12 sample jars and the strength to contain and protect the jars and their contents under ordinary handling and environmental conditions.
  3. Tubes and Crates: Undisturbed samples shall be shipped in thin walled Shelby tubes packed in crates.
  4. Core Boxes: Longitudinally partitioned, hinged top, wooden core boxes constructed of plywood and dressed lumber or other approved materials shall be used for all rock cores. As many core boxes as may be required shall be used to box all core. Core boxes shall be completely equipped with all necessary partitions, hinges, and a hasp for holding down the cover. In addition, the Contractor shall provide wood spacers made of surfaced lumber (not plywood) and having dimensions that are 1/8 inch (3 mm) less than the inside dimensions of the individual core box troughs and no less than 3/4 inch (19 mm) thick for blocking the core in the boxes and for providing a marking space to identify core runs and pull depths/elevations. The quantities of these blocks that are required are: ten blocks per core box for 3-inch (75-mm) or smaller core, five blocks per core box for 4-inch (100-mm) and PQ core, and three blocks per core box for 6-inch (150-mm) core. The box should have the following capacities:

6-inch (150-mm) core	single row of core
4-inch (100-mm) or PQ core	2 rows of core
3-inch (75-mm) or smaller core	3 or 4 rows of core

The maximum length of a core box shall be 4 feet (1.2 m) for 3-inch (75 mm) or smaller core and shall be dimensioned so that a box will hold 12 to 16 feet (3.6 to 4.9 m) of core. The maximum length of a core box for core that is larger than 3 inches (75 mm) shall be 5 feet (1.5 m).
- B. Labels
1. Sample Jar Labels: A printed or type-written, fade resistant and waterproof label shall be affixed to the outside of each jar and shall contain the following information:

PROJECT _____	LOCATION _____
(Such as Table Rock Dam)	(Such as Borrow Area B)
HOLE NO. _____	STATION _____
JAR NO. _____ of _____ JARS	
TOP ELEV. OF HOLE _____	DEPTH OF SAMPLE _____
DESCRIPTION OF MATERIAL _____	
(Such as moist, silty, medium sand)	
  2. Shipping Box Labels: Each box of jar samples shall be identified with weatherproof and wear-proof labels indicating the following:

PROJECT: [_____]
LOCATION: [_____]
JAR SAMPLES FROM HOLE OR HOLES: [_____]
  3. Core Box Labels: Core boxes shall be identified with stenciled labels. The information on this label shall contain the following:

PROJECT: [_____]
HOLE NO. [_____]
BOX NO. [_____]
TOTAL NUMBER OF BOXES FOR THE HOLE: [_____]

## 1.3 EXECUTION



A. Mobilization and Demobilization

1. Mobilization: Mobilization shall consist of the delivery to the site of all plant, equipment, materials and supplies to be furnished by the Contractor, the complete assembly in satisfactory working order of all such plant and equipment at the jobsite and the satisfactory storage at the site of all such materials and supplies.
2. Demobilization: Demobilization shall consist of the removal from the site of all plant, equipment, materials and supplies after completion of the work and also includes, at the direction of the Owner, the cleanup and removal of all scrap, waste backfill material, waste drilling fluid, soil contaminated with engine/hydraulic oil, backfilling all sumps or excavations resulting from the operations and, in general, returning the site as close to its original condition as possible.

B. Equipment and Supplies

1. Auger Boring and Sampling: The equipment to be furnished by the Contractor for making auger borings shall include, but not be limited to, standard continuous flight augers and/or standard cup-type earth augers, similar or equal to the Iwan Auger and not less than 4 inches (100 mm) in diameter unless otherwise approved. The augers shall be completely equipped with all the accessories necessary for boring and sampling of overburden materials to the depths and diameters specified or shown on the drawings.
2. Drive Sample Boring and Sampling: Equipment to be furnished by the Contractor for making drive sample borings shall include, but not be limited to, standard 2-inch (50 mm) split barrel **OR** solid barrel, **as directed**, drive samplers and power-driven drilling machinery of a type or types approved by the Owner, complete with a drive-hammer of the weight as required to meet project requirements, and all other accessories for taking samples of all types of soils or decomposed rock at the locations and to the depths indicated in the schedule in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING. The drive shoe for the split barrel samplers shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. Supplies shall include, but not be limited to, all casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling.
3. Undisturbed Sample Boring and Sampling: Equipment to be furnished by the Contractor for making undisturbed sample borings shall include, but not be limited to, power-driven drilling machinery of an approved type or types complete with the special devices and accessories enumerated and described hereinafter. Drilling machinery shall be of the hydraulic feed type. Supplies shall include, but not be limited to, all samplers, casing, drill stem, drill bits, drill fluid and additives, pumps, and power necessary to accomplish the required boring and sampling. Drill casing, if used, shall be of such minimum inside diameter as to allow use of the selected sampler.
  - a. Sands and Cohesive Soils: The sampling device used to sample fine to medium grain sands and cohesive soils shall be a fixed or stationary piston type that uses a 3-inch (75-mm) **OR** 5-inch (125-mm), **as directed**, diameter thin wall Shelby tube. Subject to the approval of the Owner, floating or free piston and non-piston type samplers may be used provided adequate means, such as check valve or vacuum system, are provided to prevent loss of samples.
  - b. Stiff and Dense Soils: The sampling device for obtaining samples of stiff and dense soils shall be similar or equal to a Denison double tube, swivel head core barrel, or a Pitcher sampler and must be approved by the Owner prior to use.
4. Core Drilling - Size BX and NX Core: Equipment to be furnished by the Contractor for core drilling shall include core-drilling machinery of a type or types approved by the Owner complete with all the accessories needed to take continuous rock cores of a diameter consistent with bit size to the depths specified. The Contractor shall use, as a minimum, a standard ball-bearing, swivel-head, double-tube core barrel, or equivalent. The capacity of the core barrel shall not exceed 10.5 feet (3.2 m) of core. Supplies for core drilling to be furnished by the Contractor shall include, but not be limited to, all casing, drill rods, core barrels, coring bits, piping, pumps, water, tools, and power required for drilling and all boxes and containers required for core samples. Selection of the type of bit shall be at the Contractor's discretion provided that the selected bit produces high quality rock core. (see paragraph SUPPLEMENTAL BORINGS or PITS). The



- Contractor's drilling equipment shall be capable of drilling inclined as well as vertical core holes as specified.
5. Pressure Testing (Hydraulic): Pressure testing equipment to be furnished by the Contractor shall include, but not be limited to, a water pump with a minimum capacity of 50 gallons per minute (3.15 liters per second) that is capable of delivering a constant discharge pressure with double expander packers with rubber expansion elements set 5 feet (1.5 m) **OR** 10 feet (3 m), **as directed**, apart with piping so arranged that water may be admitted either below the bottom packer element or between the two packer elements, a pressure relief valve, a pressure gage capable of measuring water pressures to the nearest 10 psi (1.45 kPa) and water meter capable of measuring flows to the nearest 1.6 gallon(s) per minute (0.1 liter(s) per second). Supplies shall include, but not be limited to, all accessory valves, gages, surge tanks, stopcocks, plugs, expanders, potable water for testing, standby pumps, fuels, pipes, pressure hose, and tools necessary for maintaining uninterrupted tests for each boring to be tested. The pressure test equipment shall be configured so that the pressure gage is located at the top of the hole, a by-pass water line and valve are located between the pump and the gage, a flow meter is located between the by-pass and the pressure gage, and a valve is located in the line between the flow meter and the pressure gage. All equipment and supplies used for pressure testing shall be approved by the Owner prior to use.
  6. Test Pit Excavation and Sampling: Selection of the test pit excavation, shoring/lining and dewatering (if necessary) methods and equipment shall be at the Contractor's discretion but must be approved by the Owner. When the number of test pits to be excavated is large, and when adaptable mechanical trenching equipment is available, the Owner may require that such mechanical excavating equipment be used to expedite completion of the pits. Supplies which the Contractor shall furnish for obtaining undisturbed samples shall include, but not be limited to, split metal cylinders and/or metal or wooden boxes of acceptable sizes and types. Accessories to be supplied by the Contractor shall include, but not be limited to, a small sample trimming shovel or spade, hatchet, trimming knife, wax and facilities for melting and brushing same, trowels, labels, and boxes for shipping samples. The Contractor shall also furnish all materials required for shoring/lining to comply with all applicable safety regulations. The Owner may require the Contractor to salvage and re-use this shoring/lining material in successive test pits.
- C. Identifying Samples: Sample jars, shipping boxes, and labels shall comply with paragraphs SAMPLE JARS, SHIPPING BOXES, and LABELS, respectively. The Contractor shall take all precautions required to insure that the shipping boxes are not subjected to rough handling or damaging environmental conditions, and complies with paragraph CARE AND DELIVERY OF SAMPLES. A copy of the boring log for the portion of the boring that the samples came from shall be enclosed in the shipping box.
- D. Auger Boring and Sampling: Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Samples shall be obtained for each change of overburden material and at maximum vertical intervals as directed by the Owner. In order to retain the natural moisture content of the material to the fullest extent possible, all samples shall be of sufficient volume to completely fill the sample jars and the samples shall be placed in the sample jars as soon as possible after they are taken from the hole. All sample jars shall be labeled. In general, no sample shall remain on the site of boring for more than 1 week after being taken from the boring and placed in a jar.
- E. Drive Sample Boring and Sampling: Samples shall be labeled in accordance with paragraph IDENTIFYING SAMPLES. Drive sample borings drilled through overburden materials shall be suitably cased to permit obtaining drive samples of the size or sizes specified or as directed. Samples shall be taken either continuously or at a change in materials in accordance with instructions contained in the SCHEDULE OF DRILLING, SAMPLING, AND TESTING or as otherwise directed by the Owner. To minimize the compacting effect of casing driving when casing is used to stabilize a boring, the bottom of the casing shall be kept as high above the soil sampling zone as conditions permit. If hollow stem auger is used as a casing and/or to advance the boring, a plug assembly must be used to keep soil from entering the inside of the auger. Above the water table, samples shall be obtained from a dry hole. Below the water table, water shall be maintained within the hole at or above the groundwater level.



Where information on the natural water content of soils above the water table is not needed and when approved by the Owner, boreholes may be drilled without casing by using a suitable drilling fluid to prevent collapse of sidewalls. When a drilling fluid is used, soil sampling shall be done by such means that will prevent inclusion of drilling fluid in the samples. The samples shall be placed in sample jars as soon as possible after they are taken from the hole and, when possible, the volume of the sample shall be large enough to completely fill the sample jar in order that the natural moisture content of the material may be retained to the fullest extent possible. All samples shall be labeled. No sample shall remain at the site of boring for more than one week after being taken from the hole.

- F. Undisturbed Sample Boring And Sampling: In general, labeling of undisturbed samples shall conform to paragraph IDENTIFYING SAMPLES. Particular care shall be taken to indicate the top and bottom of each sample tube. Tubes and crates for undisturbed samples shall be labeled "DO NOT JAR OR VIBRATE" and "HANDLE, HAUL, AND SHIP IN A HORIZONTAL **OR** VERTICAL POSITION," **as directed.**
1. Procedure: The procedure for Undisturbed Sample Boring and Sampling shall be the same as outlined in paragraph DRIVE SAMPLE BORING AND SAMPLING, except that the sampling device shall be advanced downward by one continuous, smooth drive using the drill rig's hydraulic feed system. The hydraulic down pressure shall be read and recorded at 6 inch (150 mm) intervals during each sample drive. The sampling device for stiff and dense soils shall be advanced by continuous rotation of the outer cutting barrel in conjunction with use of drill fluid circulation. Driving of any undisturbed sampling device by means such as a drop hammer will not be permitted.
  2. Sealing
    - a. Alternate 1: The soil sample obtained in a thin wall Shelby tube shall be retained in the tube and sealed on both ends with a mechanically expandable O-ring sealing disk of the appropriate size.
    - b. Alternate 2: The soil sample obtained in a thin wall Shelby tube shall be extruded from the tube in the field as soon as the tube is removed from the boring by a method approved by the Owner. The extruded soil sample shall immediately be wrapped in aluminum foil or thin plastic wrap and placed in the center of a metal bottomed, waxed cardboard or plastic tube that has a diameter of at least 1 inch (25 mm) larger than the diameter of the soil sample, is at least 1-inch (25 mm) longer than the length of the soil sample, and has at least 1/2-inch (13 mm) of congealed 50/50 mixture of paraffin and microcrystalline wax in the bottom. The annular space between the soil sample and the tube shall be filled with a 50/50 mixture of paraffin and microcrystalline wax to a distance of at least 1/2-inch (13 mm) above the top of the soil sample.
    - c. Alternate 3: Both ends of the soil sample tube/liner obtained with a Denison barrel, or its equivalent, shall be cleaned out to remove all drill fluid contaminated and/or disturbed soil or to a minimum distance of 2 inches (50 mm) from the ends of the tube/liner. Any material removed that is not contaminated with drill fluid shall be placed in a sample jar and labeled in accordance with paragraph IDENTIFYING SAMPLES. The cleaned out ends of the sample liner tube shall then be sealed with a 50/50 mixture of paraffin and microcrystalline wax. A metal or wooden disk, having a diameter just slightly smaller than the inside diameter of the liner tube shall be inserted into the wax to a distance of 1/4-inch (6 mm) from the end of the soil sample. The wax plugs shall be flush with the ends of the tube and a final seal consisting of a metal cap or tape shall be placed over the ends of the tube.
- G. Core Hole Overburden Drilling: Where samples of overburden materials are required in connection with core drilling, the soil overburden shall be drilled and sampled in accordance with the applicable provisions for the type of samples required. Where sampling of the overburden materials is not required, the Contractor may utilize any method and equipment for drilling and, if required, casing through the overburden that will not affect the quality of the core drilling from the rock surface downward in accordance with these specifications. The method chosen must be approved by the Owner prior to starting any overburden drilling.



H. Core Drilling - Size BX and NX core.

1. Procedure: All holes shall be drilled vertically **OR** at the inclined angles listed in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, **as directed**, to the bottom elevations or depths specified unless indicated in the schedule of borings or directed to be drilled otherwise. Off-setting of borings from the locations specified in the Plan of Borings or as shown on the drawings, will not be permitted without prior approval. Casing through the overburden may be required. This casing shall be sealed in the rock at the elevation where rock is encountered prior to commencement of rock coring. The Contractor shall operate his drills at such speeds and with such down pressures and shall control drill fluid pressures and quantities to insure maximum core quality and recovery in whatever kind of rock is encountered. Where soft or broken rock is encountered, the Contractor shall reduce the length of runs to 5 feet (1.5 m) or less in order to reduce and/or keep core loss and core disturbance to the minimum. Failure to comply with the foregoing procedures shall constitute justification for the Owner to require redrilling, at the Contractor's expense, of any boring from which the core recovery is unsatisfactory. The Contractor shall exercise particular care in recording zones of water loss, cavities, rod jerks, rough drilling and other unusual and non-ordinary coring experiences that, supplementing the core record, will throw light on the nature and the extent of any fracturing or abnormalities.
2. Arrangement of Core: Core boxes shall comply with paragraph CORE BOXES. All cores shall be arranged neatly in the partitioned boxes in the same sequence in which they occurred before removal from the hole. Facing the open box with the hinged cover above and the open box below, cores shall be arranged in descending sequence beginning at the left end of the trough nearest the hinges and continuing in the other troughs from left to right. The highest part of the core shall be placed in box 1, and the lower portions of the core shall be placed in the other boxes in consecutive order.
3. Preservation of Core: Representative samples of core shall be wrapped in aluminum foil or thin plastic wrap or cheese cloth and then sealed by applying paraffin wax to the outside of the wrapping material prior to placing the core in the core box. This sealing process shall be accomplished as soon as possible after the core is removed from the core barrel. The minimum length of core that is preserved from each boring shall be no less than 2.5 times the core diameter. Spacer blocks shall be marked and placed in the core box to show where samples have been removed.
4. Labeling, Marking and Packing Core: Stenciled labels for core boxes complying with paragraph CORE BOX LABELS shall be placed on the inside and outside of the top cover in addition to each end. In addition, the depths (or elevations) of each core run/pull shall be marked with a black waterproof pen on the spacer blocks that are placed between core pulls. When a box is full, the space between the core and the trough sides shall be filled with finely ground vermiculite or other packing material approved by the Owner.
5. Disposition of Core: While on site, the Contractor shall protect the filled core boxes from direct sunlight, precipitation, and freezing by some form of the Owner approved shelter that allows ventilation to the boxes. Upon completion of core drilling and sampling operations, core boxes containing cores shall be stored in an area provided by the Owner near the site of drilling **OR** shipped or delivered to address provided by the Owner, **as directed**.

- I. Pressure Testing (Hydraulic): The Contractor shall pressure-test each hole commencing at the top of bedrock and progressing downward to the bottom of the hole or to such depths as determined by the Owner below which testing of the hole is not necessary. Where core data from the test holes indicate only isolated zones that are open or fractured, pressure testing may be limited by the Owner to these zones only. Water pressure employed for each lift shall be determined in the field by the Owner and shall not exceed of depth one pound per square inch per foot (22.6 kPa per meter) of depth to the upper expander. The pressure test will be divided into two phases; the first phase will be a flow test which shall then be followed by the second phase which is a duration test. In performing the first phase, water is pumped slowly at first, and the flow then gradually increased to the point where the predetermined maximum pressure is maintained, by adjusting the valve on the by-pass line. The allowable pressure shall be held for 1 minute before any readings are taken. The volume of flow into the test section shall be measured for a period of 5 minutes during which time the pressure shall not vary by more than 5 psi (34.5 kPa ). After this 5-minute test, the second phase shall be started by closing the valve located



between the flow meter and the pressure gage. The drop in pressure is then read for a period of 5 minutes at 15 to 30-second intervals. In some situations, such as in a very tight formation, the Owner may eliminate phase one of the test. The Contractor may be required to make check tests at his own expense if the testing equipment or its assembly and arrangement are found to be faulty during or after the testing of any holes. The Contractor shall record all gage and meter readings made during a pressure test on a suitable form approved by the Owner.

J. Test Pit Excavation And Sampling

1. Excavation: The test pits shall be excavated in the order scheduled in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING, and shall be excavated to depths and dimensions indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING. Before excavating pits, the Contractor shall thoroughly familiarize himself with work site and with all available subsurface data, particularly groundwater conditions. Regardless of the method of excavation employed, the pits shall be excavated, dewatered and shored/lined in conformance with all applicable safety regulations.
2. Sampling: Soil samples shall be obtained from each pit at the depths/elevations indicated in paragraph SCHEDULE OF DRILLING, SAMPLING, AND TESTING **OR** at depths determined by the Owner, **as directed**. In obtaining samples from test pits, the undisturbed in situ (in place) natural physical and structural characteristics of the sampled materials shall be preserved insofar as possible both while samples are being taken and during shipment to the point of testing. In cohesive and partially cohesive soils this may be accomplished by isolating the soil column or cube to be sampled by gently trenching around it and knife-trimming it to the required dimensions of the split cylinder or box. A thin coating of melted 50/50 mixture of paraffin and microcrystalline wax shall then be applied quickly but gently to the sample with a paint brush to seal it against loss of moisture. The metal or wooden sample container, with the top and bottom removed shall then be placed over the wax coated sample such that the sample is centered within the container and the top of the container sides are at least 1 inch (25 mm) above the top of the sample. The spaces between the sample and the side walls of the container shall then be filled with melted wax. After this wax has congealed, the space between the top of the sample container sides and the top of the sample shall be filled with wax. After this wax has congealed, it shall be trimmed so that when the top of the sample container is installed there is no void between the container top and the wax. After the container top is installed, the soil column or cube shall then be cut off a few hundred inches (millimeters) below the container, the sample and container inverted and removed from the pit and the sample trimmed at the base so that the bottom of the sample is at least 1 inch (25 mm) below the bottom of the container. This space shall be filled with wax and, after the wax has congealed, it shall be trimmed so that when the bottom of the container is installed, there shall be no void between the wax and the bottom of the container. Where overburden materials to be sampled are only partially cohesive, it is best not to expose the entire soil column before waxing. By exposing and waxing small sections at a time, the sample will be subjected to less disturbance. Where natural moisture content is an important factor, delay shall be avoided in taking the sample in order that the natural moisture content of the material may be retained to the fullest extent.
3. Disposition of Samples: Samples shall be packed in vermiculite or a packing material approved by the Owner and shipped in sturdy wooden boxes of strength and construction sufficient to guarantee against damage during shipment. Boxes should be no larger than is required for shipping two such samples. All sample boxes shall be marked FRAGILE-HANDLE WITH CARE and shall be identified by labels, similar to those as specified in paragraph IDENTIFYING SAMPLES, attached to the outside of each box. Extreme care shall be taken to indicate the top and bottom of each sample. The Contractor shall avoid exposing sealed and crated samples to precipitation and extremes of temperature. Undisturbed samples permitted to freeze, even partially, shall be replaced by the Contractor at his expense. The Contractor shall not hold these samples at the site of sampling for a period in excess of one week. Prior to shipment, each sealed and boxed sample shall be checked for correct labeling.



- K. Supplemental Borings or Pits: Borings or Pits that are abandoned or from which unsatisfactory samples or cores are obtained will be supplemented by other borings or pits adjacent to the original in order that satisfactory samples or the required information will be obtained. Actual locations of any supplemental borings or pits will be established by the Owner. Penetration to the depth where the original was abandoned or to the depths where unsatisfactory samples were obtained may be made by any method selected by the Contractor that in the opinion of the Owner will permit satisfactory completion and sampling below the elevation where the last satisfactory sample was obtained in the abandoned or satisfactory sampling in the reaches where satisfactory samples were not obtained in the original borings or pits. No payment will be made for supplemental borings or pits that are required to be drilled or excavated to replace borings or pits that were abandoned or from which satisfactory samples were not obtained because of mechanical failure of drilling and sampling equipment, negligence on the part of the Contractor, or other preventable cause for which the Contractor is responsible except that payment will be made for acceptable portions of these supplementary borings or pits below the depths or outside the reaches for which payment was made for the original borings or pits.
- L. Backfilling
1. Drill Holes: Unless otherwise noted in these specifications or directed by the Owner, all drill holes shall be backfilled and abandoned in accordance with all Federal, State, and local laws, regulations and ordinances. The Contractor shall preserve all holes in good condition until final measurement and until the records and samples have been accepted. As a minimum, all holes shall be grouted from the bottom of the hole to within 2 feet (600 mm) of the ground. All grout shall be pumped through a tremie pipe that is inserted to the bottom of the boring to ensure that the grout fills the full extent of the hole. The remaining ungrouted portion of the hole shall be backfilled with local soil and tamped. All backfilling operations shall be performed in the presence of the Owner and, if required by regulation, Federal, State, and local officials. No separate payment will be made for backfilling drill holes. The cost of this work shall be included in the drilling costs.
  2. Test Pits: The Contractor shall backfill all test pits with local soil compacted to original densities as directed by the Owner. No separate payment will be made for backfilling test pits. The cost of this work shall be included in the test pit excavation costs.
- M. Records: The Contractor shall keep accurate driller's logs and records of all work accomplished under this contract and shall deliver complete, legible copies of these logs and records to the Owner upon completion of the work or at such other time or times as he may be directed. All such records shall be recorded during the actual performance of the work and shall be preserved in good condition and order by the Contractor until they are delivered and accepted. The Owner shall have the right to examine and review all such records at any time prior to their delivery to him and shall have the right to request changes to the record keeping procedure. The following information shall be included on the logs or in the records for each hole or test pit:
1. Hole or Test Pit number or designation and elevation of top of hole or test pit.
  2. Driller's name and Geologist's name.
  3. Make, size, and manufacturer's model designation of drilling, sampling, pressure testing, and test-pit excavating equipment.
  4. Type of drilling, sampling, and pressure testing operation by depth.
  5. Hole diameter.
  6. Dates and time by depths when test-pit excavation, drilling, sampling, and pressure testing operations were performed.
  7. Time required for drilling each run and pressure testing each interval tested.
  8. Drill action, rotation speed, hydraulic pressure, water pressure, tool drops, and any other unusual and non-ordinary experience which could indicate the subsurface conditions encountered.
  9. Depths at which samples or cores were recovered or attempts made to sample or core including top and bottom depth of each run and of each interval pressure tested.
  10. Classification or description by depths of the materials sampled, cored, or penetrated using the Unified Soil Classification System (ASTM D 2487) and including a description of moisture conditions, consistency and other appropriate descriptive information described in paragraph



SUPPLEMENTAL BORINGS or PITS of ASTM D 2488. This classification or description shall be made immediately after the samples or cores are retrieved.

11. Classification and description by depths of rock materials sampled or cored including rock type, composition, texture, presence and orientation of bedding, foliation, or fractures, presence of vugs or other interstices, and the RQD for each cored interval.
12. Indication of penetration resistance such as drive-hammer blows given in blows per foot for driving sample spoons and casing and the pressure in applied to push thin-wall or piston-type samplers.
13. Weight (Force) of drive hammer.
14. Percentage of sample or core recovered per run.
15. Depth at which groundwater is encountered initially and when stabilized.
16. Depths at which drill water is lost and regained and amounts.
17. Depths at which the color of the drill water return changes.
18. Type and weight of drill fluid.
19. Depth of bottom of hole.
20. Pressures employed in pressure testing.





TABLE 1 - COMMON CORE DIAMETERS

	CORE DIAMETER		HOLE DIAMETER	
	in.	(mm)	in.	(mm)
Conventional Core Barrels				
AWG	1.185	(30.1)	1.890	(48.0)
BWG	1.655	(42.0)	2.360	(60.0)
NWG	2.155	(54.7)	2.980	(75.7)
HWG	3.000	(76.2)	3.907	(99.2)
Wireline Core Barrels*				
A	1.064	(27.0)	1.890	(48.0)
B	1.432	(36.5)	2.360	(60.0)
N	1.875	(47.6)	2.980	(75.7)
H	2.450	(62.2)	3.716	(94.4)
	3.345	(85.0)	4.827	(122.6)
Large Diameter Series				
2-3/4" X 3-7/8"	2.690	(68.3)	3.875	(98.4)
4" X 5-1/2"	3.970	(100.8)	5.495	(139.6)
6" X 7-3/4"	5.970	(151.6)	7.750	(196.9)

\*No Industry Standard for Wireline Sizes. Diameters shown for wireline core barrels are nominal and vary between manufacturers.

END OF SECTION 02011



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## SECTION 02102 - SITE CLEARING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for site clearing. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. Section Includes:
  - a. Protecting existing vegetation to remain.
  - b. Removing existing vegetation.
  - c. Clearing and grubbing.
  - d. Stripping and stockpiling topsoil.
  - e. Removing above- and below-grade site improvements.
  - f. Disconnecting, capping or sealing, and removing site utilities **OR** abandoning site utilities in place, **as directed**.
  - g. Temporary erosion- and sedimentation-control measures.

#### C. Definitions

1. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.  
**OR**  
Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
2. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.  
**OR**  
Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
3. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.  
**OR**  
Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

#### D. Material Ownership

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

#### E. Submittals

1. 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.
  - a. Use sufficiently detailed photographs or videotape.



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

#### F. Quality Assurance

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

#### G. Project Conditions

- 1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - b. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- 2. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
  - a. Do not proceed with work on adjoining property until directed by the Owner.
- 3. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- 4. Utility Locator Service: Notify utility locator service **OR** Miss Utility **OR** Call Before You Dig **OR** Dig Safe System **OR** One Call, **as directed**, for area where Project is located before site clearing.
- 5. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- 6. The following practices are prohibited within protection zones:
  - a. Storage of construction materials, debris, or excavated material.
  - b. Parking vehicles or equipment.
  - c. Foot traffic.
  - d. Erection of sheds or structures.
  - e. Impoundment of water.
  - f. Excavation or other digging unless otherwise indicated.
  - g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- 7. Do not direct vehicle or equipment exhaust towards protection zones.
- 8. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- 9. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

### 1.2 PRODUCTS

#### A. Materials

- 1. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Division 02 Section "Earthwork".
  - a. If soil backfill is required in below-grade areas after site clearing, obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
- 2. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer **OR** SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating, **as directed**.
  - a. Use coating with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

### 1.3 EXECUTION

#### A. Preparation



1. Protect and maintain benchmarks and survey control points from disturbance during construction.
  2. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Wrap a 1-inch (25-mm) blue vinyl tie tape flag around, **as directed**, each tree trunk at 54 inches (1372 mm) above the ground.
  3. Protect existing site improvements to remain from damage during construction.
    - a. Restore damaged improvements to their original condition, as acceptable to Owner.
- B. Temporary Erosion And Sedimentation Control
1. 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.
  2. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
  3. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
  4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.
- C. Tree And Plant Protection
1. General: Protect trees and plants remaining on-site according to requirements in Division 02 Section "Tree Protection And Trimming".
  2. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
- D. Existing Utilities
1. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.  
**OR**  
Verify that utilities have been disconnected and capped before proceeding with site clearing.
  2. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.
    - a. Arrange with utility companies to shut off indicated utilities.  
**OR**  
Owner will arrange to shut off indicated utilities when requested by Contractor.
  3. Locate, identify, and disconnect utilities indicated to be abandoned in place.
  4. 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:
    - a. Notify the Owner not less than two days in advance of proposed utility interruptions.
    - b. Do not proceed with utility interruptions without the Owner's written permission.
  5. Excavate for and remove underground utilities indicated to be removed.  
**OR**  
Removal of underground utilities is included in Division 02.
- E. Clearing And Grubbing
1. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
    - a. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
    - b. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
    - c. Use only hand methods for grubbing within protection zones.
    - d. Chip removed tree branches and stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.
  2. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.



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

F. Topsoil Stripping

1. Remove sod and grass before stripping topsoil.
2. Strip topsoil to depth indicated on Drawings **OR** to depth of 6 inches (150 mm), **as directed**, in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - a. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
3. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
  - a. Limit height of topsoil stockpiles to 72 inches (1800 mm).
  - b. Do not stockpile topsoil within protection zones.
  - c. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
  - d. Stockpile surplus topsoil to allow for respreading deeper topsoil.

G. Site Improvements

1. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
2. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - a. 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.
  - b. 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.

H. Disposal Of Surplus And Waste Materials

1. 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.
2. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 02102



## SECTION 02112 - BUILDING DEMOLITION

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for building demolition. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes the following:
  - a. Demolition and removal of buildings and site improvements.
  - b. Abandoning in place **OR** Removing, **as directed**, below-grade construction.
  - c. Disconnecting, capping or sealing, and abandoning in-place **OR** removing, **as directed**, site utilities.
  - d. Salvaging items for reuse by Owner.

#### C. Definitions

1. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged.
2. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

#### D. Materials Ownership

1. Unless otherwise indicated, demolition waste becomes property of Contractor.
2. 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.
  - a. Carefully salvage in a manner to prevent damage and promptly return to Owner.

#### E. Informational Submittals

1. Qualification Data: For refrigerant recovery technician.
2. Proposed Protection Measures: Submit informational report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control, **as directed**. Indicate proposed locations and construction of barriers.
  - a. Adjacent Buildings: Detail special measures proposed to protect adjacent buildings to remain.
3. Schedule of Building Demolition Activities: Indicate the following:
  - a. Detailed sequence of demolition work, with starting and ending dates for each activity.
  - b. Temporary interruption of utility services.
  - c. Shutoff and capping or re-routing of utility services.
4. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.
5. Predemolition Photographs **OR** Video, **as directed**: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by building demolition operations. Submit before the Work begins.
6. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.
7. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that



recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

F. Quality Assurance

1. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.
2. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
3. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.
4. Predemolition Conference: Conduct conference at Project site.
  - a. Inspect and discuss condition of construction to be demolished.
  - b. Review structural load limitations of existing structures.
  - c. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - d. Review and finalize protection requirements.
  - e. Review procedures for noise control and dust control.
  - f. Review procedures for protection of adjacent buildings.
  - g. Review items to be salvaged and returned to Owner.

G. Project Conditions

1. Buildings to be demolished will be vacated and their use discontinued before start of the Work.
2. Buildings immediately adjacent to demolition area will be occupied. Conduct building demolition so operations of occupied buildings will not be disrupted.
  - a. Provide not less than 72 hours' notice of activities that will affect operations of adjacent occupied buildings.
  - b. Maintain access to existing walkways, exits, and other facilities used by occupants of adjacent buildings.
    - 1) Do not close or obstruct walkways, exits, or other facilities used by occupants of adjacent buildings without written permission from authorities having jurisdiction.
3. Owner assumes no responsibility for buildings and structures to be demolished.
  - a. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
  - b. Before building demolition, Owner will remove certain items, as directed by the Owner.
4. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  - a. Hazardous materials will be removed by Owner before start of the Work.
  - b. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract.

**OR**

Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

- a. Hazardous material remediation is specified elsewhere in the Contract Documents.
  - b. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  - c. Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
5. On-site storage or sale of removed items or materials is not permitted.

H. Coordination

1. Arrange demolition schedule so as not to interfere with Owner's on-site operations **OR** operations of adjacent occupied buildings, **as directed**.





## 1.2 PRODUCTS

### A. Soil Materials

1. Satisfactory Soils: Satisfactory Soils: For soils which is to be used for backfilling voids that result from demolition operations in below-grade areas, comply with requirements in Division 02 Section "Earthwork".

## 1.3 EXECUTION

### A. Examination

1. Verify that utilities have been disconnected and capped before starting demolition operations.
2. Review Project Record Documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
3. Inventory and record the condition of items to be removed and salvaged. Provide photographs **OR** video, **as directed**, of conditions that might be misconstrued as damage caused by salvage operations.
4. Perform **OR** Engage a professional engineer to perform, **as directed**, an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during building demolition operations.
  - a. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.
5. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

### B. Preparation

1. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.
2. Existing Utilities: Locate, identify, disconnect, and seal or cap off indicated utilities serving buildings and structures to be demolished.
  - a. Owner will arrange to shut off indicated utilities when requested by Contractor.  
**OR**  
Arrange to shut off indicated utilities with utility companies, **as directed**.
  - b. If removal, relocation, or abandonment of utility services will affect adjacent occupied buildings, then provide temporary utilities that bypass buildings and structures to be demolished and that maintain continuity of service to other buildings and structures.
  - c. Cut off pipe or conduit a minimum of 24 inches (610 mm) below grade. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing according to requirements of authorities having jurisdiction.**OR**  
Existing Utilities: Refer to Division 15 AND Division 16 for shutting off, disconnecting, removing, and sealing or capping utilities. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing, **as directed**.
3. Temporary Shoring: Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent unexpected movement or collapse of construction being demolished.
  - a. Strengthen or add new supports when required during progress of demolition.
4. Salvaged Items: Comply with the following:
  - a. Clean salvaged items of dirt and demolition debris.
  - b. Pack or crate items after cleaning. Identify contents of containers.
  - c. Store items in a secure area until delivery to Owner.
  - d. Transport items to storage area designated by Owner **OR** indicated on Drawings, **as directed**.
  - e. Protect items from damage during transport and storage.



### C. Protection

1. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
2. Existing Utilities: Maintain utility services to remain and protect from damage during demolition operations.
  - a. Do not interrupt existing utilities serving adjacent occupied or operating facilities unless authorized in writing by Owner and authorities having jurisdiction.
  - b. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and authorities having jurisdiction.
    - 1) Provide at least 72 hours' notice to occupants of affected buildings if shutdown of service is required during changeover.
3. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction, and as indicated. Comply with requirements in Division 01 Section "Temporary Facilities And Controls".
  - a. Protect adjacent buildings and facilities from damage due to demolition activities.
  - b. Protect existing site improvements, appurtenances, and landscaping to remain.
  - c. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
  - d. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - e. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
  - f. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
  - g. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
4. Remove temporary barriers and protections where hazards no longer exist. Where open excavations or other hazardous conditions remain, leave temporary barriers and protections in place.

### D. Demolition, General

1. General: Demolish indicated existing buildings and site improvements completely. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - a. Do not use cutting torches until work area is cleared of flammable materials. Maintain portable fire-suppression devices during flame-cutting operations.
  - b. Maintain fire watch during and for a specified time after flame cutting operations as directed by the Owner.
  - c. Maintain adequate ventilation when using cutting torches.
  - d. Locate building demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
2. Engineering Surveys: During demolition, perform surveys to detect hazards that may result from building demolition activities.
3. Site Access and Temporary Controls: Conduct building demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
  - a. Do not close or obstruct streets, walks, walkways, 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.
  - b. Use water mist and other suitable methods to limit spread of dust and dirt. Comply with governing environmental-protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.
4. Explosives: Use of explosives is not permitted, **unless directed otherwise.**

**E. Demolition By Mechanical Means**

1. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
  - a. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
3. Salvage: Items to be salvaged are indicated on Drawings **OR** below, **as directed**:
  - a. Doors and door hardware.
  - b. Windows.
  - c. Cabinets.
  - d. Mirrors.
  - e. Chalkboards.
  - f. Tackboards.
  - g. Marker boards.
  - h. Plumbing fixtures.
  - i. Other items as directed.
4. Below-Grade Construction: Abandon foundation walls and other below-grade construction. Cut below-grade construction flush with grade.  
**OR**  
Below-Grade Construction: Demolish foundation walls and other below-grade construction that are within footprint of new construction and extending 5 feet (1.5 m) outside footprint indicated for new construction. Abandon below-grade construction outside this area.
  - a. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.  
**OR**  
Below-Grade Construction: Demolish foundation walls and other below-grade construction.
  - b. Remove below-grade construction, including basements, foundation walls, and footings, completely **OR** to at least 6 inches (150 mm) below grade **OR** to at least 12 inches (300 mm) below grade **OR** to depths indicated, **as directed**.
5. Existing Utilities: Abandon existing utilities and below-grade utility structures. Cut utilities flush with grade.  
**OR**  
Existing Utilities: Demolish existing utilities and below-grade utility structures that are within 5 feet (1.5 m) outside footprint indicated for new construction. Abandon utilities outside this area.
  - a. Fill abandoned utility structures with satisfactory soil materials **OR** recycled pulverized concrete, **as directed**, according to backfill requirements in Division 02 Section "Earthwork".
  - b. Piping: Disconnect piping at unions, flanges, valves, or fittings.
  - c. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.  
**OR**  
Existing Utilities: Demolish and remove existing utilities and below-grade utility structures.
  - a. Piping: Disconnect piping at unions, flanges, valves, or fittings.
  - b. Wiring Ducts: Disassemble into unit lengths and remove plug-in and disconnecting devices.

**F. Demolition By Explosives – ONLY IF APPROVED BY OWNER**

1. Explosives: Perform explosive demolition according to governing regulations.
  - a. Obtain written permission from authorities having jurisdiction before bringing explosives to, or using explosives on, Project site.
  - b. Do not damage adjacent structures, property, or site improvements when using explosives.
2. Comply with recommendation in Explosives Consultant's report.



G. Site Restoration

1. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.

**OR**

Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials **OR** recycled pulverized concrete **OR** recycled pulverized masonry, **as directed**, according to backfill requirements in Division 02 Section "Earthwork".

2. Site Grading: Uniformly rough grade area of demolished construction to a smooth surface, free from irregular surface changes. Provide a smooth transition between adjacent existing grades and new grades.

H. Repairs

1. Promptly repair damage to adjacent buildings caused by demolition operations.

I. Disposal Of Demolished Materials

1. Remove demolition waste materials from Project site and legally dispose of them in EPA approved landfill acceptable to authorities having jurisdiction. See Division 01 Section "Construction Waste Management" for recycling and disposal of demolition waste.
  - a. Do not allow demolished materials to accumulate on-site.
  - b. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
2. Do not burn demolished materials.

J. Cleaning

1. Clean adjacent structures and improvements of dust, dirt, and debris caused by building demolition operations. Return adjacent areas to condition existing before building demolition operations began.
  - a. Clean roadways of debris caused by debris transport.

END OF SECTION 02112



## SECTION 02112a - PORTLAND CEMENT CONCRETE REMOVAL

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for portland cement concrete removal. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Section Includes:

1. Provide all labor, materials and equipment required for the removal work and disposal of existing Portland Cement Concrete indicated on the drawings and specified, including but not limited to the following:
  - a. Saw cutting existing concrete pavements, sidewalks, driveways, curbs and gutters noted on drawings to be removed.
  - b. Saw cutting existing concrete sidewalks for new tree pit openings (refer to drawings for locations).
  - c. Saw cutting existing bituminous paving noted on drawings to be removed.
  - d. Removal and disposal of demolished concrete sidewalks, driveways, curbs and gutters, including concrete removed for new tree pit openings.
  - e. Removal and disposal of demolished bituminous paving.
  - f. All excavating, rough grading and compacting as required to establish subgrade for new sidewalks, and Subgrade and Sub-Base for driveways.
  - g. Providing, placing and grading sand fill under new sidewalks. Top of compacted subgrades shall allow for the placement of sidewalks plus thickness of sand fill.
  - h. Removal and disposal of excavated material.

#### C. Special Requirements:

1. Protection: Provide protection barricades, maintain all lights and signals and other measures as required by federal, state, and municipal laws, for the full period of demolition operations and remove same when directed. In removing work, perform all work required to protect and maintain adjacent property, streets, alleys, sidewalks, curbs, and other structures remaining in place.

### 1.2 PRODUCTS

#### A. Backfilling Material:

1. Sand: Natural sand, with the following gradation: 100% passing the 1 sieve-, 65-100% passing the No. 4 sieve; 40-90% passing the No. 10 sieve- 30-80% passing the No. 16 sieve- 10-50% passing the No. 50 sieve; 0-30% passing the No. 100 sieve, and 0-10% passing the No. 200 sieve.
2. Crushed Stone: Crushed stone having a #57 crusher run gradation.

### 1.3 EXECUTION

#### A. Demolition:

1. The contractor shall accept the site as he finds it and shall inform himself as to the character and types of work to be removed. The Owner assumes no responsibility for the condition of the existing construction to be removed or demolished.
2. No demolition shall be commenced until a program of operations has been coordinated with the Owner, except that preparatory work may be started if specifically approved by the Owner.



3. Operations shall be done in such manner as to avoid hazards to persons and property and interference with use of adjacent areas or interruption of free passage to and from such areas. Maintain Pedestrian access to all private entrances where construction of new sidewalks is in progress. Provide temporary walk ways or other means as required to maintain entry into the private properties, complying with all laws and ordinances and as approved by the Owner. Care shall be taken to prevent the spread of dust and flying particles.
4. Demolition and removal work shall be executed in a careful and orderly manner. Accumulation of rubbish will not be permitted.
5. After work is started, it shall be continued to completion at a rate that will allow the balance of the work to be completed within the time specified. If extra shifts are necessary beyond regular working hours, the work shall proceed with a minimum of nuisance to surrounding properties.
6. Contractor shall determine the nature and extent of demolition that will be necessary by comparing the drawings with the existing field conditions. It is expressly understood that this contract includes all work of a demolition nature that may be required or necessary for a full and complete execution of the work, whether particularly referred to herein or not.

B. Removal And Excavation:

1. When removing existing sidewalks, driveways, curbs and gutters provisions shall be made for satisfactory transition between replacements and the portion remaining in place. The contractor shall saw cut to a minimum depth of 1-1/2 inches with a concrete sawing machine to prevent the surface from spalling when the concrete is broken out. This work shall be done in such a manner that a straight joint will be secured.
2. It shall be the responsibility of the contractor to determine the thickness of the existing sidewalk to be removed. No additional compensation will be allowed because of variations from the assumed thickness or from the thickness shown on the plans.
3. After existing concrete sidewalks and driveways have been removed, excavate to depth required for sand fill.
4. The bottoms of all excavations shall be properly leveled off and all loose materials shall be removed from excavations. All wood, timber and organic materials, that are exposed at the bottom of all excavations, shall be removed and the area backfilled with sand and compacted.
5. Any excess or unauthorized excavation shall be backfilled with sand and compacted, at no additional cost to the Owner.
6. No backfill shall be placed in standing water, on frozen ground or on surfaces which have not been approved by the Commissioner.
7. Backfilling for all areas shall be approved material. Backfill shall be compacted to 95% maximum density in accordance with ASTM D 1557.
8. Contractor shall determine the nature and extent of excavation work that will be necessary by comparing the drawings with the existing areas to be excavated. It is expressly understood that this contract includes all work of an excavation nature that may be required or necessary for a complete execution of all excavation work, whether particularly referred to herein or not.

C. Disposal Of Materials:

1. All demolished and unsuitable materials, including excavated earth removed to establish required grade elevations shall be disposed of legally in such a manner that public or private property will not be damaged or endangered.

D. Clean-Up:

1. On completion of the demolition work, excavation work and before acceptance by the Owner, clean the areas affected, including areas outside the limits of the contractor's work area where permission to work has been granted. Remove surplus construction material or debris resulting from the demolition work and excavation work, and dispose of legally off the site.
2. Access routes to and from the site shall be kept clean of debris resulting from the work.

END OF SECTION 02112a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02112	01720	Cutting and Patching
02201	01204	No Specification Required



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**SECTION 02203 - EARTHWORK****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for earthwork. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. Section Includes:
  - a. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
  - b. Excavating and backfilling for buildings and structures.
  - c. Drainage course for concrete slabs-on-grade.
  - d. Subbase course for concrete walks and pavements.
  - e. Subbase course and base course for asphalt paving.
  - f. Subsurface drainage backfill for walls and trenches.
  - g. Excavating and backfilling trenches for utilities and pits for buried utility structures.
  - h. Excavating well hole to accommodate elevator-cylinder assembly.

**C. Definitions**

1. Backfill: Soil material or controlled low-strength material used to fill an excavation.
  - a. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - b. Final Backfill: Backfill placed over initial backfill to fill a trench.
2. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
3. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
4. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
5. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
6. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
  - a. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
  - b. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
  - c. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner. Unauthorized excavation, as well as remedial work directed by the Owner, shall be without additional compensation.
7. Fill: Soil materials used to raise existing grades.
8. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) 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. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom; measured according to SAE J-1179.



- b. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- 9. If Standard Penetration Values are used to Define Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D 1586.
- 10. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- 11. 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.
- 12. 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.
- 13. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

#### D. Submittals

- 1. Product Data: For each type of the following manufactured products required:
  - a. Geotextiles.
  - b. Controlled low-strength material, including design mixture.
  - c. Geofoam.
  - d. Warning tapes.
- 2. Samples: For the following products, in sizes indicated below:
  - a. Geotextile: 12 by 12 inches (300 by 300 mm).
  - b. Warning Tape: 12 inches (300 mm) long; of each color.
- 3. Qualification Data: For qualified testing agency.
- 4. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
  - a. Classification according to ASTM D 2487.
  - b. Laboratory compaction curve according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
- 5. Blasting plan approved by authorities having jurisdiction.
- 6. Seismic survey report from seismic survey agency.
- 7. 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.

#### E. Quality Assurance

- 1. Blasting:
  - a. Blasting will not be allowed.

**OR**

Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:

  - 1) Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
  - 2) Seismographic monitoring during blasting operations.
- 2. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
  - a. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.



- b. Seismographic monitoring during blasting operations.
- 3. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- 4. Pre-excavation Conference: Conduct conference at Project site.

F. Project Conditions

- 1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
  - a. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - b. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- 2. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
- 3. Do not proceed with work on adjoining property until directed by the Owner.
- 4. Utility Locator Service: Notify utility locator service **OR** "Miss Utility" **OR** "Call Before You Dig" **OR** "Dig Safe System" **OR** "One Call", **as directed**, for area where Project is located before beginning earth moving operations.
- 5. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Division 01 Section(s) "Temporary Facilities And Controls" **OR** Division 02 Section(s) "Site Clearing", **as directed**, are in place.
- 6. Do not commence earth moving operations until plant-protection measures specified in Division 02 Section "Tree Protection And Trimming" are in place.
- 7. The following practices are prohibited within protection zones:
  - a. Storage of construction materials, debris, or excavated material.
  - b. Parking vehicles or equipment.
  - c. Foot traffic.
  - d. Erection of sheds or structures.
  - e. Impoundment of water.
  - f. Excavation or other digging unless otherwise indicated.
  - g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- 8. Do not direct vehicle or equipment exhaust towards protection zones.
- 9. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

1.2 PRODUCTS

A. Soil Materials

- 1. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- 2. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487 **OR** Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, **as directed**, or a combination of these groups; free of rock or gravel larger than 3 inches (75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- 3. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487 **OR** Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, **as directed**, or a combination of these groups.
  - a. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- 4. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- 5. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.



6. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch (37.5-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
7. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
8. Drainage Course: Narrowly graded mixture of washed, **as directed**, crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
9. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch (25-mm) sieve and 0 to 5 percent passing a No. 4 (4.75-mm) sieve.
10. Sand: ASTM C 33; fine aggregate.
11. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

#### B. Geotextiles

1. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - a. Survivability: Class 2; AASHTO M 288.
  - b. Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.250-mm) **OR** No. 70 (0.212-mm), **as directed**, sieve, maximum; ASTM D 4751.
  - c. Permittivity: 0.5 **OR** 0.2 **OR** 0.1, **as directed**, per second, minimum; ASTM D 4491.
  - d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
2. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - a. Survivability: Class 2; AASHTO M 288.
  - b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
  - c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
  - d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

#### C. Controlled Low-Strength Material

1. Controlled Low-Strength Material: Self-compacting, low-density, **as directed**, flowable concrete material produced from the following:
  - a. Portland Cement: ASTM C 150, Type I **OR** Type II **OR** Type III, **as directed**.
  - b. Fly Ash: ASTM C 618, Class C or F.
  - c. Normal-Weight Aggregate: ASTM C 33, 3/4-inch (19-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
  - d. Foaming Agent (if low-density, controlled low-strength material is required): ASTM C 869.
  - e. Water: ASTM C 94/C 94M.
  - f. Air-Entraining Admixture (not required for low-density, controlled low-strength material using foaming agent): ASTM C 260.
2. Produce low-density, controlled low-strength material with the following physical properties:
  - a. As-Cast Unit Weight: 30 to 36 lb/cu. ft. (480 to 576 kg/cu. m) **OR** 36 to 42 lb/cu. ft. (576 to 675 kg/cu. m), **as directed**, at point of placement, when tested according to ASTM C 138/C 138M.
  - b. Compressive Strength: 80 psi (550 kPa) **OR** 140 psi (965 kPa), **as directed**, when tested according to ASTM C 495.

**OR**

Produce conventional-weight, controlled low-strength material with 80-psi (550-kPa) **OR** 140-psi (965-kPa), **as directed**, compressive strength when tested according to ASTM C 495.

#### D. Geofoam



1. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.55-lb/cu. ft. (25-kg/cu. m) density, 25-psi (173-kPa) compressive strength **OR** Type X, 1.30-lb/cu. ft. (21-kg/cu. m) density, 15-psi (104-kPa) compressive strength **OR** Type VI, 1.80-lb/cu. ft. (29-kg/cu. m) density, 40-psi (276-kPa) compressive strength **OR** Type VII, 2.20-lb/cu. ft. (35-kg/cu. m) density, 60-psi (414-kPa) compressive strength **OR** Type V, 3.00-lb/cu. ft. (48-kg/cu. m) density, 100-psi (690-kPa) compressive strength, **as directed**.
2. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90-lb/cu. ft. (15-kg/cu. m) density, 10-psi (69-kPa) compressive strength **OR** Type VIII, 1.15-lb/cu. ft. (18-kg/cu. m) density, 13-psi (90-kPa) compressive strength **OR** Type II, 1.35-lb/cu. ft. (22-kg/cu. m) density, 15-psi (104-kPa) compressive strength, **as directed**.
  - a. Manufacture molded polystyrene with an inorganic mineral registered with the EPA and suitable for application as a termite deterrent.
3. Rigid Cellular Polystyrene Geofoam: ASTM D 6817, Type EPS 19, 1.15-lb/cu. ft. (18.4-kg/cu. m) density, 5.8-psi (40-kPa) compressive strength at 1 percent deformation; 16-psi (110-kPa) compressive strength at 10 percent deformation **OR** Type EPS 39, 2.40-lb/cu. ft. (38.4-kg/cu. m) density, 15-psi (103-kPa) compressive strength at 1 percent deformation; 40-psi (276-kPa) compressive strength at 10 percent deformation, **as directed**.
4. Connectors: Geofoam manufacturer's multibarbed, galvanized-steel sheet connectors **OR** Deformed steel reinforcing bars, 3/4 inch (19 mm) in diameter, **as directed**.

E. Accessories

1. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
  - a. Red: Electric.
  - b. Yellow: Gas, oil, steam, and dangerous materials.
  - c. Orange: Telephone and other communications.
  - d. Blue: Water systems.
  - e. Green: Sewer systems.**OR**  
Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) 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 (750 mm) deep; colored as follows:
  - f. Red: Electric.
  - g. Yellow: Gas, oil, steam, and dangerous materials.
  - h. Orange: Telephone and other communications.
  - i. Blue: Water systems.
  - j. Green: Sewer systems.

### 1.3 EXECUTION

A. Preparation

1. 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.
2. Protect and maintain erosion and sedimentation controls during earth moving operations.
3. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

B. Dewatering

1. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.



2. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - a. 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.

C. Explosives

1. Explosives: Do not use explosives.

**OR**

Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.

- a. Perform blasting without damaging adjacent structures, property, or site improvements.
- b. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

D. Excavation, General

1. 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.
  - a. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - b. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    - 1) 24 inches (600 mm) outside of concrete forms other than at footings.
    - 2) 12 inches (300 mm) outside of concrete forms at footings.
    - 3) 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
    - 4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    - 5) 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
    - 6) 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.
2. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by the Owner. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.
  - a. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
    - 1) Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
  - b. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
    - 1) 24 inches (600 mm) outside of concrete forms other than at footings.
    - 2) 12 inches (300 mm) outside of concrete forms at footings.
    - 3) 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
    - 4) Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    - 5) 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
    - 6) 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.



E. Excavation For Structures

1. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - a. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - b. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
  - c. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
2. Excavations at Edges of Tree- and Plant-Protection Zones:
  - a. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
  - b. Cut and protect roots according to requirements in Division 02 Section "Tree Protection And Trimming".

F. Excavation For Walks And Pavements

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

G. Excavation For Utility Trenches

1. Excavate trenches to indicated gradients, lines, depths, and elevations.
  - a. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
2. 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 (300 mm) higher than top of pipe or conduit unless otherwise indicated.
  - a. Clearance: 12 inches (300 mm) each side of pipe or conduit **OR** As indicated, **as directed**.
3. Trench Bottoms (if a bedding course is not required under pipe and conduit): Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.
  - a. For pipes and conduit less than 6 inches (150 mm) in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
  - b. For pipes and conduit 6 inches (150 mm) or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
  - c. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
  - d. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
4. Trench Bottoms (if a bedding course is required under pipe and conduit): Excavate trenches 4 inches (100 mm) 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 (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
5. Trenches in Tree- and Plant-Protection Zones:
  - a. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.



- b. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
  - c. Cut and protect roots according to requirements in Division 02 Section "Tree Protection And Trimming".
- H. Excavation For Elevator Cylinder
  - 1. Drill well hole plumb in elevator pit to accommodate installation of elevator-cylinder assembly. Coordinate with applicable requirements for diameter and tolerances in Division 14 Section(s) "Hydraulic Elevators" OR "Hydraulic Freight Elevators", **as directed**.
  - 2. Provide well casing as necessary to retain walls of well hole.
- I. Subgrade Inspection
  - 1. Notify the Owner when excavations have reached required subgrade.
  - 2. If the Owner determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
  - 3. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
    - a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
    - b. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
  - 4. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
  - 5. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owner, without additional compensation.
- J. Unauthorized Excavation
  - 1. 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 (17.2 MPa), may be used when approved by the Owner.
    - a. Fill unauthorized excavations under other construction, pipe, or conduit as directed by the Owner.
- K. Storage Of Soil Materials
  - 1. 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.
    - a. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
- L. Backfill
  - 1. Place and compact backfill in excavations promptly, but not before completing the following:
    - a. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
    - b. Surveying locations of underground utilities for Record Documents.
    - c. Testing and inspecting underground utilities.
    - d. Removing concrete formwork.
    - e. Removing trash and debris.
    - f. Removing temporary shoring and bracing, and sheeting.
    - g. Installing permanent or temporary horizontal bracing on horizontally supported walls.
  - 2. Place backfill on subgrades free of mud, frost, snow, or ice.
- M. Utility Trench Backfill
  - 1. Place backfill on subgrades free of mud, frost, snow, or ice.





2. 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.
3. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches (450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
4. Trenches under Roadways: Provide 4-inch- (100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches (750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches (100 mm) of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 03 Section "Cast-in-place Concrete".
5. Backfill voids with satisfactory soil while removing shoring and bracing.
6. If soil material is required as initial backfill, place and compact initial backfill of subbase material **OR** satisfactory soil, **as directed**, free of particles larger than 1 inch (25 mm) in any dimension, to a height of 12 inches (300 mm) over the 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.
7. Controlled Low-Strength Material: If controlled low-strength material is permitted or required as initial backfill, place initial backfill of controlled low-strength material to a height of 12 inches (300 mm) over the pipe or conduit. Coordinate backfilling with utilities testing.
8. If satisfactory soil material is required as final backfill, place and compact final backfill of satisfactory soil to final subgrade elevation.
9. Controlled Low-Strength Material: If controlled low-strength material is permitted or required as final backfill, place final backfill of controlled low-strength material to final subgrade elevation.
10. Install warning tape directly above utilities, 12 inches (300 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

N. Soil Fill

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

O. Geofoam Fill

1. Place a leveling course of sand, 2 inches (50 mm) thick, over subgrade. Finish leveling course to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.
  - a. Place leveling course on subgrades free of mud, frost, snow, or ice.
  - b. Install geofoam blocks in layers with abutting edges and ends and with the long dimension of each block at right angles to blocks in each subsequent layer. Offset joints of blocks in successive layers.
  - c. Install geofoam connectors at each layer of geofoam to resist horizontal displacement according to geofoam manufacturer's written instructions.
2. Cover geofoam with subdrainage **OR** separation, **as directed**, geotextile before placing overlying soil materials.

P. Soil Moisture Control

1. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - a. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.



- b. 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.

Q. Compaction Of Soil Backfills And Fills

1. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.
2. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
3. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**:
  - a. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - b. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - c. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - d. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

R. Grading

1. 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.
  - a. Provide a smooth transition between adjacent existing grades and new grades.
  - b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
2. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
  - a. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
  - b. Walks: Plus or minus 1 inch (25 mm).
  - c. Pavements: Plus or minus 1/2 inch (13 mm).
3. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch (13 mm) when tested with a 10-foot (3-m) straightedge.

S. Subsurface Drainage

1. Subdrainage Pipe: Specified in Division 02 Section "Storm Drainage".
2. Subsurface Drain: If nonwoven geotextile is used in subsurface drainage applications, place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
  - a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.
3. Drainage Backfill: If using free-draining granular backfill against walls, place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
  - a. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698 **OR** with a minimum of two passes of a plate-type vibratory compactor, **as directed**.



- b. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.
- T. Subbase And Base Courses Under Pavements And Walks
- 1. Place subbase course and base course, **as directed**, on subgrades free of mud, frost, snow, or ice.
  - 2. On prepared subgrade, place subbase course and base course, **as directed**, under pavements and walks as follows:
    - a. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
    - b. Place base course material over subbase course under hot-mix asphalt pavement.
    - c. Shape subbase course and base course, **as directed**, to required crown elevations and cross-slope grades.
    - d. Place subbase course and base course, **as directed**, 6 inches (150 mm) or less in compacted thickness in a single layer.
    - e. Place subbase course and base course, **as directed**, that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
    - f. Compact subbase course and base course, **as directed**, at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
  - 3. Pavement Shoulders: Place shoulders along edges of subbase course and base course, **as directed**, to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base, **as directed**, layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698 **OR** ASTM D 1557, **as directed**.
- U. Drainage Course Under Concrete Slabs-On-Grade
- 1. Place drainage course on subgrades free of mud, frost, snow, or ice.
  - 2. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
    - a. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
    - b. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
    - c. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
    - d. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.
- V. Field Quality Control
- 1. Special Inspections: If special inspections are required by code, engage a qualified special inspector to perform the following special inspections:
    - a. Determine prior to placement of fill that site has been prepared in compliance with requirements.
    - b. Determine that fill material and maximum lift thickness comply with requirements.
    - c. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
  - 2. Testing Agency: Engage a qualified geotechnical engineering testing agency to perform tests and inspections.
  - 3. 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.
  - 4. 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 the Owner.

5. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
  - a. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab, but in no case fewer than three tests.
  - b. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length, but no fewer than two tests.
  - c. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length, but no fewer than two tests.
6. 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.

W. Protection

1. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
2. 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.
  - a. Scarify or remove and replace soil material to depth as directed by the Owner; reshape and recompact.
3. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - a. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

X. Disposal Of Surplus And Waste Materials

1. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.  
**OR**  
Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by the Owner.
  - a. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 02203

**SECTION 02203a - EMBANKMENT****1.1 GENERAL****A. Description Of Work**

1. This specification covers the reuse of suitable excavated material or furnishing material at the Contractor's expense to construct embankments where and as required by the Owner.

**B. Submittals**

1. Preconstruction Submittals
  - a. Construction equipment list.
  - b. Contractor shall record Existing Conditions prior to starting work in accordance with the paragraph entitled, "Existing Conditions," of this section.
  - c. Location of Utilities
  - d. Location of Tests
  - e. Location of Inspection
  - f. Location of Approved Utilities
  - g. A protection plan verifying the Existing Utilities left in place.
2. Test Reports for Soil Test within three working days of test date. Soil test shall comply with paragraph entitled, "Quality Control Testing During Construction."
3. Certificates of compliance for Proposed Soil Materials shall be submitted in accordance with paragraph entitled, "Tests for Proposed Soil Materials."

**C. Definitions**

1. Soil Materials
  - a. Cohesionless soil materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Moisture-density relations of compacted cohesionless soils when plotted on graphs will show straight lines or reverse-shaped moisture-density curves.
  - b. Cohesive soil materials include clayey and silty gravels, sand-clay mixtures, gravel-silt mixtures, clayey and silty sands, sand-silt mixtures, clays, silts, and very fine sands. Moisture density relations of compacted cohesive soils when plotted on graphs will show normal moisture-density curves.
2. Subgrade shall mean the top surface of a backfill or fill or the uppermost surface of an excavation, graded to conform to the required subgrade elevation and compacted to densities indicated.
3. Degree of compaction required is expressed as a percentage of the maximum density obtained by the test procedure in AASHTO T 180, Method B or D.
4. Classified Excavation: Separate consideration will be given to the nature of the materials excavated, in accordance with the following designations and classifications.
  - a. Rock excavation shall include blasting, excavating, grading, and disposing of material classified as rock and shall include the satisfactory removal and disposition of boulders 1/2-cu yd (0.4 cu m) or more in volume; solid rock; rock material in ledges, bedded deposits, and unstratified masses which cannot be removed without systematic drilling and blasting; and conglomerate deposits that are so firmly cemented as to possess the characteristics of solid rock that is impossible to remove without systematic drilling and blasting. The removal of any concrete or masonry structures, except pavements, exceeding 1/2-cu yd (0.4 cu m) in volume that may be encountered in the work shall be included in this classification.
  - b. Common excavation shall include the satisfactory removal and disposition of materials not classified as rock excavation.
5. Unclassified Excavation: No consideration will be given to the nature of the materials, and all excavation will be designated as unclassified excavation.

**D. Sampling And Testing**



1. Soil Test and Inspection Service: Soil survey for satisfactory soil materials and samples of soil materials shall be furnished by the Contractor. A certified soil testing service approved by the Owner shall be provided by the Contractor. Testing shall include soil survey for satisfactory soil materials, sampling and testing soil materials proposed for use in the work, and field-testing facilities for quality control during construction period.
2. Tests for Proposed Soil Materials: Soil materials proposed for use in the work shall be tested. The materials shall be approved by the Owner prior to start of work as follows:

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>NUMBER OF TESTS</u>
Satisfactory soil materials	Sampling	AASHTO T 2	One for each source of materials to determine conformance to definition of satisfactory soil materials; additional tests whenever there is any apparent change
	Preparation of samples	AASHTO T 87	
	Sieve analysis of fine and coarse aggregate	ASTM C 136	
	Mechanical analysis of soils	ASTM D 422	
	Liquid limit of Soils	ASTM D 4318	
	Plastic limit and plasticity index of soils	ASTM D 4318	
	Moisture-density relations of soil	AASHTO T 180, Method B or D	



3. Quality Control Testing During Construction: Soil Test on materials shall be performed during construction as follows:

<u>MATERIAL</u>	<u>REQUIREMENT</u>	<u>TEST METHOD</u>	<u>MATERIAL TESTED AND NUMBER OF TESTS</u>
Soil material- in-place after compaction	Density of soil- in-place	ASTM D 1556 Sand Cone Method or ASTM D 2922 Nuclear Method	At least three daily for each subgrade soil material, and for each layer of soil material; additional tests whenever there is any change in moisture

4. Field Testing Facilities at Subbase Mixing Plant: Field-testing facilities for the purpose of testing subbase course material at the mixing plant shall be provided by the Contractor's soil-testing service.

5. Reports: No soil material shall be used until soil test reports have been reviewed and approved.

6. Evaluation of Test Results

- Soil materials of any classification shall not have a moisture content at the time of compaction that would be classified as unsatisfactory soil materials in the paragraph entitled, "Definitions."
- Results of density of soil-in-place tests shall be considered satisfactory if the average of any group of four consecutive density tests which may be selected is in each instance equal to or greater than the specified density, and if no density test has a value more than 2 percentage points below the specified density.

E. Use Of Explosives:

- Explosives shall not be used or brought to the project site without prior written approval. Such approval shall not be construed as relieving the Contractor of responsibility for injury to persons or for damage to property due to blasting operations. Blasting shall be performed by skilled personnel in accordance with governing authorities and as approved. Minimum safety requirements for blasting shall be in accordance with OSHA Regulations 29 CFR 1926, Subpart U.

**OR**

The use of explosives will not be permitted.

F. Protection Of Persons And Property

- Excavations shall be barricaded and posted with warning signs for the safety of persons. Warning lights shall be provided during hours of darkness.
- Structures, utilities, sidewalks, pavements, and other facilities immediately adjacent to excavations shall be protected against damage including settlement, lateral movement, undermining, and washout.
- Topsoil removal operations shall be conducted to ensure safety of persons and to prevent damage to existing structures and utilities, construction in progress, trees and vegetation to remain standing, and other property.

G. Construction Equipment List: Construction Equipment List for all major equipment to be used in this section shall be submitted to the Owner prior to start of work.

H. Existing Conditions

- Records of Existing Conditions shall be submitted by the Contractor prior to the start of work. The Contractor shall verify the existing conditions are correct as shown on the plans and described in the specifications. the Owner shall be notified immediately if any discrepancies are found.



2. Records of underground utilities, Location of Utilities, Location of Inspection, Location of Tests, and Location of Approved Utilities shall be submitted to the Owner prior to start of work.

## 1.2 PRODUCTS

### A. Materials

1. Satisfactory Materials shall mean AASHTO M 145 (ASTM D 3282), Soil Classification Groups A-1, A-2-4, A-2-5, and A-3.
2. Unsatisfactory Materials shall mean AASHTO M 145, Soil Classification Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7, peat and other highly organic soils, and soil materials of any classification that have a moisture content, at the time of compaction, beyond the range of 1 percentage point below and 3 percentage points above the optimum moisture content of the soil material as determined by moisture-density relations test.
3. Topsoil shall be any soil removed from the project site which consists of clay or sandy loam. The topsoil shall be reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and shall be free from stones, stumps, roots, and other objectionable material larger than 2 in. (50 mm) in any dimension.
4. Compost shall be yard trimmings or yard waste compost processed and graded according to state and local regulations.
5. Topsoil Blend: Where insufficient topsoil is removed from the project site for later reuse, the topsoil removed shall be stockpiled and blended with compost at the site to achieve the required volume.

## 1.3 EXECUTION

### A. Blasting:

1. Where explosives are used in rock excavation, the charges shall be so proportioned and placed that they will not loosen the rock outside the excavation lines indicated, or as specified. Contractor shall remove, at no additional cost, any material outside the authorized cross section that may be shattered or loosened by blasting.

**OR**

Blasting is not required or permitted.

- B. Conservation Of Topsoil: Topsoil shall be stripped to a depth of not less than 4 in. (100 mm); when stored it shall be kept separate from other excavated materials, free of roots, stones, and other undesirable materials. Where indicated, topsoil shall be removed without contamination with subsoil and spread on areas already graded and prepared for topsoil, or when so specified, topsoil shall be transported and deposited in stockpiles convenient to areas that are to receive application of the topsoil later or at locations indicated or specified by the Owner. Topsoil blend shall be used on all embankments when there is not enough topsoil available.

### C. Excavation

1. Excavations specified shall be done on either a classified or unclassified basis as directed by the Owner.
2. Contractor shall perform excavation of every type of material encountered by cutting accurately to the cross sections to the lines, grades, and elevations indicated. Grading shall be in conformity with the typical sections indicated and the tolerances specified in paragraph entitled, "Finishing."
3. Satisfactory excavated materials shall be transported to and placed in fill or embankment areas within the limits of the work. Unsatisfactory materials encountered within the limits of the work shall be excavated below grade and replaced with satisfactory materials as directed. Surplus satisfactory excavated material not required for fill or embankment shall be disposed in areas approved for surplus materials storage or designated waste areas. Unsatisfactory excavated material shall be disposed in designated waste or spoil areas. During construction, excavation





- and filling shall be performed in a manner and sequence that will provide proper drainage at all times. Material required for fill or embankment in excess of that produced by excavation within the grading limits shall be excavated from the borrow areas indicated or from other approved areas selected by the Owner.
4. Excavation of Ditches, Gutters, and Channels: Care shall be taken not to excavate ditches and gutters below grades shown. Excessive open-ditch or gutter excavation shall be backfilled with suitable materials to grades indicated at no additional cost. Materials excavated shall be disposed as indicated, except that in no case shall material be deposited less than 3 ft. (1 m) from the edge of a ditch. Contractor shall maintain excavations free from debris until final acceptance of the work.
  5. Excavation for Drainage Structures
    - a. Dimensions and elevations of footings and foundation excavations indicated are only approximate and may be changed if necessary to ensure adequate foundation support. Trenches and foundation pits shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Rock or other hard foundation material shall be cleaned of loose debris and cut to a firm surface, either level, stepped, or serrated. Loose disintegrated rock and thin strata shall be removed. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before concrete or masonry is to be placed.
    - b. Where pile foundations are to be used, the excavation of each pit shall be stopped at an elevation 1 ft. (300 mm) above the base of the footing, as specified, before piles are driven. After pile driving has been completed, loose and displaced material shall be removed and excavation completed, leaving a smooth, solid, undisturbed surface to receive concrete or masonry.
  6. Protection or Removal of Utility Lines: Existing Utilities that are indicated to be retained, or the locations of which have been ascertained from Owner utility drawings, as well as utility lines encountered during excavation, shall be protected from damage during excavation and backfilling. However, reliance on the information obtained from Owner drawings does not absolve the Contractor of responsibility for damages, so careful hand methods shall be used to verify the location of underground utilities. Damage shall be reported immediately and satisfactorily repaired by the Contractor at no additional cost. The Contractor shall provide sketches of existing conditions if there are variances, as well as any modifications, on "as-built" drawings. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall give notice in ample time for the necessary measures to be taken to prevent interruption of service.
- D. Classification Of Excavation: Excavations specified shall be done on either a classified or unclassified basis as provided for under the item designations of the Contract.
- E. Utilization Of Excavation Materials: Unsatisfactory materials removed from excavations shall be disposed in designated areas. Satisfactory material removed from excavations shall be used, insofar as practicable, in the construction of fills, embankments, subgrades, shoulders, bedding; as backfill; and for similar purposes. No satisfactory excavated material shall be wasted without specific written authorization. Satisfactory material authorized to be wasted shall be disposed in designated areas approved for surplus material storage or designated waste areas as directed. Coarse rock from excavations shall be stockpiled and used for constructing slopes of embankments adjacent to streams, for constructing slopes or sides and bottoms of channels, and for protecting against erosion. Hand placing of coarse rock from excavations will not be required. Excavated material shall not be disposed in a manner as to obstruct the flow of any stream, endanger a partly finished structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.
- F. Selection Of Borrow Material: Borrow material shall be selected to meet the requirements and conditions of the particular fill or embankment for which it is to be used. Borrow material shall be obtained from the borrow areas indicated on the plans or from other approved sources, either private or within the limits of the project site, selected by the Contractor. Unless otherwise provided in the



contract, the Contractor shall obtain from the Owners the right to procure material, pay all royalties and other charges involved, and bear all expense of developing the sources, including rights-of-way for hauling. Borrow material from approved sources on Owner-controlled land may be obtained without payment of royalties. Unless specifically provided, no borrow shall be obtained within the limits of the project site without prior written approval. Necessary clearing, grubbing, and satisfactory drainage of borrow pits and the disposal of debris shall be considered related operations to the borrow excavation and shall be performed by the Contractor at no additional cost to the Owner.

- G. Opening And Drainage Of Excavation And Borrow Pits: The Contractor shall give notice sufficiently in advance of the opening of any excavation or borrow pit to permit elevations and measurements of the undisturbed ground surface to be taken. Unless otherwise permitted, borrow pits and other excavation areas shall be excavated in such manner as will afford adequate drainage. Overburden and other spoil material shall be transported to designated spoil areas or otherwise disposed as directed. Borrow pits shall be neatly trimmed and left in such shape as will facilitate accurate measurements after the excavation is completed.
- H. Grading Areas: When so provided and indicated, work under contract will be divided into grading areas, within which satisfactory excavated material shall be placed in embankments, fills, and required backfills. Contractor shall not haul satisfactory material excavated in one grading area to another grading area, except when so directed in writing.
- I. Preparation Of Ground Surface For Embankments
  - 1. Ground surface on which fill is to be placed shall be stripped of live, dead, or decayed vegetation, rubbish, debris, and other unsatisfactory material; shall be plowed, disked, or otherwise broken up; pulverized; moistened or aerated as necessary; mixed; and compacted to at least 90 percent maximum density for cohesive materials or 100 percent maximum density for cohesionless materials.
  - 2. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment. The prepared ground surface shall be scarified and moistened or aerated just prior to placement of embankment materials to ensure adequate bond between embankment material and the prepared ground surface.
- J. Embankments
  - 1. Earth Embankments
    - a. Earth embankments shall be constructed from satisfactory materials free of organic or frozen material and rocks with maximum dimensions not greater than 3 in. (75 mm). The material shall be placed in successive horizontal layers of loose material not more than 6 in. (150 mm) in depth. Each layer shall be spread uniformly on a prepared surface, i.e., a soil surface that has been moistened or aerated and scarified plowed, disked, or otherwise broken up in such a manner that the fill will bond with the surface on which it is placed, mixed, and compacted to at least 90 percent maximum density for borrow materials or 100 percent maximum density for excavated materials. Compaction requirements for the upper portion of earth embankments forming subgrade for pavements shall be identical to those requirements specified in paragraph entitled, "Subgrade Preparation."
    - b. Compaction shall be accomplished by sheepsfoot rollers, pneumatic-tired rollers, steel-wheeled rollers, or other approved equipment.
  - 2. Rock Embankments
    - a. Rock embankments shall be constructed from material essentially classified as rock excavation, placed in successive horizontal layers of loose material not more than 8 to 10 in. (200 to 250 mm) in depth. Pieces of rock larger than 8 to 10 in. (200 to 250 mm) in greatest dimension shall not be used.
    - b. Each layer of material shall be spread uniformly and shall be completely saturated and compacted to density as directed by the Owner.



- c. Each layer of material shall be spread uniformly and shall be completely saturated and compacted until the interstices are filled with well-compacted materials and the entire layer is a dense, compacted mass.
- d. Each successive layer of material shall adequately bond to the material on which it is placed.
- e. Compaction shall be accomplished with vibratory compactors with a minimum static weight of 20,000 lbs. (90 kN), heavy rubber-tired rollers weighing not less than 25,000 lbs. (110 kN) or steel-wheeled rollers with a loaded weight of not less than 4,000 lb/ft (58,400 N/m) of drum length.
- f. Rock shall not be used above a point 6 in. (150 mm) below the surface of an embankment that is to be paved.

K. Subgrade Preparation

1. Construction

- a. Subgrade shall be shaped to line, grade, and cross section and compacted as specified. This operation shall include plowing, disking, and any moistening or aerating required to obtain proper compaction. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Rock encountered in the cut sections shall be excavated to a depth of 6 in. (150 mm) below finished grade for the subgrade. Low areas resulting from removal of unsatisfactory material or excavation of rock shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade, and cross section and compacted as specified.
- b. After rolling, the surface of the subgrade for roadways and/or airfields shall indicate a deviation not greater than 3/8 in. (10 mm) when tested with a 10-ft (3.0 m) straightedge applied both parallel with, and at right angles to, the centerline of the area.
- c. Elevation of the finished subgrade shall vary not more than 1/4-in. (6 mm) from the established grade and approved cross section.

2. Compaction: Compaction for pavements and shoulders shall be accomplished with approved equipment until the layer is compacted to the full depth to at least 95 percent maximum density.

- L. Shoulder Construction: Shoulders shall be constructed of satisfactory excavated or borrow materials or as otherwise indicated on the plans. Shoulders shall be constructed as soon as possible after adjacent paving is complete, but in the case of rigid pavements, shoulders shall not be constructed until permission has been obtained. The entire shoulder area shall be compacted to at least the percentage of maximum density as specified for specific ranges of depth below the surface of the shoulder. Compaction shall be accomplished with approved equipment. Shoulder construction shall be done in proper sequence in such a manner that adjacent ditches will be drained effectively and no damage of any kind is done to the adjacent, completed pavement. The completed shoulders shall be true to alignment and grade and shaped to drain in conformity with the cross section indicated.

- M. Finishing: Surface of excavations, embankments, and subgrades shall be finished to a reasonably smooth and compact surface substantially in accordance with the lines, grades, and cross sections or elevations indicated. Degree of finish for graded areas shall be within 1/10 ft (30 mm) of the grades and elevations indicated, except that the degree of finish for subgrades shall be as specified. Gutters and ditches shall be finished as indicated. Surface of areas to be turfed shall be finished to a smoothness suitable for the application of turfing materials.

- N. Subgrade And Embankment Protection: During construction, embankments and excavations shall be kept shaped and drained. Ditches and drains along subgrade shall be maintained in such a manner as to drain effectively at all times. Finished subgrade shall not be disturbed by traffic or other operations and shall be protected and maintained by the Contractor in a satisfactory condition until ballast, subbase, base, or pavement is placed. Storage or stockpiling materials on finished subgrade will not be permitted. Subbase, base course, ballast, or pavement shall not be laid until the subgrade has been checked and approved, and in no case shall subbase, base, surfacing, pavement, or ballast be placed on a muddy, spongy, or frozen subgrade.



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END OF SECTION 02203a



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Task	Specification	Specification Description
02204	02203	Earthwork
02205	02203	Earthwork

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## SECTION 02212 - LEVEE CLOSURE

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing of labor and materials for providing levee closures.

### 1.2 PRODUCTS - (Not Used)

### 1.3 EXECUTION

#### A. If there is deemed, by the Owner, to be considerable risk of flooding involved with removing drainage structures and gates in the existing Levee System, the Contractor shall perform the work of this contract as follows:

1. Only one drainage structure/flap gate will be allowed to be disrupted at one time. All proposed work at each drainage structure shall be completed before proceeding to the next structure.
2. The Contractor shall have all materials required for each structure installation secured on site, before beginning construction on that structure.
3. The Contractor shall have all necessary materials on site to temporarily plug existing and/or proposed piping through the levee.
4. Weather and river flow conditions shall be monitored at all times by the Contractor while each drainage structure is open to flow. The Contractor shall construct an adequate closure in a timely fashion to plug the drainage structure preventing flow through the levee.

END OF SECTION 02212



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02212	02203	Earthwork
02212	02203a	Embankment

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**SECTION 02213 - SUBDRAINAGE****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for subdrainage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. Section Includes:
  - a. Perforated-wall pipe and fittings.
  - b. Drainage conduits.
  - c. Drainage panels.
  - d. Geotextile filter fabrics.

**C. Submittals**

1. Drainage conduits, including rated capacities.
2. Drainage panels, including rated capacities.
3. Geotextile filter fabrics.

**1.2 PRODUCTS****A. Perforated-Wall Pipes And Fittings**

1. Perforated PE Pipe and Fittings:
  - a. NPS 6 (DN 150) and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
  - b. NPS 8 (DN 200) and Larger: ASTM F 667; AASHTO M 252, Type CP; or AASHTO M 294, Type CP; corrugated; for coupled joints.
  - c. Couplings: Manufacturer's standard, band type.
2. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.
3. Perforated Clay Pipe and Fittings: ASTM C 700, Standard- and Extra-Strength classes, unglazed, socket-and-spigot ends, for gasketed joints.
  - a. Gaskets: ASTM C 425, rubber.
4. Perforated Concrete Pipe and Fittings: ASTM C 444 (ASTM C 444M), Type 1, and applicable requirements in ASTM C 14 (ASTM C 14M), Class 2, socket-and-spigot ends for gasketed joints.
  - a. Gaskets: ASTM C 443 (ASTM C 443M), rubber.

**B. Drainage Conduits**

1. Molded-Sheet Drainage Conduits: Prefabricated geocomposite with cusped, molded-plastic drainage core wrapped in geotextile filter fabric.
  - a. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Filter Fabric: PP geotextile.
  - d. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.



2. **Multipipe Drainage Conduits:** Prefabricated geocomposite with interconnected, corrugated, perforated-pipe core molded from HDPE complying with ASTM D 1248 and wrapped in geotextile filter fabric.
  - a. Nominal Size: 6 inches (152 mm) high by approximately 1-1/4 inches (31 mm) thick.
    - 1) Minimum In-Plane Flow: 15 gpm (57 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 12 inches (305 mm) high by approximately 1-1/4 inches (31 mm) thick.
    - 1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Nominal Size: 18 inches (457 mm) high by approximately 1-1/4 inches (31 mm) thick.
    - 1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - d. Filter Fabric: Nonwoven, needle-punched geotextile.
  - e. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
  - f. Couplings: HDPE.
3. **Single-Pipe Drainage Conduits:** Prefabricated geocomposite with perforated corrugated core molded from HDPE complying with ASTM D 3350 and wrapped in geotextile filter fabric.
  - a. Nominal Size: 12 inches (305 mm) high by approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 30 gpm (114 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 18 inches (457 mm) high by approximately 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 45 gpm (170 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Filter Fabric: Nonwoven, PP geotextile.
  - d. Fittings: HDPE with combination NPS 4 and NPS 6 (DN 100 and DN 150) outlet connection.
  - e. Couplings: Corrugated HDPE band.
4. **Mesh Fabric Drainage Conduits:** Prefabricated geocomposite with plastic-filament drainage core wrapped in geotextile filter fabric. Include fittings for bends and connection to drainage piping.
  - a. Nominal Size: 6 inches (2-mm) high by approximately 0.9 inch (23 mm) thick.
    - 1) Minimum In-Plane Flow: 2.4 gpm (9.1 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Filter Fabric: Nonwoven geotextile made of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
5. **Ring Fabric Drainage Conduits:** Drainage conduit with HDPE-rings-in-grid-pattern drainage core, for field-applied geotextile filter fabric. Include fittings for bends and connection to drainage piping.
  - a. Nominal Size: 18 inches (0.5 m) high by 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 82 gpm (310 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - b. Nominal Size: 36 inches (1 m) high by 1 inch (25 mm) thick.
    - 1) Minimum In-Plane Flow: 164 gpm (621 L/min.) at hydraulic gradient of 1.0 when tested according to ASTM D 4716.
  - c. Filter Fabric: Specified in Part 1.2 "Geotextile Filter Fabrics" Article.

#### C. Drainage Panels

1. **Molded-Sheet Drainage Panels:** Prefabricated geocomposite, 36 to 60 inches (915 to 1525 mm) wide with drainage core faced with geotextile filter fabric.
  - a. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
    - 1) Minimum Compressive Strength: 10,000 lbf/sq. ft. (479 kPa) **OR** 15,000 lbf/sq. ft. (718 kPa) **OR** 18,000 lbf/sq. ft. (862 kPa) **OR** 21,000 lbf/sq. ft. (1005 kPa), **as directed**, when tested according to ASTM D 1621.



- 2) Minimum In-Plane Flow Rate: 2.8 gpm/ft. (35 L/min. per m) **OR** 7 gpm/ft. (87 L/min. per m) **OR** 15 gpm/ft. (188 L/min. per m), **as directed**, of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig (172 kPa) when tested according to ASTM D 4716.
    - b. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
      - 1) Survivability: Class 1 **OR** 2 **OR** 3, **as directed**.
      - 2) Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.25-mm) **OR** No. 70 (0.212-mm), **as directed**, sieve, maximum.
      - 3) Permittivity: 0.5 **OR** 0.2 **OR** 0.1, **as directed**, per second, minimum.
    - c. Filter Fabric: Woven geotextile fabric, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation less than 50 percent; complying with the following properties determined according to AASHTO M 288:
      - 1) Survivability: Class 1 **OR** 2 **OR** 3, **as directed**.
      - 2) Apparent Opening Size: No. 40 (0.425-mm) **OR** No. 60 (0.25-mm) **OR** No. 70 (0.212-mm) **OR** No. 30 (0.6-mm), **as directed**, sieve, maximum.
      - 3) Permittivity: 0.5 **OR** 0.2 **OR** 0.1 **OR** 0.02, **as directed**, per second, minimum.
    - d. Film Backing: Polymeric film bonded to drainage core surface.
  2. Mesh Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
    - a. Drainage Core: Open-construction, resilient, approximately 0.4-inch- (10.2-mm-) thick, plastic-filament mesh.
      - 1) Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
    - b. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
  3. Net Fabric Drainage Panels: Prefabricated geocomposite with drainage core faced with geotextile filter fabric.
    - a. Drainage Core: 3-dimensional, PE nonwoven-strand geonet, approximately 0.25-inch- (6-mm-) thick.
      - 1) Minimum In-Plane Flow Rate: 2.4 gpm/ft. (30 L/min. per m) **OR** 5 gpm/ft. (62 L/min. per m), **as directed**, of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
    - b. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
  4. Ring Fabric Drainage Panels: Drainage-core panel for field application of geotextile filter fabric.
    - a. Drainage Core: 3-dimensional, HDPE rings in grid pattern, approximately 1 inch (25 mm) thick.
      - 1) Minimum In-Plane Flow Rate: 40 gpm/ft. (500 L/min. per m) of unit width at hydraulic gradient of 1.0 and normal pressure of 25 psig (172 kPa) when tested according to ASTM D 4716.
  5. Fabric-Covered Insulated Drainage Panels: Extruded PS board insulation complying with ASTM C 578; fabricated with shiplap **OR** tongue-and-groove, **as directed**, edges and with one side having grooved drainage channels; unfaced **OR** ;faced with geotextile filter fabric, **as directed**.
    - a. Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) minimum density and 25-psig (172-kPa) minimum compressive strength.
    - b. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40-psig (276-kPa) minimum compressive strength.
    - c. Minimum In-Plane Flow Rate: 9 gpm/ft. (112 L/min. per m) of unit width when tested according to ASTM D 4716.



- d. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.
- 6. Noncovered Insulated Drainage Panels: Extruded PS board insulation complying with ASTM C 578; fabricated with rabbeted edges and with one side having ribbed drainage channels.
  - a. Type VI, 1.8-lb/cu. ft. (29-kg/cu. m) minimum density and 40-psig (276-kPa) minimum compressive strength.
  - b. Type VII, 2.2-lb/cu. ft. (35-kg/cu. m) minimum density and 60-psig (414-kPa) minimum compressive strength.
  - c. Minimum In-Plane Flow Rate: 9 gpm/ft. (112 L/min. per m) of unit width when tested according to ASTM D 4716.
- 7. Expanded PS Insulated Drainage Panels: PS bead board insulation; panels are 4 inches (102 mm) thick by 48 inches (1220 mm) wide and faced with geotextile filter fabric.
  - a. Density: 2 lb/cu. ft. (32 kg/cu. m).
  - b. Compressive Strength: 800 lbf/sq. ft. (38 kPa).
  - c. Minimum In-Plane Flow Rate: 3 gpm/ft. (37 L/min. per m) of unit width when tested according to ASTM D 4716.
  - d. Filter Fabric: Nonwoven geotextile of PP or polyester fibers or combination of both. Flow rates range from 120 to 200 gpm/sq. ft. (81 to 136 L/s per sq. m) when tested according to ASTM D 4491.

#### D. Soil Materials

- 1. Soil materials are specified in Division 02 Section "Earthwork".

#### E. Waterproofing Felts

- 1. Material: Comply with ASTM D 226, Type I, asphalt **OR** ASTM D 227, coal-tar, **as directed**, -saturated organic felt.

#### F. Geotextile Filter Fabrics

- 1. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.
  - a. Structure Type: Nonwoven, needle-punched continuous filament.
    - 1) Survivability: AASHTO **M 288 Class 2**.
    - 2) Style(s): Flat **OR** sock, **as directed**.

### 1.3 EXECUTION

#### A. Earthwork

- 1. Excavating, trenching, and backfilling are specified in Division 02 Section "Earthwork".

#### B. Foundation Drainage Installation

- 1. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.
- 2. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
- 3. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
- 4. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
- 5. Install drainage piping as indicated in Article 1.3 "Piping Installation" for foundation subdrainage.
- 6. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
- 7. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.



8. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
9. Place layer of flat-style geotextile filter fabric **OR** waterproofing felt, **as directed**, over top of drainage course, overlapping edges at least 4 inches (100 mm).
10. Install drainage panels on foundation walls as follows:
  - a. Coordinate placement with other drainage materials.
  - b. Lay perforated drainage pipe at base of footing. Install as indicated in Article 1.3 "Piping Installation."
  - c. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
  - d. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.
11. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

C. Underslab Drainage Installation

1. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches (150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
2. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
3. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
4. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
5. Install drainage piping as indicated in Part 1.3 "Piping Installation" Article for underslab subdrainage.
6. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
7. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.
8. Install horizontal drainage panels as follows:
  - a. Coordinate placement with other drainage materials.
  - b. Lay perforated drainage pipe at inside edge of footings.
  - c. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
  - d. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

D. Retaining-Wall Drainage Installation

1. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
2. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches (100 mm).
3. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.
4. Install drainage piping as indicated in Article 1.3 "Piping Installation" for retaining-wall subdrainage.
5. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.
6. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.
7. Place drainage course in layers not exceeding 3 inches (75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.
8. Place layer of flat-style geotextile filter fabric **OR** waterproofing felt, **as directed**, over top of drainage course, overlapping edges at least 4 inches (100 mm).
9. Install drainage panels on walls as follows:



- a. Coordinate placement with other drainage materials.
  - b. Lay perforated drainage pipe at base of footing as described elsewhere in this Specification. Do not install aggregate.
  - c. If weep holes are used instead of drainage pipe, cut 1/2-inch- (13-mm-) diameter holes on core side at weep-hole locations. Do not cut fabric.
  - d. Mark horizontal chalk line on wall at a point 6 inches (150 mm) less than panel width above footing bottom. Before marking wall, subtract footing width.
  - e. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
  - f. Attach panel to wall at horizontal mark and at beginning of wall corner. Place core side of panel against wall. Use concrete nails with washers through product. Place nails from 2 to 6 inches (50 to 150 mm) below top of panel, approximately 48 inches (1200 mm) apart. Construction adhesives, metal stick pins, or double-sided tape may be used instead of nails. Do not penetrate waterproofing. Before using adhesives, discuss with waterproofing manufacturer.
  - g. If another panel is required on same row, cut away 4 inches (100 mm) of installed panel core and wrap fabric over new panel.
  - h. If additional rows of panel are required, overlap lower panel with 4 inches (100 mm) of fabric.
  - i. Cut panel as necessary to keep top 12 inches (300 mm) below finish grade.
  - j. For inside corners, bend panel. For outside corners, cut core to provide 3 inches (75 mm) for overlap.
10. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

#### E. Landscaping Drainage Installation

1. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
2. Lay flat-style geotextile filter fabric in trench and overlap trench sides.
3. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).
4. Install drainage conduits as indicated in Article 1.3 "Piping Installation" for landscaping subdrainage with horizontal distance of at least 6 inches (150 mm) between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with adhesive or tape.
5. Add drainage course to top of drainage conduits.
6. After satisfactory testing, cover drainage conduit to within 12 inches (300 mm) of finish grade.
7. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.
8. Place layer of flat-style geotextile filter fabric **OR** waterproofing felt, **as directed**, over top of drainage course, overlapping edges at least 4 inches (100 mm).
9. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Fill to finish grade.

#### F. Piping Installation

1. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
  - a. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
  - b. Underslab Subdrainage: Install piping level.
  - c. Plaza Deck Subdrainage: Install piping level.





- d. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping level and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
- e. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches (915 mm), unless otherwise indicated.
- f. Lay perforated pipe with perforations down.
- g. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.
2. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
3. Install thermoplastic piping according to ASTM D 2321.

G. Pipe Joint Construction

1. Join perforated PE pipe and fittings with couplings according to ASTM D 3212 with loose banded, coupled, or push-on joints.
2. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.
3. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

1.4 Backwater Valve Installation

1. Comply with requirements for backwater valves specified in Division 2 Section "Storm Drainage."
2. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.
3. Install horizontal backwater valves in piping in manholes or pits where indicated.

B. Cleanout Installation

1. Comply with requirements for cleanouts specified in Division 2 Section "Storm Drainage."
2. Cleanouts for Foundation, Retaining-Wall, and Landscaping Subdrainage:
  - a. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - b. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
  - c. In nonvehicular-traffic areas, use NPS 4 (DN 100) cast-iron **OR** PVC, **as directed**, pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) in depth. Set top of cleanout plug 1 inch (25 mm) above grade.
3. Cleanouts for Underslab Subdrainage:
  - a. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
  - b. Use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

C. Connections

1. Comply with requirements for piping specified in Division 2 Section "Storm Drainage." Drawings indicate general arrangement of piping, fittings, and specialties.
2. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.



3. Where required, connect low elevations of foundation **OR** Underslab, **as directed**, subdrainage to stormwater sump pumps.

D. Identification

1. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in Division 02 Section "Earthwork".
  - a. Install PE warning tape or detectable warning tape over ferrous piping.
  - b. Install detectable warning tape over nonferrous piping and over edges of underground structures.

E. Field Quality Control

1. Tests and Inspections:
  - a. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
  - b. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.
2. Drain piping will be considered defective if it does not pass tests and inspections.
3. Prepare test and inspection reports.

F. Cleaning

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

END OF SECTION 02213



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02213	02203	Earthwork

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## SECTION 02215 - EXCAVATION SUPPORT AND PROTECTION

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for excavation support and protection. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Performance Requirements

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

#### C. Submittals

1. Shop Drawings: For excavation support and protection system.
2. Delegated-Design Submittal: For excavation support and protection system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### D. Quality Assurance

1. Preinstallation Conference: Conduct conference at Project site.

#### E. Project Conditions

1. 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:
  - a. Notify the Owner no fewer than two days in advance of proposed interruption of utility.
  - b. Do not proceed with interruption of utility without the Owner's written permission.
2. 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.
  - a. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify the Owner if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

### 1.2 PRODUCTS

#### A. Materials

1. General: Provide materials that are either new or in serviceable condition.
2. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
3. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.



- a. Corners: Site-fabricated mechanical interlock **OR** Roll-formed corner shape with continuous interlock, **as directed**.
4. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application, **OR** 3 inches (75 mm) **OR** 4 inches (100 mm), **as directed**.
5. Shotcrete: Comply with Division 03 Section "Shotcrete" for shotcrete materials and mixes, reinforcement, and shotcrete application.
6. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
7. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
8. Tiebacks: Steel bars, ASTM A 722/A 722M.
9. Tiebacks: Steel strand, ASTM A 416/A 416M.

### 1.3 EXECUTION

#### A. Preparation

1. 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.
  - a. Shore, support, and protect utilities encountered.
2. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - a. 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.
3. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.
4. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
5. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

#### B. Soldier Piles And Lagging

1. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment.
2. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
3. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

#### C. Sheet Piling

1. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches (1500 mm). Accurately align exposed faces of sheet piling to vary not more than 2 inches (50 mm) from a horizontal line and not more than 1:120 out of vertical alignment. Cut tops of sheet piling to uniform elevation at top of excavation.

#### D. Tiebacks

1. Tiebacks: Drill, install, grout, and tension tiebacks. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.
  - a. Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.



- b. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.
- E. Bracing
  - 1. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
    - a. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by the Owner.
    - b. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
    - c. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.
- F. Removal And Repairs
  - 1. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
    - a. Remove excavation support and protection systems to a minimum depth of 48 inches (1200 mm) below overlaying construction and abandon remainder.
    - b. Fill voids immediately with approved backfill compacted to density specified in Division 02 Section "Earthwork".
    - c. Repair or replace, as approved by the Owner, adjacent work damaged or displaced by removing excavation support and protection systems.
  - 2. Leave excavation support and protection systems permanently in place.

END OF SECTION 02215



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02215	02203	Earthwork
02218	02215	Excavation Support And Protection
02218	02203	Earthwork
02223	02203	Earthwork



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## SECTION 02240 - SOIL STABILIZATION-LIME

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers furnishing of materials and the preparation and production of a stabilized subgrade by the addition of hydrated lime to the native material.

### 1.2 PRODUCTS

#### A. Hydrated lime material requirements shall be as follows:

1. Available Lime Index as Calcium Hydroxide: 90 percent minimum.
2. Residue retained on No. 30 Sieve: 1 percent maximum.
3. Residue retained on No. 200 Sieve: 20 percent maximum.

### 1.3 EXECUTION:

- A. Preparation: Scarify the subgrade to the depth required and pulverize the material until it is substantially free of lumps greater than three inches in diameter.
- B. Installation: Lime shall be applied to the pulverized material as a slurry, unless otherwise directed. Water shall be added as needed to provide a moisture content of not less than 20 percent. Surface-applied lime slurry shall be plowed and/or disked into the soil as necessary. The resulting mixture shall be aged for not less than 48 hours before compaction.

END OF SECTION 02240



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02241	02240	Soil Stabilization-Lime

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## SECTION 02242 - PIPED UTILITIES BASIC MATERIALS AND METHODS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for piped utilities - basic materials and methods. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes the following:
  - a. Piping joining materials.
  - b. Transition fittings.
  - c. Dielectric fittings.
  - d. Sleeves.
  - e. Identification devices.
  - f. Grout.
  - g. Flowable fill.
  - h. Piped utility demolition.
  - i. Piping system common requirements.
  - j. Equipment installation common requirements.
  - k. Painting.
  - l. Concrete bases.
  - m. Metal supports and anchorages.

#### C. Definitions

1. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.
2. 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.
3. ABS: Acrylonitrile-butadiene-styrene plastic.
4. CPVC: Chlorinated polyvinyl chloride plastic.
5. PE: Polyethylene plastic.
6. PVC: Polyvinyl chloride plastic.

#### D. Submittals

1. Product Data: For the following:
  - a. Dielectric fittings.
  - b. Identification devices.
2. Welding certificates.

#### E. Quality Assurance

1. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - a. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - b. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
3. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.



F. Delivery, Storage, And Handling

1. 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.
2. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.2 PRODUCTS

A. Piping Joining Materials

1. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - a. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise indicated.
    - 1) Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - 2) Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - b. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
3. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
4. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
5. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
6. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
7. Solvent Cements for Joining Plastic Piping:
  - a. ABS Piping: ASTM D 2235.
  - b. CPVC Piping: ASTM F 493.
  - c. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  - d. PVC to ABS Piping Transition: ASTM D 3138.
8. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

B. Transition Fittings

1. Transition Fittings, General: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
2. Transition Couplings NPS 1-1/2 (DN 40) and Smaller:
  - a. Underground Piping: Manufactured piping coupling or specified piping system fitting.
  - b. Aboveground Piping: Specified piping system fitting.
3. AWWA Transition Couplings NPS 2 (DN 50) and Larger:
  - a. Description: AWWA C219, metal sleeve-type coupling for underground pressure piping.
4. Plastic-to-Metal Transition Fittings:
  - a. Description: CPVC and 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.
5. Plastic-to-Metal Transition Unions:
  - a. Description: MSS SP-107, CPVC and PVC four-part union. Include brass or stainless-steel threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.
6. Flexible Transition Couplings for Underground Nonpressure Drainage Piping:
  - a. Description: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.



**C. Dielectric Fittings**

1. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.
2. Dielectric Unions:
  - a. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.
    - 1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**, at 180 deg F (82 deg C).
    - 2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.
3. Dielectric Flanges:
  - a. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.
    - 1) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 175 psig (1200 kPa) minimum **OR** 300 psig (2070 kPa), **as directed**.
    - 2) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Kits:
  - a. Description: Nonconducting materials for field assembly of companion flanges, NPS 2-1/2 (DN 65) and larger.
    - 1) Pressure Rating: 150 psig (1035 kPa) minimum.
    - 2) Gasket: Neoprene or phenolic.
    - 3) Bolt Sleeves: Phenolic or polyethylene.
    - 4) Washers: Phenolic with steel backing washers.
5. Dielectric Couplings:
  - a. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.
    - 1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    - 2) End Connections: Threaded.
6. Dielectric Nipples:
  - a. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.
    - 1) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    - 2) End Connections: Threaded or grooved.

**D. Sleeves**

1. Mechanical sleeve seals for pipe penetrations are specified in Division 15 Section "Common Work Results For Plumbing".
2. Galvanized-Steel Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
3. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.
4. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
5. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.
6. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.
7. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

**E. Identification Devices**

1. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.
  - a. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
  - b. Location: Accessible and visible.
2. Stencils: Standard stencils prepared with letter sizes complying with recommendations in ASME A13.1. Minimum letter height is 1-1/4 inches (30 mm) for ducts, and 3/4 inch (20 mm) for access door signs and similar operational instructions.
  - a. Material: Fiberboard **OR** Brass, **as directed**.



- b. Stencil Paint: Exterior, oil-based, alkyd-gloss black enamel, unless otherwise indicated. Paint may be in pressurized spray-can form.
  - c. Identification Paint: Exterior, oil-based, alkyd enamel in colors according to ASME A13.1, unless otherwise indicated.
- 3. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.
- 4. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.
- 5. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.
- 6. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.
- 7. Lettering: Manufacturer's standard preprinted captions as selected by the Owner.
- 8. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
  - a. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.
- 9. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.
  - a. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
  - b. Color: Comply with ASME A13.1, unless otherwise indicated.
- 10. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.
  - a. Material: 0.032-inch- (0.8-mm-) thick, polished brass **OR** aluminum, **as directed**.
  - b. Material: 0.0375-inch- (1-mm-) thick stainless steel.
  - c. Material: 3/32-inch- (2.4-mm-) thick plastic laminate with 2 black surfaces and a white inner layer.
  - d. Material: Valve manufacturer's standard solid plastic.
  - e. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
  - f. Shape: As indicated for each piping system.
- 11. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.
- 12. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.
  - a. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.
  - b. Thickness: 1/16 inch (1.6 mm), for units up to 20 sq. in. (130 sq. cm) or 8 inches (200 mm) in length, and 1/8 inch (3 mm) for larger units.
  - c. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.
- 13. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:
  - a. Green: Cooling equipment and components.
  - b. Yellow: Heating equipment and components.
  - c. Brown: Energy reclamation equipment and components.
  - d. Blue: Equipment and components that do not meet criteria above.
  - e. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
  - f. Terminology: Match schedules as closely as possible. Include the following:
    - 1) Name and plan number.
    - 2) Equipment service.
    - 3) Design capacity.
    - 4) Other design parameters such as pressure drop, entering and leaving conditions, and speed.



- g. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.
- 14. Plasticized Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with mat finish suitable for writing.
  - a. Size: 3-1/4 by 5-5/8 inches (83 by 143 mm).
  - b. Fasteners: Brass grommets and wire.
  - c. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
- 15. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in piped utility identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of piped utility systems and equipment.
  - a. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

F. Grout

- 1. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  - a. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - b. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  - c. Packaging: Premixed and factory packaged.

G. Flowable Fill

- 1. Description: Low-strength-concrete, flowable-slurry mix.
  - a. Cement: ASTM C 150, Type I, portland.
  - b. Density: 115- to 145-lb/cu. ft. (1840- to 2325-kg/cu. m).
  - c. Aggregates: ASTM C 33, natural sand, fine and crushed gravel or stone, coarse  
**OR**  
Aggregates: ASTM C 33, natural sand, fine with admixture, ASTM C 618, fly-ash mineral.
  - d. Water: Comply with ASTM C 94/C 94M.
  - e. Strength: 100 to 200 psig (690 to 1380 kPa) at 28 days.

### 1.3 EXECUTION

A. Piped Utility Demolition

- 1. Refer to Division 01 Section(s) "Cutting And Patching" AND "Selective Demolition" for general demolition requirements and procedures.
- 2. Disconnect, demolish, and remove piped utility systems, equipment, and components indicated to be removed.
  - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  - b. Piping to Be Abandoned in Place: Drain piping. Fill abandoned piping with flowable fill, and cap or plug piping with same or compatible piping material.
  - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make operational.
  - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- 3. 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.

B. Dielectric Fitting Applications

- 1. Dry Piping Systems: Connect piping of dissimilar metals with the following:
  - a. NPS 2 (DN 50) and Smaller: Dielectric unions.
  - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Dielectric flanges or dielectric flange kits.



2. Wet Piping Systems: Connect piping of dissimilar metals with the following:
  - a. NPS 2 (DN 50) and Smaller: Dielectric couplings **OR** dielectric nipples, **as directed**.
  - b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Dielectric nipples.
  - c. NPS 2-1/2 to NPS 8 (DN 65 to DN 200): Dielectric nipples or dielectric flange kits.
  - d. NPS 10 and NPS 12 (DN 250 and DN 300): Dielectric flange kits.

#### C. Piping Installation

1. Install piping according to the following requirements and Division 02 specifying piping systems.
2. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.
3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
4. Install piping to permit valve servicing.
5. Install piping at indicated slopes.
6. Install piping free of sags and bends.
7. Install fittings for changes in direction and branch connections.
8. Select system components with pressure rating equal to or greater than system operating pressure.
9. Sleeves are not required for core-drilled holes, unless directed otherwise.
10. Permanent sleeves are not required for holes formed by removable PE sleeves, unless directed otherwise.
11. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
  - a. Cut sleeves to length for mounting flush with both surfaces.
    - 1) Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches (50 mm) above finished floor level.
  - b. Install sleeves in new walls and slabs as new walls and slabs are constructed.
    - 1) PVC **OR** Steel, **as directed**, Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - 2) Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
12. Verify final equipment locations for roughing-in.
13. Refer to equipment specifications in other Sections for roughing-in requirements.

#### D. Piping Joint Construction

1. Join pipe and fittings according to the following requirements and Division 02 specifying piping systems.
2. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
3. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
4. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
5. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1.1 "Quality Assurance" Article.
6. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
7. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.



8. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
  9. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
  10. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.
  11. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    - b. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
    - c. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
    - d. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    - e. PVC Nonpressure Piping: Join according to ASTM D 2855.
    - f. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
  12. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
  13. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
  14. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
    - a. Plain-End PE Pipe and Fittings: Use butt fusion.
    - b. Plain-End PE Pipe and Socket Fittings: Use socket fusion.
  15. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- E. Piping Connections
1. Make connections according to the following, unless otherwise indicated:
    - a. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
    - b. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
    - c. Install dielectric fittings at connections of dissimilar metal pipes.
- F. Equipment Installation
1. Install equipment level and plumb, unless otherwise indicated.
  2. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.
  3. Install equipment to allow right of way to piping systems installed at required slope.
- G. Painting
1. Painting of piped utility systems, equipment, and components is specified in Division 09.
  2. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- H. Identification
1. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
    - a. Stenciled Markers: According to ASME A13.1.
    - b. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
    - c. Locate pipe markers on exposed piping according to the following:
      - 1) Near each valve and control device.



- 2) Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
  - 3) Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
  - 4) At manholes and similar access points that permit view of concealed piping.
  - 5) Near major equipment items and other points of origination and termination.
2. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.
- a. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
  - b. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
3. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

I. Concrete Bases

1. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  - a. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  - b. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of base.
  - c. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - d. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - e. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - f. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  - g. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-place Concrete".

J. Erection Of Metal Supports And Anchorages

1. Refer to Division 05 Section "Metal Fabrications" for structural steel.
2. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.
3. Field Welding: Comply with AWS D1.1/D1.1M.

K. Grouting

1. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.
2. Clean surfaces that will come into contact with grout.
3. Provide forms as required for placement of grout.
4. Avoid air entrapment during placement of grout.
5. Place grout, completely filling equipment bases.
6. Place grout on concrete bases and provide smooth bearing surface for equipment.
7. Place grout around anchors.
8. Cure placed grout.

END OF SECTION 02242



## SECTION 02242a - GEOSYNTHETIC FABRIC

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing of labor, material and equipment for the installation of geosynthetic fabric.

### 1.2 PRODUCTS

#### A. Materials

1. Erosion Control Fabric - Photo and biodegradable plastic Curlex Blanket as manufactured by American Excelsior Co. or approved equal.
2. Drainage/Leach Bed - Non-woven polypropylene/polyethylene fabric, Mirafi 140N or approved equal.
3. Road Base and Structure Reinforcement - Woven polypropylene fabric, Mirafi 600X or approved equal.
4. Sediment and Job Site erosion control - woven polypropylene fabric - Envirofence by Mirafi or approved equal.

### 1.3 EXECUTION

- A. For sediment and job site erosion control fabric, the Contractor shall provide and install silt fence as detailed on the Storm Water Management and Erosion Control Plan. It shall be the Contractor's option to provide fabricated reinforced silt fence or prefabricated units, unless otherwise noted. In all installations, the bottom flap of filter cloth shall be firmly embedded into undisturbed or stabilized grade. Embedment shall resist pullout and prevent flow under the installation.

END OF SECTION 02242a



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## SECTION 02242b - SEWAGE TREATMENT LAGOONS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for the repair and maintenance of sewage treatment lagoons. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Materials

1. Concrete Block shall comply with ASTM C 129.
2. Concrete Grout shall comply with Fed. Spec. MMM-A-001993.
3. Riprap Stone shall comply with AREA-01.
4. Concrete Repair Material shall comply with Fed. Spec. MMM-A-001993.
5. Sand shall comply with ASTM C 33.
6. Portland Cement shall comply with ASTM C 150, Type V.
7. Rubble shall consist of broken concrete or broken stone.

### 1.3 EXECUTION

- A. Algae Removal shall be by mechanical or manual methods and shall include, but not be limited to, skimming, pumping through a screen, raking, or draining and cleaning the lagoon.
- B. Slope and Dike Reconstruction shall be made to re-establish the original design configuration and grades. Place riprap, where required, so that its angle of repose is not exceeded.
- C. Liner Reconstruction and Repair shall be made with materials compatible with the existing liner and compatible with the wastewater and sludge to be contained therein.
- D. Repairs to Elastomeric Membrane Liners shall be made with like material and shall overlap all cuts, tears, fractures or other defects a minimum of 4 inches. Cut repair pieces square or rectangular. The method of bonding the new material to existing material shall be similar to the original joint banding method, except when the original joints have failed. In this case, the material supplier shall demonstrate that an alternate jointing system shall be satisfactory to the Owner. Replace earth or sand cover removed during repair or replacement of plastic liner to the same thickness as the original installation.
- E. Repairs to Non-Elastomeric Membrane Liners shall be made by cutting out defective areas back to sound liner material and replacing with similar material. Joints shall be watertight.

END OF SECTION 02242b



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**SECTION 02242c - POND RESERVOIR LINERS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for pond and reservoir liners. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. This Section includes geomembrane liners and floating covers for ponds and reservoirs.

**C. Definitions**

1. Plastics Terminology: See ASTM D 1600 for definitions of abbreviated terms for plastics not otherwise defined in this Section.
2. CSPE: Chlorosulfonated polyethylene.
3. EIA: Ethylene interpolymer alloy.
4. EPDM: Ethylene-propylene-diene terpolymer.
5. PE: Polyethylene.
6. PP: Polypropylene.

**D. Performance Requirements**

1. Provide geomembrane liners and floating covers, **as directed**, that prevent the passage of water and gas, **as directed**.

**E. Submittals**

1. Product Data: For each type of product indicated. Include the following:
  - a. Sheets for geomembrane liners and floating covers.
  - b. Seaming adhesives, solvents, and extrusions.
  - c. Penetration assemblies.
  - d. Accessories for floating covers.
2. Shop Drawings: Show fabrication and installation details for geomembrane liners. Show panel layout, seams, penetrations, perimeter anchorage, floating cover, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.
3. Samples: For the following products, in sizes indicated:
  - a. Geomembrane Panels: For each type, not less than one 12-inch (300-mm) seam length for factory-bonded sheets and one 12-inch (300-mm) seam length for field-bonded sheets.
4. Qualification Data: For qualified Installer **OR** testing agency, **as directed**.
5. Product Certificates: For each type of geomembrane liner and floating cover, from manufacturer.
6. Product Test Reports: For each geomembrane sheet, based on evaluation of comprehensive tests performed by a qualified testing agency.
7. Source quality-control reports.
8. Field quality-control reports.
9. Maintenance Data: For geomembrane liner and floating cover to include in maintenance manuals.
10. Warranty: Special warranty specified in this Section.

**F. Quality Assurance**

1. Installer Qualifications: Fabricator of products **OR** An employer of workers trained and approved by manufacturer, **as directed**.
2. Source Limitations: Obtain geomembrane liner and floating cover, accessories, and required seaming materials, solvents, and adhesives from single source.
3. Preinstallation Conference: Conduct conference at Project site.



- a. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
- b. Review structural load limitations.
- c. Review limitations on equipment and Installer's personnel.
- d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- e. Review required testing, inspecting, and certifying procedures.
- f. Review existing and forecasted weather conditions and procedures for unfavorable conditions.

G. Project Conditions

1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit placement and seaming of geomembrane liners and floating covers to be performed according to manufacturers' written instructions and warranty requirements.

H. Warranty

1. Special Warranty: Specified form in which geomembrane manufacturer, geomembrane liner and floating cover fabricator, and geomembrane liner and floating cover Installer agree to repair or replace geomembrane liner and floating cover that fail(s) in materials or workmanship or that deteriorate(s) under conditions of normal weather within specified warranty period. Warranty does not include deterioration or failure of geomembrane liner and floating cover due to exposure to harmful chemicals, gases or vapors, abnormal and severe weather phenomena, fire, earthquakes, floods, vandalism, or abuse by persons, animals, or equipment.
  - a. Failures include, but are not limited to, the following:
    - 1) Leaks in geomembrane liner and floating cover.
    - 2) Defects in seams.
    - 3) Cracks and holes in floating cover.
  - b. Warranty Period: One **OR** Five **OR** 10, **as directed**, year(s) from date of Substantial Completion.

## 1.2 PRODUCTS

A. CSPE Sheet Materials

1. CSPE Sheet: Formulated from CSPE for use in hydraulic structures and formed into uniform, flexible sheets.
  - a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
    - 1) Construction: 6 x 6 - 1000 d **OR** 8 x 8 - 250 d **OR** 10 x 10 - 1000 d, **as directed**.
  - b. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
  - c. Nominal Thickness over Scrim: 11-mil- (0.28-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
  - d. Breaking Strength: Not less than 200 lbf (0.89 kN) minimum average per ASTM D 751, Procedure A.
  - e. Tear Strength, Initial: Not less than 70 lbf (0.31 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
  - f. Tear Strength, after Aging: Not less than 35 lbf (0.16 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
  - g. Puncture Resistance: Not less than 200 lbf (0.89 kN) minimum average per ASTM D 4833.
  - h. Hydrostatic Resistance: Not less than 250-psi (1725-kPa) minimum average resistance per ASTM D 5514, Procedure A or ASTM D 751, Method A, Procedure 1.
  - i. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.



- j. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D 2136.
- k. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G 155.
- l. Ply Adhesion: Not less than 7 lbf/in. (1.2 kN/m) **OR** 10 lbf/in. (1.75 kN/m), **as directed**, of seam width, or film tearing bond, according to ASTM D 413, Machine Method.
- m. Water Absorption (for low-water-absorption CSPE): Not more than 2 percent at 70 deg F (21 deg C) and not more than 30 percent at 158 deg F (70 deg C) for 30 days each per ASTM D 471, 30-mil- (0.76-mm-) thick sheet.

B. EIA Sheet Materials

- 1. EIA Sheet: Formulated from EIA for use in hydraulic structures and formed into uniform, flexible sheets.
  - a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
    - 1) Construction: 6 x 6 - 1000 d **OR** 8 x 8 - 500 d **OR** 10 x 10 - 1000 d **OR** 10 x 11 - 2520 d x 2000 d, **as directed**.
  - b. Nominal Thickness: 36-mil- (0.91-mm-) thick sheet per ASTM D 1593 or ASTM D 751, Optical Method.
  - c. Tensile Strength: Not less than 400 lbf (1.8 kN) minimum average per ASTM D 751, Procedure A.
  - d. Tear Strength: Not less than 35 lbf (0.16 kN) minimum average per ASTM D 5884 or ASTM D 751, Procedure B.
  - e. Puncture Resistance: Not less than 150 lbf (0.67 kN) minimum average per ASTM D 4833.
  - f. Hydrostatic Resistance: Not less than 100-psi (690-kPa) minimum average resistance per ASTM D 751, Procedure A.
  - g. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
  - h. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 30 deg F (minus 34 deg C), and per ASTM D 2136.
  - i. UV-Light Resistance: Pass, 4000 hours at 176 deg F (80 deg C), per ASTM G 155.
  - j. Ply Adhesion: Not less than 7 lbf/in. (1.2 kN/m) **OR** 10 lbf/in. (1.75 kN/m), **as directed**, of seam width, or film tearing bond, according to ASTM D 413, Machine Method.

C. EPDM Sheet Materials

- 1. EPDM Sheet: Formulated from EPDM, compounded for use in hydraulic structures and formed into uniform, flexible sheets.
  - a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
    - 1) Construction: 9 x 9 - 1000 d **OR** 10 x 10 - 1000 d, **as directed**.
  - b. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method.
  - c. Breaking Strength: Not less than 190 lbf (0.85 kN) minimum average per ASTM D 882, ASTM D 7004, or ASTM D 751, Procedure A.
  - d. Tear Resistance: Not less than 130 lb (0.58 kN) minimum average per ASTM D 1004.
  - e. Puncture Strength: Not less than 60 lbf (0.27 kN) minimum average per ASTM D 4833.

D. PE Sheet Materials

- 1. PE Sheet: Formulated from virgin PE, compounded for use in hydraulic structures, and formed into uniform sheets.
  - a. Sheet Texture: One side smooth; other side smooth **OR** textured, **as directed**.
  - b. Nominal Density: Low density, 0.910 to 0.925 g/cu. cm **OR** Linear low density, 0.919 to 0.925 g/cu. cm **OR** Medium density, 0.926 to 0.939 g/cu. cm **OR** High density, 0.940 to 0.959 g/cu. Cm, **as directed**, per ASTM D 1505.
  - c. Nominal Thickness: 60-mil- (1.5-mm-) thick sheet per ASTM D 5199 **OR** ASTM D 5994, **as directed**.
  - d. Melt Flow Index: Not more than 0.035 oz./10 minutes (1.0 g/10 minutes) per ASTM D 1238, Condition 190/2.16.



- e. Carbon Black Content: 2 to 3 percent per ASTM D 1603 or ASTM D 4218.
- f. Carbon Black Dispersion: Per ASTM D 5596, Category 1 and 2.
- g. Oxidation Induction Time: Not less than 100 minutes per ASTM D 3895.
- h. Tensile Properties: Not less than indicated for each direction, per ASTM D 638, Type IV or ASTM D 6693, Type IV.
  - 1) Strength at Yield: Not less than 126 lbf/in. (22 kN/m) and 2100 psi (14.5 MPa) minimum average.
  - 2) Strength at Break: Not less than 228 lbf/in. (40 kN/m) and 3800 psi (26.2 MPa) minimum average.
  - 3) Elongation at Yield: Not less than 12 percent minimum average.
  - 4) Elongation at Break: Not less than 700 percent minimum average.
- i. Tear Resistance: Not less than 39 lbf (0.18 kN) minimum average per ASTM D 1004.
- j. Puncture Resistance: Not less than 108 lbf (0.48 kN) minimum average per ASTM D 4833.
- k. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 2 percent per ASTM D 1204.
- l. Low-Temperature Brittleness: Four hours at minus 76 deg F (minus 60 deg C) per ASTM D 746.
- m. Environmental Stress Cracking Resistance: Not less than 1500 hours per ASTM D 1693, Condition B.

#### E. PP Sheet Materials

- 1. PP Sheet: Formulated from virgin PP, compounded for use in hydraulic structures, and formed into uniform, flexible sheets.
  - a. Reinforcing Scrim: One-ply polyester fabric totally encapsulated between two sheets.
    - 1) Construction: 9 x 9 - 1000 d **OR** 10 x 10 - 1000 d, **as directed**.
  - b. Sheet Texture: One side smooth; other side smooth **OR** textured, **as directed**.
  - c. Nominal Thickness: 45-mil- (1.14-mm-) thick sheet per ASTM D 5199 or ASTM D 751, Optical Method **OR** ASTM D 5994, **as directed**.
  - d. Tensile Strength: Not less than 250 lbf (1.1 kN) minimum average per ASTM D 412, ASTM D 7003, ASTM D 6693, or ASTM D 751, Procedure A.
  - e. Tear Resistance: Not less than 55 lbf (0.24 kN) minimum average per ASTM D 1004, ASTM D 5884, ASTM D 7003, or ASTM D 751, Procedure B.
  - f. Puncture Resistance: Not less than 200 lbf (0.88 kN) minimum average per ASTM D 4833 or ASTM D 7003.
  - g. Low-Temperature Flexibility: Pass, 1/8-inch (3-mm) mandrel, four hours at minus 40 deg F (minus 40 deg C), and per ASTM D 2136.
  - h. Hydrostatic Resistance: Not less than 250-psi (1725-kPa) minimum average resistance per ASTM D 5514, Procedure A or ASTM D 751, Method A, Procedure 1.
  - i. Dimensional Stability, Reinforced Sheet: Not more than plus or minus 1 percent per ASTM D 1204.
  - j. Ply Adhesion: Not less than 20 lbf/in. (3.5 kN/m) of seam width, or film tearing bond, according to ASTM D 413, Machine Method.

#### F. PVC Sheet Materials

- 1. PVC Sheet: Formulated from virgin PVC with plasticizers and other modifiers, compounded for use in hydraulic structures, and formed into uniform, flexible sheets with material properties complying with ASTM D 7176 **OR** PGI 1104, "Specification for PVC Geomembranes", **as directed**, for nominal thickness indicated.
  - a. Nominal Thickness: 10 mils (0.25 mm) **OR** 20 mils (0.51 mm) **OR** 30 mils (0.76 mm) **OR** 40 mils (1.02 mm) **OR** 50 mils (1.3 mm) **OR** 60 mils (1.5 mm), **as directed**.
  - b. Sheet Texture: One side smooth; other side smooth **OR** matte **OR** faille textured, **as directed**.

#### G. Floating Cover Accessories



1. Screened Scupper Hoses: Manufacturer's standard.
2. Flotation Blocks: Closed-cell polyethylene foam blocks approximately 4 by 12 inches (102 by 300 mm), 2.2 lb/cu. ft. (35.2 kg/cu. m).
3. Access Hatch: Manufacturer's standard, in size indicated.

#### H. Miscellaneous Materials

1. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.
2. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.
3. Battens: Long-length strips of material indicated, size as shown on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide anchors, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.
  - a. Batten Material: Liner manufacturer's standard system.  
**OR**  
Batten Material: Aluminum; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.  
**OR**  
Batten Material: Stainless steel; with stainless-steel anchors, complete with gasket and sealant compatible with geomembrane liner, containment conditions, and materials.  
**OR**  
Batten Material: Plastic compatible with geomembrane liner, cast in place or fastened with stainless-steel anchors, designed to continuously seal geomembrane liner to batten.
4. Sand: ASTM C 33; fine aggregate, natural or manufactured sand.

#### I. Fabrication

1. Fabricate geomembrane liner and floating cover, **as directed**, panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.
2. Fabricate flotation blocks, wrap in geomembrane, and attach to underside of floating cover according to manufacturer's written instructions.
3. Fabricate ballast tubes of sand-filled geomembrane and attach to top surface of floating cover according to manufacturer's written instructions.
4. Install built-in accessories, hatches, access panels, vents, and walkways on geomembrane floating cover.

#### J. Source Quality Control

1. Testing Agency: Engage a qualified testing agency to evaluate geomembrane seams.
2. Destructive Testing: Test for bonded seam strength and peel adhesion every 3000 feet (915 m) or once per panel, whichever is more frequent.
3. CSPE Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 180 lbf/in. (32 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
4. EIA Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 270 lbf/in. (48 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 36 mils (0.91 mm).
5. EPDM Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than 160 lbf/in. (28 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).



6. PE Liner: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion and for bonded seam strength indicated.
  - a. Peel Adhesion/Extrusion: Film tear bond and not less than 78 lbf/in. (13.7 kN/m) of extrusion-bonded seam width.  
**OR**  
Peel Adhesion/Fusion: Film tear bond and not less than 90 lbf/in. (15.8 kN/m) of fused seam width.
  - b. Bonded Seam Strength: Not less than 120 lbf/in. (21 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
7. PP Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 20 lbf/in. (3.5 kN/m) of seam width and for bonded seam strength not less than 200 lbf/in. (35 kN/m) of seam width for seams constructed from two scrim-reinforced sheets, each with nominal sheet thickness of not less than 45 mils (1.14 mm).
8. PVC Liner and Floating Cover: Test and inspect factory seams, according to ASTM D 4545, for peel adhesion not less than 10 lbf/in. (1.75 kN/m) of seam width and for bonded seam strength not less than that indicated below for seams constructed from two sheets of minimum nominal thickness indicated for each:
  - a. Bonded Seam Strength for 10-mil- (0.25-mm-) Thick Sheets: 20 lbf/in. (3.5 kN/m) of seam width.
  - b. Bonded Seam Strength for 20-mil- (0.51-mm-) Thick Sheets: 38.5 lbf/in. (6.7 kN/m) of seam width.
  - c. Bonded Seam Strength for 30-mil- (0.76-mm-) Thick Sheets: 58.4 lbf/in. (10.2 kN/m) of seam width.
  - d. Bonded Seam Strength for 40-mil- (1.02-mm-) Thick Sheets: 77.6 lbf/in. (13.6 kN/m) of seam width.
  - e. Bonded Seam Strength for 50-mil- (1.3-mm-) Thick Sheets: 96 lbf/in. (16.8 kN/m) of seam width.
  - f. Bonded Seam Strength for 60-mil- (1.5-mm-) Thick Sheets: 116 lbf/in. (20.3 kN/m) of seam width.

### 1.3 EXECUTION

#### A. Examination

1. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.
2. Examine anchor trench excavation **OR** concrete perimeter, **as directed**, where geomembrane liner and floating cover, **as directed**, will be secured, for substrate conditions indicated above and for correct location and configuration.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.
2. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.
3. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

#### C. Installation





1. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.
  2. Field Seams: Comply with geomembrane liner and floating cover manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches (50 to 102 mm) unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.
    - a. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.  
**OR**  
Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.
  3. Installation in Anchor Trench: Install geomembrane liner and floating cover in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.
  4. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum 8-inch- (200-mm-) wide concrete substrate unless otherwise indicated.
    - a. Install batten strips over geomembrane liner and floating cover as shown on Drawings.
    - b. Install antichafing strips of geomembrane sheet between geomembrane liner and floating cover according to manufacturer's written instructions.
    - c. Install floating cover with perimeter fold.
  5. Floating Cover Flotation Control: Connect drainage hoses in perimeter fold, sumps, or scuppers to pump or gravity drain system.
  6. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.
- D. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  2. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and floating cover and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.
  3. Prepare test and inspection reports.
- E. Disinfection
1. Disinfect the complete installation according to procedures in AWWA C652.
- F. Protection
1. Protect installed geomembrane liner and floating cover according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.



2. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane and seams and reinspect repaired work.

END OF SECTION 02242c



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02242	02240	Soil Stabilization-Lime

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## SECTION 02243 - SOIL STABILIZATION-VIBROFLOTATION

### 1.1 GENERAL

- A. This specification covers soil stabilization of sandy subsurfaces by the method of vibroflotation.

### 1.2 PRODUCTS - (Not Used)

### 1.3 EXECUTION

- A. The vibroflotation process shall be applied only to areas of clean, granular soils, with not over 20 percent silt or 10 percent clay. Vibrators shall be water-jetted into the soil mass to the depth required. The vibrator shall be withdrawn in 1 foot increments as the saturated soil compacts laterally and at a rate of approximately 1 ft/min to a minimum relative density of 70 percent. As the surface crater forms, sand or crushed rock shall be added and compacted to the appropriate line and grade. The horizontal distance between successive treatments shall not exceed 5 feet, or as directed.

END OF SECTION 02243



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**SECTION 02244 - TREE PROTECTION AND TRIMMING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for tree protection and trimming. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

**C. Definitions**

1. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at 6 inches (150 mm) above the ground for trees up to, and including, 4-inch (100-mm) size; and 12 inches (300 mm) above the ground for trees larger than 4-inch (100-mm) size.
2. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
3. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings **OR** defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated, **as directed**.
4. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

**D. Submittals**

1. Product Data: For each type of product indicated.
2. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.
3. Qualification Data: For qualified arborist and tree service firm.
4. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
5. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
6. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
  - a. Use sufficiently detailed photographs or videotape.
  - b. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

**E. Quality Assurance**

1. Arborist Qualifications: Certified Arborist as certified by ISA **OR** Certified Arborist-Municipal Specialist as certified by ISA **OR** Licensed arborist in jurisdiction where Project is located **OR** Current member of ASCA **OR** Registered Consulting Arborist as designated by ASCA, **as directed**.
2. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
3. Preinstallation Conference: Conduct conference at Project site.

**F. Project Conditions**



1. The following practices are prohibited within protection zones:
  - a. Storage of construction materials, debris, or excavated material.
  - b. Parking vehicles or equipment.
  - c. Foot traffic.
  - d. Erection of sheds or structures.
  - e. Impoundment of water.
  - f. Excavation or other digging unless otherwise indicated.
  - g. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
2. Do not direct vehicle or equipment exhaust toward protection zones.
3. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

## 1.2 PRODUCTS

### A. Materials

1. Topsoil: Natural or cultivated top layer of the soil profile or manufactured topsoil; containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 1 inch (25 mm) in diameter; and free of weeds, roots, and toxic and other nonsoil materials.
  - a. Obtain topsoil only from well-drained sites where topsoil is 4 inches (100 mm) deep or more; do not obtain from bogs or marshes.

**OR**

Topsoil: Stockpiled topsoil from location shown on Drawings **OR** Imported or manufactured topsoil complying with ASTM D 5268, **as directed**.
2. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
  - a. Type: Shredded hardwood **OR** Ground or shredded bark **OR** Wood and bark chips, **as directed**.
  - b. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
3. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements, **as directed**. Previously used materials may be used when approved by the Owner.
  - a. Chain-Link Protection-Zone Fencing: Galvanized-steel **OR** Polymer-coated steel **OR** Polymer-coated galvanized-steel, **as directed**, fencing fabricated from minimum 2-inch (50-mm) opening, 0.148-inch- (3.76-mm-) diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- (60-mm-) OD line posts, and 2-7/8-inch- (73-mm-) OD corner and pull posts; with 1-5/8-inch- (42-mm-) OD top rails **OR** with 0.177-inch- (4.5-mm-) diameter top tension wire, **as directed**, and 0.177-inch- (4.5-mm-) diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
    - 1) Height: 4 feet (1.2 m) **OR** 6 feet (1.8 m) **OR** 8 feet (2.4 m), **as directed**.
    - 2) Polymer-Coating Color (if polymer coating is required): Dark green **OR** Olive green **OR** Brown **OR** Black, **as directed**.
  - b. Plywood Protection-Zone Fencing: Plywood framed with four 2-by-4-inch (50-by-100-mm) rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.
    - 1) Height: 4 feet (1.2 m) **OR** 6 feet (1.8 m), **as directed**.
    - 2) Plywood and Lumber: Comply with requirements in Division 06 Section "Rough Carpentry" **OR** Division 06 Section "Miscellaneous Carpentry", **as directed**.
  - c. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch (50-by-100-mm) horizontal rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart, and lower rail set halfway between top rail and ground.
    - 1) Height: 4 feet (1.2 m).





- 2) Lumber: Comply with requirements in Division 06 Section "Rough Carpentry" **OR** Division 06 Section "Miscellaneous Carpentry", **as directed**.
- d. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and weighing a minimum of 0.4 lb/ft. (0.6 kg/m); remaining flexible from minus 60 to plus 200 deg F (minus 16 to plus 93 deg C); inert to most chemicals and acids; minimum tensile yield strength of 2000 psi (13.8 MPa) and ultimate tensile strength of 2680 psi (18.5 MPa); secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 8 feet (2.4 m) apart.
  - 1) Height: 4 feet (1.2 m).
  - 2) Color: High-visibility orange, nonfading.
- e. Gates: Single **OR** Double, **as directed**, swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 24 inches (610 mm) **OR** 36 inches (914 mm) **OR** As indicated, **as directed**.
- 4. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:
  - a. Size and Text: As shown on Drawings.
  - b. Lettering: 3-inch- (75-mm-) high minimum, white **OR** black, **as directed**, characters on white **OR** red, **as directed**, background.

### 1.3 EXECUTION

#### A. Examination

- 1. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- 2. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

#### B. Preparation

- 1. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Flag **OR** Tie a 1-inch (25-mm) blue-vinyl tape around, **as directed**, each tree trunk at 54 inches (1372 mm) above the ground.
- 2. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- 3. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.
  - a. Apply 4-inch (100-mm) **OR** 6-inch (150-mm), **as directed**, average thickness of organic mulch. Do not place mulch within 6 inches (150 mm) of tree trunks.

#### C. Tree- And Plant-Protection Zones

- 1. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
  - a. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
  - b. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to the Owner.
  - c. Access Gates: Install where indicated; adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption,



or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

2. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by the Owner. Install one sign spaced approximately every 20 feet (6 m) **OR** 35 feet (10.5 m) **OR** 50 feet (15 m), **as directed**, on protection-zone fencing, but no fewer than four signs with each facing a different direction.
3. Maintain protection zones free of weeds and trash.
4. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
5. Maintain protection-zone fencing and signage in good condition as acceptable to the Owner and remove when construction operations are complete and equipment has been removed from the site.
  - a. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
  - b. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

#### D. Excavation

1. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 02 Section "Earthwork".
2. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
3. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches (75 mm) back from new construction and as required for root pruning.
4. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

#### E. Root Pruning

1. Prune roots that are affected by temporary and permanent construction. Prune roots as follows:
  - a. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
  - b. Cut Ends: Do not paint cut root ends **OR** Coat cut ends of roots more than 1-1/2 inches (38 mm) in diameter with an emulsified asphalt or other coating formulated for use on damaged plant tissues and that is acceptable to arborist, **as directed**.
  - c. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
  - d. Cover exposed roots with burlap and water regularly.
  - e. Backfill as soon as possible according to requirements in Division 02 Section "Earthwork".
2. Root Pruning at Edge of Protection Zone: Prune roots 12 inches (300 mm) outside **OR** 12 inches (300 mm) inside **OR** 6 inches (150 mm) outside **OR** 6 inches (150 mm) inside **OR** flush with the edge, **as directed**, of the protection zone, by cleanly cutting all roots to the depth of the required excavation.
3. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

**F. Crown Pruning**

1. Prune branches that are affected by temporary and permanent construction. Prune branches as follows:
  - a. Prune trees to remain to compensate for root loss caused by damaging or cutting root system. Provide subsequent maintenance during Contract period as recommended by arborist.
  - b. Pruning Standards: Prune trees according to ANSI A300 (Part 1) and the following:
    - 1) Type of Pruning: Cleaning **OR** Thinning **OR** Raising **OR** Reduction, **as directed**.
    - 2) Specialty Pruning: Restoration **OR** Vista **OR** Palm **OR** Utility, **as directed**.
  - c. Cut branches with sharp pruning instruments; do not break or chop.
  - d. Do not apply pruning paint to wounds.
2. Chip removed branches and spread over areas identified by the Owner **OR** stockpile in areas approved by the Owner **OR** dispose of off-site, **as directed**.

**G. Regrading**

1. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.  
**OR**  
Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
  - a. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
2. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.  
**OR**  
Minor Fill within Protection Zone: Where existing grade is 2 inches (50 mm) or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

**H. Field Quality Control**

1. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

**I. Repair And Replacement**

1. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by the Owner.
  - a. Submit details of proposed root cutting and tree and shrub repairs.
  - b. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
  - c. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
  - d. Perform repairs within 24 hours.
  - e. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by the Owner.
2. Trees: Remove and replace trees indicated to remain that are more than 25 **OR** 66, **as directed**, percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that the Owner determines are incapable of restoring to normal growth pattern.
  - a. Provide new trees of same size and species as those being replaced for each tree that measures 6 inches (150 mm) **OR** 4 inches (100 mm), **as directed**, or smaller in caliper size.  
**OR**  
Provide one **OR** two, **as directed**, new tree(s) of 6-inch (150-mm) **OR** 4-inch (100-mm), **as directed**, caliper size for each tree being replaced that measures more than 6 inches (150 mm) **OR** 4 inches (100 mm), **as directed**, in caliper size.
    - 1) Species: Species selected by the Owner.



- b. Plant and maintain new trees as specified in Division 02 Section "Exterior Plants".
- 3. Soil Aeration: Where directed by the Owner, aerate surface soil compacted during construction. Aerate 10 feet (3 m) beyond drip line and no closer than 36 inches (900 mm) to tree trunk. Drill 2-inch- (50-mm-) diameter holes a minimum of 12 inches (300 mm) deep at 24 inches (600 mm) o.c. Backfill holes with an equal mix of augered soil and sand.
- J. Disposal Of Surplus And Waste Materials
  - 1. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 02244

**SECTION 02244a - TERMITE CONTROL****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for termite control. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. Section Includes:
  - a. Soil and wood treatment with termiticide.
  - b. Bait-station system.
  - c. Metal mesh barrier system.
  - d. Polymer sheet barrier system with termiticide.
  - e. Polymer barrier fittings with termiticide for installation around utility penetrations.

**C. Submittals**

1. Product Data: For each type of termite control product.
  - a. Include the EPA-Registered Label for termiticide products.
2. Qualification Data: For qualified Installer.
3. Product Certificates: For termite control products, from manufacturer.
4. Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
  - a. Date and time of application.
  - b. Moisture content of soil before application.
  - c. Termiticide brand name and manufacturer.
  - d. Quantity of undiluted termiticide used.
  - e. Dilutions, methods, volumes used, and rates of application.
  - f. Areas of application.
  - g. Water source for application.
5. Wood Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and include the following:
  - a. Date and time of application.
  - b. Termiticide brand name and manufacturer.
  - c. Quantity of undiluted termiticide used.
  - d. Dilutions, methods, volumes used, and rates of application.
  - e. Areas of application.
6. Bait-Station System Application Report: After installation of bait-station system is completed, submit report for Owner's records and include the following:
  - a. Location of areas and sites conducive to termite feeding and activity.
  - b. Plan drawing showing number and locations of bait stations.
  - c. Dated report for each monitoring and inspection occurrence indicating level of termite activity, procedure, and treatment applied before time of Substantial Completion.
  - d. Termiticide brand name and manufacturer.
  - e. Quantities of termiticide and nontoxic termite bait used.
  - f. Schedule of inspections for one year from date of Substantial Completion.
7. Polymer Sheet Barrier System with Termiticide Application Report: After installation of polymer sheet barrier system with termiticide is completed, submit report for Owner's records and include the following:
  - a. Plan drawing showing extent of sheet barrier and number and locations of each type of polymer barrier fitting.
  - b. Termiticide brand name and manufacturer.



- c. Schedule of inspections for one year from date of Substantial Completion.
  8. Polymer Barrier Fittings with Termiticide Application Report: After installation of polymer barrier fittings with termiticide is completed, submit report for Owner's records and include the following:
    - a. Plan drawing showing number and locations of each type of polymer barrier fitting with termiticide.
    - b. Termiticide brand name and manufacturer.
    - c. Schedule of inspections for one year from date of Substantial Completion.
  9. Warranties: Sample of special warranties.
- D. Quality Assurance
  1. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located, and who employs workers trained and approved by manufacturer to install manufacturer's products.
  2. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.
  3. Source Limitations: Obtain termite control products from single source.
  4. Preinstallation Conference: Conduct conference at Project site.
- E. Project Conditions
  1. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
  2. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.
  3. Apply wood treatment after framing, sheathing, and exterior weather protection is completed but before electrical and mechanical systems are installed.
  4. Install bait-station system during construction to determine areas of termite activity and after construction, including landscaping, is completed.
  5. Install polymer sheet barrier system with termiticide prior to placing concrete slab reinforcement and pouring concrete and after installation and inspection of footings, foundations, and plumbing and electrical pipes and conduits.
  6. Install polymer barrier fittings with termiticide around utility penetrations prior to pouring concrete and after installation and inspection of plumbing and electrical pipes and conduits, slab vapor barrier, and concrete slab reinforcement.
- F. Warranty
  1. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
    - a. Warranty Period: Three **OR** Five, **as directed**, years from date of Substantial Completion.
  2. Wood Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied wood termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite damage is discovered during warranty period, repair or replace damage caused by termite infestation and treat replacement wood.
    - a. Warranty Period: 12 years from date of Substantial Completion.
  3. Polymer Sheet Barrier System with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer sheet barrier system with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.
    - a. Warranty Period: 10 years from date of Substantial Completion.



4. Polymer Barrier Fittings with Termiticide Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of installation of polymer barrier fittings with termiticide, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat and repair or replace damage caused by termite infestation.
  - a. Warranty Period: Five years from date of Substantial Completion.

G. Maintenance Service

1. Continuing Service (as directed): Beginning at Substantial Completion, provide 12 months' continuing service including monitoring, inspection, and re-treatment for occurrences of termite activity. Provide a standard continuing service agreement. State services, obligations, conditions, terms for agreement period, and terms for future renewal options.

## 1.2 PRODUCTS

A. Soil Treatment

1. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
  - a. Service Life of Treatment: Soil treatment termiticide that is effective for not less than three **OR** five, **as directed**, years against infestation of subterranean termites.

B. Wood Treatment

1. Borate: Provide an EPA-Registered borate termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution for spray application and a gel solution for pressure injection, formulated to prevent termite infestation in wood. Provide quantity required for application at the label volume and rate for the maximum diffusible borate concentration allowed for each specific use, according to product's EPA-Registered Label.

C. Bait-Station System

1. Provide bait stations based on the dimensions of building perimeter indicated on Drawings, according to manufacturer's EPA-Registered Label for product, manufacturer's written instructions, and the following:
  - a. No fewer than one bait station per 8 linear feet (2.4 linear meters) **OR** 20 linear feet (6.1 linear meters), **as directed**.
  - b. No fewer than one cluster of bait stations per 20 linear feet (6.1 linear meters), consisting of no fewer than three bait stations per cluster.

D. Metal Mesh Barrier System

1. Stainless-Steel Mesh: 0.025-by-0.018-inch (0.64-by-0.45-mm) mesh of 0.08-inch- (2.0-mm-) diameter, stainless-steel wire, Type 316.

E. Polymer Sheet Barrier System

1. Polymer Sheet: 16-mil- (0.40-mm-) thick, multilayered, laminated, polymer sheet with lambda-cyhalothrin termiticide sealed between two outer polymer layers.

F. Polymer Barrier Fittings

1. Pipe/Conduit Fitting: Integral 2-1/2-inch- (65-mm-) long polymer sleeve and 1-inch- (25-mm-) wide circular flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.
2. Tub Trap Fitting: Integral polymer boot and 23-by-23-inch (585-by-585-mm) flange with lambda-cyhalothrin termiticide sealed between two outer polymer layers; with fasteners.



### 1.3 EXECUTION

#### A. Examination

1. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termiticide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
2. Proceed with application only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's written instructions for preparation before beginning application of termite control treatment. Remove all extraneous sources of wood cellulose and other edible materials such as wood debris, tree stumps and roots, stakes, formwork, and construction waste wood from soil within and around foundations.
2. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.
  - a. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

#### C. Application, General

1. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

#### D. Applying Soil Treatment

1. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
  - a. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
  - b. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
  - c. Crawlspace: Soil under and adjacent to foundations as previously indicated. Treat adjacent areas including around entrance platform, porches, and equipment bases. Apply overall treatment only where attached concrete platform and porches are on fill or ground.
  - d. Masonry: Treat voids.
  - e. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
2. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
3. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
4. Post warning signs in areas of application.
5. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

#### E. Applying Wood Treatment





1. Application: Mix wood treatment solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of borate, according to manufacturer's EPA-Registered Label, so that wood framing, sheathing, siding, and structural members subject to infestation receive treatment.
  - a. Framing and Sheathing: Apply termiticide solution by spray to bare wood for complete coverage.
  - b. Wood Members More Than 4 Inches (100 mm) Thick: Inject termiticide gel solution under pressure into holes of size and spacing required by manufacturer for treatment.
  - c. Exterior Uncoated Wood Trim and Siding: Apply termiticide solution to bare wood siding. After 48 hours, apply a seal coat of paint as specified in Division 07.
- F. Installing Bait-Station System
  1. Place bait stations according to the EPA-Registered Label for the product and manufacturer's written instructions, in the following areas that are conducive to termite feeding and activity:
    - a. Conducive sites and locations indicated on Drawings.
    - b. In and around infested trees and stumps.
    - c. In mulch beds.
    - d. Where wood directly contacts soil.
    - e. Areas of high soil moisture.
    - f. Near irrigation sprinkler heads.
    - g. Each area where roof drainage system, including downspouts and scuppers, drains to soil.
    - h. Along driplines of roof overhangs without gutters.
    - i. Where condensate lines from mechanical equipment drip or drain to soil.
    - j. At plumbing penetrations through ground-supported slabs.
    - k. Other sites and locations as determined by licensed Installer.
  2. Inspect and service bait stations from time of their application until Substantial Completion unless extended by continuing service agreement, according to the EPA-Registered Label for product and manufacturer's written instructions for termite management system and bait products.
    - a. Service Frequency: Inspect bait stations not less than once every **OR** every three, **as directed**, month(s).
- G. Installing Metal Mesh Barrier System
  1. Install metal mesh barrier system where indicated to provide a continuous barrier to entry of subterranean termites according to manufacturer's written instructions.
    - a. Fit mesh tightly around pipe or other penetrations, and terminate at slab and foundation perimeters.
    - b. Install mesh under the perimeter of concrete slab edges and joints after vapor barrier and reinforcing steel are in place, and comply with manufacturer's written installation methods.
  2. Inspect annually for termite activity and effectiveness of metal mesh barrier system according to manufacturer's written instructions.
- H. Installing Polymer Sheet Barrier System
  1. Install polymer sheet barrier system according to manufacturer's EPA-Registered Label to provide a complete and continuous barrier to entry of subterranean termites.
  2. Remove any pipe wrap material so that the polymer sheet barrier system and fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.
  3. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and/or foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.
- I. Installing Polymer Barrier Fittings
  1. Remove any pipe wrap material so that the polymer barrier fittings can be applied directly to the pipe or conduit. After installing the barrier, reapply pipe wrap material both below and above the blocker to protect the pipe from contact with concrete.



2. Install polymer barrier fittings around each utility pipe and conduit penetrating concrete slab and/or foundation walls according to the EPA-Registered Label for the product and manufacturer's written instructions.

END OF SECTION 02244a



## SECTION 02261 - RIPRAP

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of riprap. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Demolition and removal of materials shall be as required to support the work.

### 1.2 PRODUCTS

- A. Riprap: Stone used for dumped riprap shall be hard, durable, angular in shape, resistant to weathering and to water action, and free from overburden, spoil, shale, and organic material. Neither width nor thickness of a single stone should be less than one third its length. Rounded stone, boulders, shale, and stone with shale seams will not be acceptable. The minimum density of the riprap material shall be 162 pounds per cubic foot. Each load of riprap shall be reasonably well graded. Sand and rock dust exceeding 5 percent by weight of each load shall not be permitted.
- B. Riprap Bedding: The riprap bedding blanket shall consist of well graded gravel, crushed rock, sand, or a combination thereof with a maximum size of 6 inches. All material comprising the riprap bedding blanket shall be composed of tough, durable particles, reasonably free from thin, flat, and elongated pieces, and shall contain no organic matter nor soft, friable particles in excess quantities.

### 1.3 EXECUTION

- A. Preparation: Prepare earth slopes by grading and compacting.
- B. Installation:
  1. Riprap Bedding Blanket Layers shall be placed on the prepared slope or area to develop the full thickness. Each layer shall be placed in one operation, using methods that will not cause segregation of particle sizes within the bedding. The surface of the finished layer should be reasonably even and free from mounds or windows.
  2. Stone for Riprap shall be placed on the prepared slope or area in a manner that will product a reasonably well-graded mass of stone with the minimum practicable percentage of voids. Riprap shall be placed to its full course in one operation and in such a manner as to avoid displacing the underlying material. The larger stones shall be well distributed and the entire mass of stone shall be well-graded. The result shall be a compact, uniform riprap layer.

END OF SECTION 02261



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02261	02242b	Sewage Treatment Lagoons

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## SECTION 02262 - WIRE MESH GABIONS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of wire mesh gabions. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

- B. Description: Gabion units shall consist of compartmented rectangular basket containers filled with stone. The required sizes of the gabion units are Length times Width times Depth. Twisted or welded wire mesh shall be used. Baskets shall be fabricated from galvanized steel wire formed into a nonraveling mesh.

#### C. Submittals

1. Samples: Stone fill material submitted for approval prior to delivery.

### 1.2 PRODUCTS

- A. Steel Twisted Wire Mesh Gabions: Gabion basket units shall be of nonraveling construction and fabricated from a double twisted hexagonal wire mesh. The size of mesh openings shall be approximately 3-1/4 in. by 4-1/2 in. (80 by 115 mm). The gabion mesh wires shall be wrapped around the selva wire no less than 1 1/2 times and shall interconnect with adjacent mesh wires. All steel wire used shall be galvanized prior to fabrication into mesh. All gabion diaphragm and frame wire shall equal or exceed ASTM A 641, and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5, Class 3, zinc coating, as indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.
- B. Steel Welded Wire Mesh Gabions: Gabion basket units shall be of nonraveling construction and fabricated from a welded square wire mesh. The size of mesh openings shall be approximately 3 in. by 3 in. (75 by 75 mm). The welded joints of the wire mesh shall conform to ASTM A 185 except that the weld shears shall be at least 600 lbs (2700 N). All gabion diaphragm and frame wire shall equal or exceed ASTM A 641, and possess soft tensile strength of 60,000 psi (415 Mpa) with a tolerance of minus 2,000 psi (14 Mpa). The galvanized wire shall have a Finish 5 Class 3 zinc coating, indicated in ASTM A 641. The weight of coating shall be determined by ASTM A 90. The grade of zinc used for coating shall be High Grade or Special High Grade as prescribed in ASTM B 6, Table 1. The uniformity of coating shall equal or exceed four 1-minute dips by the Preece Test, as determined by ASTM A 239.
- C. Mesh wire shall be minimum 0.120-in. (3.05 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.
- D. Selva wire shall be minimum 0.150-in. (3.80 mm) diameter after coating with 0.85 oz/sq ft (240 g/sq m) zinc coating.
- E. Wire used for lacing or as internal connecting wire within basket cells shall be minimum 0.087-in. (2.21 mm) diameter after coating with 0.70 oz/sq ft (220 g/sq m) zinc coating and may have soft tensile strength designation.
- F. Stone Fill



1. **Quality:** Stone shall be durable and of suitable quality to ensure permanence in the structure and climate in which it is to be used. It shall be free of cracks, seams, and other defects that would tend to increase unduly its deterioration from natural causes or reduce its size to that which could not be retained in the gabion baskets. The inclusion of more than 5% by weight of dirt, sand, clay, and rock fines will not be permitted. The sources from which the Contractor proposes to obtain the material shall be selected well in advance of the time when the material will be required in the work. Suitable samples of stone fill material shall be collected in the presence of the Owner's representative and submitted to the Owner for approval prior to delivery of any such material to the site of the work. Unless otherwise specified, all test samples shall be obtained by the Contractor and delivered at his expense to the Owner. Suitable tests and/or service records will be used to determine the acceptability of the stone. In the event suitable test reports and service records are not available, the material shall be subjected to such tests as are necessary to determine its acceptability for use in the work. Tests to which the material may be subjected include petrographic analysis, specific gravity, absorption, wetting and drying, freezing and thawing, and such other tests as may be considered necessary to demonstrate to the satisfaction of the Owner that the materials are acceptable for use in the work.
2. **Gradation:** Stone fill used in the gabions shall be a well-graded mixture with sizes ranging between 4 in. and 8 in. (100 and 200 mm), based on US Standard square mesh sieves. No stone shall have a minimum dimension less than 4 in. (100 mm) and a maximum dimension greater than 12 in. (300 mm) in any direction. The ratio of the maximum dimension to the minimum dimension shall not be greater than two. If the height of the gabion basket is 12 in. (300 mm) or less, stone shall have no dimensions greater than 8 in. (200 mm) in any direction.
3. **Filter Material:** The material shall be composed of tough durable particles, reasonably free from thin, flat, and elongated pieces, and contain no organic matter or soft friable particles in quantities considered objectionable by the Owner. Filter material shall consist of sand and gravel or crushed stone, well graded between the prescribed limits listed below, and conform to the requirements of paragraph STONE FILL, subparagraph QUALITY as to quality.

### 1.3 EXECUTION:

- A. **Foundation Preparation:** No foundation preparation work shall take place on frozen or snow-covered ground. After excavation or stripping to the extent indicated on the drawings or as directed by the Owner, all remaining loose or otherwise unsuitable materials shall be removed. All depressions shall be carefully backfilled to grade. If pervious materials are encountered in the foundation depressions, the areas shall be backfilled with free-draining materials. Otherwise, the depressions shall be backfilled with suitable materials from adjacent required excavation, or other approved source, and compacted to a density at least equal to that of the adjacent foundation. Any buried debris protruding from the foundation that will impede the proper installation and final appearance of the gabion layer shall also be removed, and the voids carefully backfilled and compacted as specified above. Immediately prior to placing the material, the prepared foundation surface shall be inspected by the Owner, and no material shall be placed thereon until that area has been approved.
- B. **Filter Placement:** Filter material shall be spread uniformly on the prepared foundation surface in a manner satisfactory to the Owner, and to the slopes, lines, and grades as indicated on the drawings or as directed. Placing of filter material by methods which will tend to segregate particle sizes will not be permitted. Any damage to the foundation surface during filter placement shall be repaired before proceeding with the work. Compaction of the filter materials will not be required, but it shall be finished to present a reasonably even surface free from mounds or windrows.
- C. **Fabrication:** Gabions shall be fabricated in such a manner that the sides, ends, lid, and diaphragms can be assembled at the construction site into rectangular baskets of the sizes specified and shown on the drawings. Gabions shall be of single unit construction, i.e., the base, lid, ends, and sides shall be either woven into a single unit, or one edge of these members connected to the base section of the gabion in such a manner that the minimum strengths of the wire mesh and connections as stated in paragraph





MATERIALS are met. Where the length of the gabion exceeds one and one-half its horizontal width, the gabion shall be equally divided by diaphragms of the same mesh and gage as the body of the gabions, into cells whose length does not exceed the horizontal width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary. For twisted wire gabions, all perimeter edges of the mesh forming the gabion shall be securely selvaged. In addition, the selvaged edges shall be so wrapped and reinforced with the mesh ends that the selva ge wire will not be deformed locally about the lacing wire or wire fasteners when baskets are filled or during lid closing. Lacing wire, connecting wire, and/or wire fasteners shall be supplied in sufficient quantity for securely fastening all diaphragms and edges of the gabion.

- D. Assembly And Installation: For gabion units in excess of 4 ft. (1.3 m) in thickness, and placed in horizontal or near horizontal position to resist high velocity flow, or as part of a stilling basin feature, a minimum of two uniformly spaced vertical connecting wires per cell linking the foundation mesh to basket lid mesh should be specified. Empty gabion units shall be assembled individually and placed on the approved surface with the sides, ends, and diaphragms erected in such a manner to ensure the correct position of all creases and that the tops of all sides are level. Filling of gabion units in one place and then transporting them to their final position in the work will not be permitted. The front row of gabion units shall be placed first and successively constructed toward the top of the slope or the back of the structure. All gabion units shall be properly staggered horizontally and vertically. Finished gabion structure shall have no gaps along the perimeter of the contact surfaces between adjoining gabion basket units. All adjoining empty gabion units shall be connected by lacing wire/or wire fasteners along the perimeter of their contact surfaces in order to obtain a monolithic structure. Lacing of adjoining basket units shall be accomplished by continuous stitching with alternating single and double loops at intervals of not more than 5 in. (125 mm), and a half hitch shall be included at every double loop. All lacing wire terminals shall be securely fastened. Wire fasteners may be used in lieu of lacing wire for forming individual baskets and joining empty baskets together prior to stone filling. All joining shall be made through selva ge-to-selva ge or selva ge-to-edge wire connection; mesh-to-mesh or selva ge-to-mesh wire connection is prohibited except in the case where baskets are offset or stacked and selva ge-to-mesh or mesh-to-mesh wire connection would be necessary. Wire fasteners shall not be used to tie or join stone-filled baskets, unless approved by the Owner. As a minimum, a fastener shall be installed at each mesh opening at the location where mesh wire meets selva ge or edge wire. The initial line of basket units shall be placed on the prepared filter layer surface and partially filled to provide anchorage against deformation and displacement during filling operations. After adjoining empty basket units are set to line and grade and common sides with adjacent units thoroughly laced or fastened, they shall be placed in tension and stretched to remove any kinks from the mesh and to a uniform alignment. The stretching of empty basket units shall be accomplished in such a manner as to prevent any possible unraveling. Stone filling operations shall carefully proceed with placement by hand or machine so as not to damage galvanized wire coating, to assure a minimum of voids between the stones, and the maintenance of alignment throughout the filling process. Undue deformation and bulging of the mesh shall be corrected prior to further stone filling. To avoid localized deformation, the basket units in any row are to be filled in stages consisting of maximum 12-in. (300 mm) courses, and at no time shall any cell be filled to a depth exceeding 1 ft. (300 mm) more than the adjoining cell. The maximum height from which the stone may be dropped into the basket units shall be 36 in. (1 m). For gabion units in excess of 2 ft. (0.67 m) in height, two uniformly spaced internal connecting wires shall be placed between each stone layer in all front and side gabion units, connecting the back and the front faces of the compartments. Connecting wires or alternatively the preformed stiffeners shall be looped around two twisted wire mesh openings or a welded wire joint at each basket face and the wire terminals shall be securely twisted to prevent their loosening. For twisted wire gabions, the internal connecting wires or preformed stiffeners are installed. For welded wire gabion units, preformed stiffeners are installed across the corners of gabion panels. Along all exposed faces, the outer layer of stone shall be carefully placed and arranged by hand to ensure a neat and compact appearance. The last layer of stone shall be uniformly overfilled 1 to 2 in. (25 to 50 mm) to compensate for the future settlement in rock but still allow for the proper closing of the lid and to provide an even surface that is uniform in appearance. Final adjustments for compaction and surface tolerance shall be done by hand. Lids shall be stretched tight over the stone fill using only an approved lid closing tool, until the lid meets the perimeter edges of



the front and end panels. Using crowbars or other single point leverage bars for lid closing shall be prohibited. The lid shall then be tightly tied with lacing wire, or with wire fasteners if approved by the Owner, along all edges, ends, and internal cell diaphragms by continuous stitching with alternating single and double loops at intervals of not more than 5 in. (125 mm), and a half hitch shall be included at every double loop. Special attention shall be given to see that all projections or wire ends are turned into the baskets. The Contractor shall have the option of providing gabion baskets with separate roll-out lids for the slope baskets. Roll-out lids shall be fabricated of the same material as the basket units and shall be furnished in widths as required for the contract work. as directed by the Owner, or where a complete gabion unit cannot be installed because of space limitations, the basket unit shall be cut, folded, and wired together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh cut out completely, or folded back and neatly wired to an adjacent gabion face. The assembling, installation, filling, lid closing, and lacing of the reshaped gabion units shall be carried out as specified above.

END OF SECTION 02262



## **SECTION 02264 - SEDIMENT REMOVAL**

### **1.1 GENERAL**

#### **A. Description Of Work**

1. This specification covers the furnishing of labor and equipment for sediment removal.

### **1.2 PRODUCTS - (Not Used)**

### **1.3 EXECUTION**

- A. The Contractor shall remove all material from areas as required to meet project requirements. Water and sediment removed from these areas shall be discharged to a sedimentation basin constructed and maintained by the Contractor. All work shall be in strict compliance with Pollution Control requirements and Dewatering requirements. All material removed shall be disposed of in an approved landfill in accordance with all State and Federal Regulations.

END OF SECTION 02264



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## SECTION 02264a - EROSION CONTROL

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of mesh or netting for erosion control. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

### 1.2 PRODUCTS

#### A. Materials

1. Jute Mesh: Fed. Spec. CCC-C-467.
2. Plastic Mesh: Manufacturer's recommendation.
3. Plastic Netting: Manufacturer's recommendation.
4. Polypropylene Mesh: Manufacturer's recommendation.
5. Woven Fabric Fence: EPA specifications.
6. Hay-Bales: EPA specifications.

### 1.3 EXECUTION:

- A. Preparation: Grade, compact, fertilize, and seed the area to be protected.
- B. Installation: Apply blankets either horizontally or vertically to the slope. In ditches, apply blanket in direction of water flow. Lap and anchor blankets according to the manufacturer's instructions. Install woven fabric fence and hay bales adjacent to all excavated areas.

END OF SECTION 02264a



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## SECTION 02264b - SILT FENCES

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing of labor, material and equipment for the installation of silt fencing.

### 1.2 PRODUCTS

#### A. Materials

1. Fabricated Units
  - a. Posts: 36" long, 2" hardwood or "T" or "U" type steel.
  - b. Fence: Woven wire, 14-1/2 ga. 6-inch max. mesh opening.
  - c. Filter Cloth: MIRAFL 100X or approved equal.
2. Prefabricated Units
  - a. Envirofence by MIRAFL or approved equal.

### 1.3 EXECUTION

- A. The Contractor shall provide and install silt fences as directed by the Owner. It shall be the Contractor's option to provide fabricated reinforced silt fence or prefabricated units, unless otherwise directed. In all installations, the bottom flap of filter cloth shall be firmly embedded into undisturbed or stabilized grade. Embedment shall resist pullout and prevent flow under the installation.

END OF SECTION 02264b



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**SECTION 02264c - UNIT PAVERS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for unit pavers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. This Section includes the following:
  - a. Brick pavers set in aggregate, bituminous or mortar setting beds.
  - b. Concrete pavers set in aggregate, bituminous or mortar setting beds.
  - c. Asphalt-block pavers set in bituminous setting beds.
  - d. Stone pavers set in aggregate or mortar setting beds.
  - e. Plastic or Steel or Aluminum edge restraints.
  - f. Cast-in-place concrete edge restraints.
  - g. Precast concrete curbs.
  - h. Stone curbs.

**C. Preconstruction Testing**

1. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, samples of paving materials that will contact or affect mortar and grout that contain latex additives.
  - a. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimum adhesion with, and will be nonstaining to, installed pavers and other materials constituting paver installation.

**D. Action Submittals**

1. Product Data: For materials other than water and aggregates.
2. Product Data: For the following:
  - a. Pavers.
  - b. Bituminous setting materials.
  - c. Mortar and grout materials.
  - d. Edge restraints.
  - e. Precast concrete curbs.
  - f. Stone curbs.
3. LEED Submittals:
  - a. Product Certificates for Credit MR 5: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
4. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.
5. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.
6. Samples for Initial Selection: For the following:
  - a. Each type of unit paver indicated.
  - b. Joint materials involving color selection.
  - c. Exposed edge restraints involving color selection.
  - d. Precast concrete curbs.
  - e. Granite for stone curbs.
7. Samples for Verification:



- a. Full-size units of each type of unit paver indicated. Assemble no fewer than five Samples of each type of unit on suitable backing and grout joints.]
- b. Joint materials.
- c. Exposed edge restraints.
- d. Precast concrete curbs.
- e. Stone curbs.

#### E. Quality Assurance

- 1. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.
- 2. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - a. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- 3. Preinstallation Conference: Conduct conference at Project site.

#### F. Delivery, Storage, And Handling

- 1. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- 2. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- 3. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- 4. Store liquids in tightly closed containers protected from freezing.
- 5. Store asphalt cement and other bituminous materials in tightly closed containers.

#### G. Project Conditions

- 1. Cold-Weather Protection: Do not use frozen materials or build on frozen subgrade or setting beds.
- 2. Weather Limitations for Bituminous Setting Bed:
  - a. Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
  - b. Apply asphalt adhesive only when ambient temperature is above 50 deg F (10 deg C) and when temperature has not been below 35 deg F (2 deg C) for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.
- 3. Weather Limitations for Mortar and rout:
  - a. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  - b. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.
    - 1) When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set pavers within 1 minute of spreading setting-bed mortar.

## 1.2 PRODUCTS

#### A. Brick Pavers

- 1. Regional Materials: Provide brick pavers that have been manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.



2. Brick Pavers: Light-traffic paving brick; ASTM C 902; Class SX for exposure to freezing weather **OR** Class MX for exterior uses that do not expose brick to freezing, **as directed**, Type I for locations exposed to extensive abrasion, such as sidewalks and driveways in public spaces **OR** Type II for locations exposed to intermediate abrasion, such as heavily traveled residential walkways and driveways **OR** Type III for locations exposed to low abrasion, such as floors and patios exposed in single-family homes, **as directed**. Application PS normal tolerance for installation with grouted joints **OR** Application PX close tolerance for ungrouted joints **OR** Application PA non-uniform sized for decorative effect, **as directed**. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
    - a. Thickness: 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-5/8 inches (41 mm) **OR** 2-1/4 inches (57 mm) **OR** 2-5/8 inches (67 mm), **as directed**.
    - b. Face Size: 3-3/4 by 7-1/2 inches (95 by 190 mm) **OR** 3-5/8 by 7-5/8 inches (92 by 194 mm) **OR** 3-5/8 by 11-5/8 inches (92 by 295 mm) **OR** 7-5/8 by 7-5/8 inches (194 by 194 mm) **OR** 4 by 8 inches (102 by 203 mm) **OR** 4 by 12 inches (102 by 305 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
    - c. Color: As selected from manufacturer's full range.
  3. Brick Pavers: Heavy vehicular paving brick; ASTM C 1272, Type F, Application PX **OR** Type R, Application PS **OR** Type R, Application PX **OR** Type R, Application PA, **as directed**. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.
    - a. Type R is for units set in a mortar setting bed or a bituminous setting bed supported by an adequate base. Type F is for units set in a sand setting bed with sand between the pavers. Application PS is for general use; Application PX is for pavers with close dimensional tolerances. Application PX must be selected if specifying Type F
    - b. Thickness: 2-1/4 inches (57 mm) **OR** 2-5/8 inches (67 mm), **as directed**.
    - c. Face Size: 3-3/4 by 7-1/2 inches (95 by 190 mm) **OR** 3-5/8 by 7-5/8 inches (92 by 194 mm) **OR** 3-5/8 by 11-5/8 inches (92 by 295 mm) **OR** 7-5/8 by 7-5/8 inches (194 by 194 mm) **OR** 4 by 8 inches (102 by 203 mm) **OR** 4 by 12 inches (102 by 305 mm) **OR** 8 by 8 inches (203 by 203 mm), **as directed**.
    - d. Color: As selected from manufacturer's full range.
  4. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67.
  5. Temporary Protective Coating: Precoat exposed surfaces of brick pavers with a continuous film of a temporary protective coating that is compatible with brick, mortar, and grout products and can be removed without damaging grout or brick. Do not coat unexposed brick surfaces; handle brick to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
- B. Concrete Pavers
1. Concrete Pavers: Solid interlocking paving units complying with ASTM C 936 and resistant to freezing and thawing when tested according to ASTM C 67, made from normal-weight aggregates.
    - a. Thickness: 2-3/8 inches (60 mm) **OR** 3-1/8 inches (80 mm), **as directed**.
    - b. Face Size and Shape: 3-7/8 inches (98 mm) square **OR** 4-7/16 inches (113 mm) **OR** 8-7/8 inches (225 mm) **OR** 9 inches (229 mm) square, **as directed**.
    - c. Face Size and Shape: 3-7/8-by-7-7/8 inch (98-by-200 mm) **OR** 4-by-8-inch (102-by-203-mm) **OR** 4-7/16-by-8-7/8 inch (113-by-225-mm), **as directed**, rectangle.
    - d. Face Size and Shape: 5-1/2-inch (140-mm) octagon with attached 3-1/2-inch (89-mm) square **OR** 4-1/2-by-9 inch (114-by-229 mm) rectangle with saw-tooth edges **OR** 4-3/4-inch (121-mm) rectangular and trapezoidal units arranged in semicircular courses to produce fan-shaped pattern, **as directed**.
    - e. Color: As selected from manufacturer's full range.
  2. Concrete Pavers: Solid paving units, made from normal-weight concrete with a compressive strength not less than 5000 psi (34 MPa) **OR** 6000 psi (41 MPa), **as directed**, water absorption not more than 5 percent according to ASTM C 140, and no breakage and not more than 1 percent mass loss when tested for freeze-thaw resistance according to ASTM C 67.



- a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm) **OR** 2-3/8 inches (60 mm), **as directed**.
  - b. Face Size and Shape: 8-7/8 inches (225 mm) square **OR** 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 24 inches (610 mm) square, **as directed**.
  - c. Face Size and Shape: 9-by-18 inch (229-by-457 mm) **OR** 12-by-24 inch (305-by-610 mm), **as directed**, rectangle.
  - d. Face Size and Shape: As indicated.
  - e. Color: As selected from manufacturer's full range.
3. Concrete Pavers: Solid paving units complying with ASTM C 1491, made from lightweight concrete.
    - a. Thickness: 1-5/8 inches (41 mm) **OR** 1-3/4 inches (45 mm) **OR** 2 inches (51 mm), **as directed**.
    - b. Face Size and Shape: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square, **as directed**.
    - c. Color: As selected from manufacturer's full range.

#### C. Asphalt-Block Pavers

1. Asphalt-Block Pavers: Solid units made from asphalt cement complying with ASTM D 312, Type III; inorganic stone dust or cement filler; and coarse aggregate, consisting of clean, hard, unweathered stone crushed into angular particles varying in size up to 3/8 inch (9.5 mm).
  - a. Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm), **as directed**.
  - b. Face Size: 4 by 6 inches (102 by 152 mm) **OR** 6 by 6 inches (152 by 152 mm) **OR** 8 by 8 inches (203 by 203 mm) **OR** 5 by 12 inches (127 by 305 mm) **OR** 6 by 12 inches (152 by 305 mm) **OR** 8-inch- (203-mm-) wide hexagon, **as directed**.
  - c. Finish: Natural, smooth **OR** Ground **OR** Ground and sandblasted, **as directed**.
  - d. Color: As selected from manufacturer's full range.

#### D. Stone Pavers

1. Granite Pavers: Rectangular paving slabs made from granite complying with ASTM C 615
  - a. Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed**, with medium **OR** fine, **as directed**, grain.
  - b. Finish: Honed **OR** Thermal, **as directed**.
  - c. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
  - d. Thickness: Not less than 3/4 inch (20 mm) **OR** 30 mm **OR** 1-1/4 inches (32 mm) **OR** 1-5/8 inches (40 mm), **as directed**, unless otherwise indicated.
  - e. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed**.
2. Limestone Pavers: Rectangular paving slabs made from limestone complying with ASTM C 568.
  - a. Classification: II Medium-Density **OR** III High-Density, **as directed**.
  - b. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
  - c. Finish: Smooth **OR** Chat sawed **OR** Shot sawed, **as directed**.
  - d. Match Architect's samples for color, finish, and other stone characteristics relating to aesthetic effects.
  - e. Thickness: Not less than 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-5/8 inches (40 mm) **OR** 2 inches (50 mm), **as directed**, unless otherwise indicated.
  - f. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed**.
3. Marble Pavers: Rectangular paving slabs made from marble complying with ASTM C 503.
  - a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
  - b. Description: Uniform, fine- to medium-grained, white stone with only slight veining.



- c. Finish: Honed **OR as directed.**
    - d. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
    - e. Thickness: Not less than 3/4 inch (20 mm) **OR** 30 mm **OR** 1-1/4 inches (32 mm), **as directed.**
    - f. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm) **as directed.**
  - 4. Quartz-Based Stone Pavers: Rectangular paving slabs **OR** Random polygonal flagstones made from quartz-based stone complying with ASTM C 616, Classification I Sandstone **OR** II Quartzitic Sandstone **OR** III Quartzite, **as directed.**
    - a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
    - b. Finish: Sand rubbed **OR** Natural cleft **OR** Thermal, **as directed.**
    - c. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
    - d. Thickness: Not less than 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm) **OR** 1-5/8 inches (40 mm) **OR** 2 inches (50 mm), **as directed.**
    - e. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed.**
  - 5. Slate Pavers: Rectangular paving slabs **OR** Random polygonal flagstones made from slate complying with ASTM C 629, Classification I Exterior, with a fine, even grain and unfading color, from clear, sound stock.
    - a. Color: Black **OR** Blue-black **OR** Gray **OR** Blue-gray **OR** Green **OR** Purple **OR** Mottled purple and green **OR** Red, **as directed.**
    - b. Stone Abrasion Resistance: Minimum value of 8, based on testing according to ASTM C 241 or ASTM C 1353.
    - c. Finish: Honed **OR** Sand rubbed **OR** Natural cleft, **as directed.**
    - d. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
    - e. Thickness: Not less than 1/2 inch (13 mm) **OR** 3/4 inch (20 mm) **OR** 1 inch (25 mm), **as directed.**
    - f. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed.**
  - 6. Travertine Pavers: Rectangular paving slabs made from travertine complying with ASTM C 1527, Classification I Exterior.
    - a. Stone Abrasion Resistance: Minimum value of 10, based on testing according to ASTM C 241 or ASTM C 1353.
    - b. Cut: Vein cut.
    - c. Filling: Fill pores on faces of stone with cementitious filler of color as selected by the Owner.
    - d. Finish: Honed **OR as directed.**
    - e. Match samples for color, finish, and other stone characteristics relating to aesthetic effects.
    - f. Thickness: Not less than 3/4 inch (20 mm) **OR** 30 mm **OR** 1-1/4 inches (32 mm), **as directed.**
    - g. Face Size: 9 inches (229 mm) square **OR** 12 inches (305 mm) square **OR** 18 inches (457 mm) square **OR** 9 by 18 inches (229 by 457 mm), **as directed.**
  - 7. Rough-Stone Pavers: Rectangular tumbled paving stones, with split or thermal-finished faces and edges, made from granite complying with ASTM C 615.
    - a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed**, with medium **OR** fine, **as directed**, grain.
    - b. Thickness: 1-1/4 inches (32 mm) **OR** 2 inches (51 mm) **OR** 3 inches (76 mm) **OR** 4 inches (102 mm) **OR** 4 inches (102 mm), plus or minus 1/2 inch (13 mm), **as directed.**
    - c. Face Size: 4 by 4 inches (100 by 100 mm), plus or minus 1/2 inch (13 mm) **OR** 3 to 5 inches (75 to 125 mm) by 8 to 12 inches (200 to 300 mm), **as directed.**
- E. Curbs And Edge Restraints
- 1. Plastic Edge Restraints: Manufacturer's standard triangular PVC extrusions 1-3/4 inches (45 mm) high by 3-1/2 inches (89 mm) wide **OR** 3-1/8 inches (79 mm) high by 9-1/2 inches (241 mm) wide, **as directed**, designed to serve as edge restraints for unit pavers; rigid type for straight



edges and flexible type for curved edges, with pipe connectors and 3/8-inch (9.5-mm) diameter by 12-inch- (300-mm-) long steel spikes.

2. Steel Edge Restraints: Manufacturer's standard painted steel edging 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high **OR** 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high, **as directed** with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and steel stakes 15 inches (380 mm) long for each loop.
  - a. Color: As selected from manufacturer's full range.
3. Aluminum Edge Restraints: Manufacturer's standard straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high **OR** straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high **OR** L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high **OR** L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high, **as directed** extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches (300 mm) o.c., and aluminum stakes 12 inches (300 mm) long for each loop.
4. Job-Built Concrete Edge Restraints: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi (20 MPa).
5. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi (34 MPa) **OR** 6000 psi (41 MPa), **as directed** and water absorption not more than 5 percent, in shapes and sizes indicated.
6. Stone Curbs: Granite curbing, with face battered 1 inch per foot (1:12), produced in random lengths not less than 36 inches (900 mm) from granite complying with ASTM C 615.
  - a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed** with fine **OR** medium **OR** coarse grain, **as directed**.
  - b. Top Width: 4 inches (102 mm) **OR** 5 inches (127 mm) **OR** 6 inches (152 mm), **as directed**.
  - c. Face Height: 4 inches (102 mm) **OR** 6 inches (152 mm) **OR** 8 inches (203 mm), **as directed**.
  - d. Total Height: 12 inches (305 mm) **OR** 16 inches (406 mm) **OR** 18 inches (457 mm), **as directed**.
  - e. Top Finish: Sawed **OR** Thermal **OR** Bush hammered, **as directed**.
  - f. Face Finish: Split **OR** Sawed **OR** Thermal **OR** Bush hammered, **as directed**.

#### F. Accessories

1. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.
2. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

#### G. Aggregate Setting-Bed Materials

1. Graded Aggregate for Sub-base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 57 **OR** ASTM D 2940, sub-base material **OR** requirements in Division 02 Section "Earthwork" for sub-base material, **as directed**.
2. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** ASTM D 2940, base material **OR** requirements in Division 02 Section "Earthwork" for base course, **as directed**.
3. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTM D 448 for Size No. 10.
5. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
  - a. Provide sand of color needed to produce required joint color.
6. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - a. Survivability: Class 2, AASHTO M 288.
  - b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.



- c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
    - d. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
  - 7. Drainage Geotextile: Nonwoven needle-punched geotextile made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
    - a. Survivability: Class 2, AASHTO M 288.
    - b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
    - c. Permittivity: 0.5 per second, minimum; ASTM D 4491.
    - d. UV Stability: 50 percent after 500 hours' exposure, ASTM D 4355.
  - 8. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.
- H. Bituminous Setting-Bed Materials
  - 1. Primer for Base: ASTM D 2028, cutback asphalt, grade as recommended by unit paver manufacturer.
  - 2. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.
  - 3. Asphalt Cement: ASTM D 3381, Viscosity Grade AC-10 or Grade AC-20.
  - 4. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.
  - 5. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 (1.18-mm) sieve and no more than 10 percent passing No. 200 (0.075-mm) sieve.
    - a. Provide sand of color needed to produce required joint color.
- I. Mortar Setting-Bed Materials
  - 1. Portland Cement: ASTM C 150, Type I or II.
  - 2. Hydrated Lime: ASTM C 207, Type S.
  - 3. Sand: ASTM C 144.
  - 4. Latex Additive: Manufacturer's standard, acrylic resin or styrene-butadiene-rubber water emulsion, **as directed** serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.
  - 5. Thinset Mortar: Latex-modified portland cement mortar complying with ANSI A118.4.
    - a. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
    - b. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site, as directed.
  - 6. Water: Potable.
  - 7. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2-by-2-inch (51-by-51-mm) by 0.062-inch- (1.57-mm-) diameter wire; comply with ASTM A 185/A 185M and ASTM A 82/A 82M except for minimum wire size.
- J. Grout Materials
  - 1. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement, unfading mineral pigments and white or colored sand as required to produce required color.
    - a. Colored Mortar Pigments for Grout: Natural and synthetic iron and chromium oxides, compounded for use in mortar and grout mixes. Use only pigments that have proved, through testing and experience, to be satisfactory for use in portland cement grout.
  - 2. Standard Cement Grout: ANSI A118.6, sanded.
  - 3. Polymer-Modified Grout: ANSI A118.7, sanded grout; in color indicated.
    - a. Polymer Type: Ethylene-vinyl acetate or acrylic additive in dry, redispersible form; prepackaged with other dry ingredients.
    - b. Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
  - 4. Grout Colors: As selected from manufacturer's full range.
  - 5. Water: Potable.



K. Bituminous Setting-Bed Mix

1. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate, unless otherwise indicated. Heat mixture to 300 deg F (149 deg C).

L. Mortar And Grout Mixes

1. General: Comply with referenced standards and with manufacturers' written instructions. Discard mortars and grout if they have reached their initial set before being used.
2. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive **OR** water, **as directed**, to a creamy consistency.
3. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.
4. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
5. Latex-Modified, Portland Cement Slurry Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
6. Thinset Mortar Bond Coat: Proportion and mix thinset mortar ingredients according to manufacturer's written instructions.
7. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and aggregate grout to match setting-bed mortar except omit hydrated lime and use enough water to produce a pourable mixture.
  - a. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
  - b. Colored-Aggregate Grout: Produce color required by combining colored sand with portland cement of selected color.
8. Package Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

### 1.3 EXECUTION

A. Examination

1. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.
3. Proceed with installation only after unsatisfactory conditions have been corrected and waterproofing protection is in place.

B. Preparation

1. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.
2. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
3. Proof-roll prepared subgrade according to requirements in Division 02 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

C. Installation, General

1. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.





2. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
3. Cut unit pavers with motor-driven masonry saw equipment to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible.
  - a. For concrete pavers, a block splitter may be used.
4. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.
5. Joint Pattern: Running bond **OR** Herringbone **OR** Basket weave **OR** Match and continue existing unit paver joint pattern, **as directed**.
6. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
  - a. Provide joint filler at waterproofing that is turned up on vertical surfaces, unless otherwise indicated; where unfilled joints are indicated, provide temporary filler or protection until paver installation is complete.
7. Tolerances: For smooth pavers where slopes to drains are critical. Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.

**OR**

Tolerances: For smooth, flat pavers. Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.
8. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Division 07 Section "Joint Sealants".

**OR**

Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
9. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
  - a. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
  - b. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
  - c. Install job-built concrete edge restraints to comply with requirements in Division 03 Section "Cast-in-place Concrete".
  - d. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
  - e. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.
10. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
  - a. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

D. Aggregate Setting-Bed Applications

1. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, laboratory density.



2. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined, and replace with compacted backfill or fill as directed.
3. Place separation geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
4. Place aggregate subbase and base **OR** base, **as directed**.
  - a. For light-traffic compact by tamping with plate vibrator, and screed to depth indicated.
  - b. For heavy duty compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.
5. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
6. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm), taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.
7. Treat leveling course with herbicide to inhibit growth of grass and weeds.
8. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size unit pavers.
  - a. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.
9. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
  - a. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
  - b. Before ending each day's work, compact installed concrete pavers except for 36-inch (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
  - c. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
  - d. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
10. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.
11. Do not allow traffic on installed pavers until sand has been vibrated into joints.
12. Repeat joint-filling process 30 days later.

#### E. Bituminous Setting-Bed Applications

1. Apply primer to concrete slab or binder course immediately before placing setting bed.
2. Prepare for setting-bed placement by locating 3/4-inch- (19-mm-) deep control bars approximately 11 feet (3.3 m) apart, to serve as guides for striking board. Adjust bars for accurate setting of paving units to finished grades indicated.
3. Place bituminous setting bed between control bars. Spread mix at a minimum temperature of 250 deg F (121 deg C). Strike setting bed smooth, firm, even, and not less than 3/4 inch (19 mm) thick. Add fresh bituminous material to low, porous spots after each pass of striking board. Carefully fill depressions that remain after removing depth-control bars.
  - a. Roll setting bed with power roller to a nominal depth of 3/4 inch (19 mm). Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F (85 deg C).
4. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch (1.6 mm). Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.



5. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.
6. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

F. Mortar Setting-Bed Applications

1. Saturate concrete sub-base with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.
2. Apply mortar-bed bond coat over surface of concrete sub-base about 15 minutes before placing setting bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat.
3. Apply mortar bed over bond coat immediately after applying bond coat. Spread and screed to subgrade elevations required for accurate setting of pavers to finished grades indicated.
4. Place reinforcing wire over concrete sub-base, lapped at joints by at least one full mesh and supported so mesh becomes embedded in the middle of setting bed. Hold edges back from vertical surfaces approximately 1/2 inch (13 mm).
5. Place mortar bed with reinforcing wire fully embedded in middle of setting bed. Spread and screed setting bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
6. Mix and place only that amount of mortar that can be covered with pavers before initial set. Cut back and discard setting-bed material that has reached initial set before placing pavers.
7. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
8. Place pavers before initial set of cement occurs. Immediately before placing pavers, apply uniform 1/16-inch- (1.5-mm-) thick, slurry bond coat to bed or to back of each paver.
9. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.
10. Spaced Joint Widths: Provide 3/8-inch (10-mm) **OR** 1/2-inch (13-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal joint width with variations not exceeding plus or minus 1/16 inch (1.5 mm) **OR** 1/8 inch (3 mm) **OR** 3/16 inch (4.5 mm), **as directed**.
11. Grouted Joints: Grout paver joints complying with ANSI A108.10.
12. Grout joints as soon as possible after initial set of setting bed.
  - a. Force grout into joints, taking care not to smear grout on adjoining surfaces.
  - b. Clean pavers as grouting progresses by dry brushing or rubbing with dry burlap to remove smears before tooling joints.
  - c. Tool exposed joints slightly concave when thumbprint hard.
  - d. If tooling squeezes grout from joints, remove excess grout and smears by dry brushing or rubbing with dry burlap and tool joints again to produce a uniform appearance.
13. Cure grout by maintaining in a damp condition for seven days, unless otherwise recommended by grout or liquid-latex manufacturer.

G. Repairing, Pointing, And Cleaning

1. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
2. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.



3. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.
  - a. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.
  - b. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION 02264c



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02264	02242a	Geosynthetic Fabric

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## SECTION 02452 - STORM DRAINAGE

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for storm drainage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. Section Includes:
  - a. Pipe and fittings.
  - b. Nonpressure transition couplings.
  - c. Pressure pipe couplings.
  - d. Expansion joints and deflection fittings.
  - e. Backwater valves.
  - f. Cleanouts.
  - g. Drains.
  - h. Encasement for piping.
  - i. Manholes.
  - j. Channel drainage systems.
  - k. Catch basins.
  - l. Stormwater inlets.
  - m. Stormwater detention structures.
  - n. Pipe outlets.
  - o. Dry wells.
  - p. Stormwater disposal systems.

#### C. Definitions

1. FRP: Fiberglass-reinforced plastic.

#### D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings:
  - a. Manholes: Include plans, elevations, sections, details, frames, and covers.
  - b. Catch basins, stormwater inlets, and dry wells. Include plans, elevations, sections, details, frames, covers, and grates.
  - c. Stormwater Detention Structures: Include plans, elevations, sections, details, frames, covers, design calculations, and concrete design-mix reports.
3. 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.
4. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
6. Field quality-control reports.

#### E. Delivery, Storage, And Handling

1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
2. Protect pipe, pipe fittings, and seals from dirt and damage.
3. Handle manholes according to manufacturer's written rigging instructions.



4. Handle catch basins and stormwater inlets according to manufacturer's written rigging instructions.

F. Project Conditions

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

## 1.2 PRODUCTS

A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings

1. Pipe and Fittings: ASTM A 74, Service class **OR** Extra-Heavy class, **as directed**.
2. Gaskets: ASTM C 564, rubber.
3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

B. Hubless Cast-Iron Soil Pipe And Fittings

1. Pipe and Fittings: ASTM A 888 or CISPI 301.
2. CISPI-Trademarked, Shielded Couplings:
  - a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
3. Heavy-Duty, Shielded Couplings:
  - a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
4. Cast-Iron, Shielded Couplings:
  - a. Description: ASTM C 1277 and ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Ductile-Iron, Culvert Pipe And Fittings

1. Pipe: ASTM A 716, for push-on joints.
2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
3. Compact Fittings: AWWA C153, for push-on joints.
4. Gaskets: AWWA C111, rubber.

D. Ductile-Iron, Pressure Pipe And Fittings

1. Push-on-Joint Piping:
  - a. Pipe: AWWA C151, for push-on joints.
  - b. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
  - c. Compact Fittings: AWWA C153, for push-on joints.
  - d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
2. Mechanical-Joint Piping:
  - a. Pipe: AWWA C151, with bolt holes in bell.
  - b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
  - c. Compact Fittings: AWWA C153, with bolt holes in bells.
  - d. Glands: Cast or ductile iron, with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
  - e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.

E. Steel Pipe And Fittings





1. Corrugated-Steel Pipe and Fittings: ASTM A 760/A 760M, Type I with fittings of similar form and construction as pipe.
  - a. Special-Joint Bands: Corrugated steel with O-ring seals.
  - b. Standard-Joint Bands: Corrugated steel.
  - c. Coating: Aluminum **OR** Zinc, **as directed**.
- F. Aluminum Pipe And Fittings
  1. Corrugated Aluminum Pipe and Fittings: ASTM B 745/B 745M, Type I with fittings of similar form and construction as pipe.
    - a. Special-Joint Bands: Corrugated steel with O-ring seals.
    - b. Standard-Joint Bands: Corrugated steel.
- G. ABS Pipe And Fittings
  1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
    - a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
    - b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
  2. Gaskets: ASTM F 477, elastomeric seals.
- H. PE Pipe And Fittings
  1. Corrugated PE Drainage Pipe and Fittings NPS 3 to NPS 10 (DN 80 to DN 250): AASHTO M 252M, Type S, with smooth waterway for coupling joints.
    - a. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
    - b. Soiltight Couplings: AASHTO M 252M, corrugated, matching tube and fittings.
  2. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.
    - a. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
    - b. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.
- I. PVC Pipe And Fittings
  1. PVC Cellular-Core Piping:
    - a. PVC Cellular-Core Pipe and Fittings: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
    - b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
  2. PVC Corrugated Sewer Piping:
    - a. Pipe: ASTM F 949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
    - b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
    - c. Gaskets: ASTM F 477, elastomeric seals.
  3. PVC Profile Sewer Piping:
    - a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
    - b. Fittings: ASTM D 3034, PVC with bell ends.
    - c. Gaskets: ASTM F 477, elastomeric seals.
  4. PVC Type PSM Sewer Piping:
    - a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
    - b. Fittings: ASTM D 3034, PVC with bell ends.
    - c. Gaskets: ASTM F 477, elastomeric seals.
  5. PVC Gravity Sewer Piping:
    - a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
  6. PVC Pressure Piping:
    - a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.



- b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends
    - c. Gaskets: ASTM F 477, elastomeric seals.
  - 7. PVC Water-Service Piping:
    - a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
    - b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.
- J. Fiberglass Pipe And Fittings
  - 1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
    - a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
    - b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
    - c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
  - 2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF for gasketed joints.
    - a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
    - b. Reinforcement: Grade with finish compatible with resin.
  - 3. Gaskets: ASTM F 477, elastomeric seals.
- K. Concrete Pipe And Fittings
  - 1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed** ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets **OR** sealant joints with ASTM C 990 (ASTM C 990M), bitumen or butyl-rubber sealant, **as directed**.
  - 2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
    - a. Bell-and-spigot **OR** Tongue-and-groove, **as directed**, ends and gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets **OR** sealant joints with ASTM C 990 (ASTM C 990M), bitumen or butyl-rubber sealant, **as directed**.
    - b. Class I, Wall A **OR** Wall B, **as directed**.
    - c. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.
    - d. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
    - e. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
    - f. Class V, Wall B **OR** Wall C, **as directed**.
- L. Nonpressure Transition Couplings
  - 1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 2. Sleeve Materials:
    - a. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
    - b. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    - c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  - 3. Unshielded, Flexible Couplings:
    - a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 4. Shielded, Flexible Couplings:



- a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- 5. Ring-Type, Flexible Couplings:
  - a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
- M. Pressure Pipe Couplings
  - 1. Description: AWWA C219, tubular-sleeve coupling, with center sleeve, gaskets, end rings, and bolt fasteners.
  - 2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends sized to fit adjoining pipes.
  - 3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
  - 4. Gasket Material: Natural or synthetic rubber.
  - 5. Metal Component Finish: Corrosion-resistant coating or material.
- N. Expansion Joints And Deflection Fittings
  - 1. Ductile-Iron Flexible Expansion Joints:
    - a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
  - 2. Ductile-Iron Expansion Joints:
    - a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron or steel with protective coating, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
  - 3. Ductile-Iron Deflection Fittings:
    - a. Description: Compound-coupling fitting, with ball joint, flexing section, gaskets, and restrained-joint ends, complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.
- O. Backwater Valves
  - 1. Cast-Iron Backwater Valves:
    - a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
    - b. Horizontal type; with swing check valve and hub-and-spigot ends.
    - c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
    - d. Terminal type; with bronze seat, swing check valve, and hub inlet.
  - 2. Plastic Backwater Valves:
    - a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
- P. Cleanouts
  - 1. Cast-Iron Cleanouts:
    - a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
    - b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
    - c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
  - 2. Plastic Cleanouts:



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

#### Q. Drains

##### 1. Cast-Iron Area Drains:

- a. Description: ASME A112.6.3 gray-iron round body with anchor flange and round secured **OR** non-secured, **as directed**, grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
- b. Top-Loading Classification(s): Medium Duty **OR** Heavy Duty, **as directed**.

##### 2. Cast-Iron Trench Drains:

- a. Description: ASME A112.6.3, 6-inch- (150-mm-) wide top surface, rectangular body with anchor flange or other anchoring device, and rectangular secured **OR** non-secured, **as directed**, grate. Include units of total length indicated and quantity of bottom outlets with inside calk or spigot connections, of sizes indicated.
- b. Top-Loading Classification(s): Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty **OR** Medium and Heavy Duty **OR** Medium and Extra-Heavy Duty **OR** Heavy and Extra-Heavy Duty **OR** Medium, Heavy, and Extra-Heavy Duty, **as directed**.

##### 3. Steel Trench Drains:

- a. Description: Factory fabricated from ASTM A 242/A 242M, welded steel plate, to form rectangular body with uniform bottom downward slope of 2 percent toward outlet, anchor flange, and grate. Include units of total length indicated, bottom outlet of size indicated, outlet strainer, acid-resistant enamel coating on inside and outside surfaces, and grate with openings of total free area at least two times cross-sectional area of outlet.
- b. Plate Thicknesses: 1/8 inch (3.2 mm) **OR** 1/4 inch (6.4 mm), **as directed**.
- c. Overall Widths: 7-1/2 inches (190 mm) **OR** 12-1/3 inches (313 mm), **as directed**.
  - 1) Grate Openings: 1/4 inch (6.4 mm) circular **OR** 3/8 inch (9.5 mm) circular **OR** 3/8-by-3-inch (9.5-by-76-mm) slots, **as directed**.

#### R. Encasement For Piping

- 1. Standard: ASTM A 674 or AWWA C105.
- 2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
- 3. Form: Sheet **OR** Tube, **as directed**.
- 4. Color: Black **OR** Natural, **as directed**.

#### S. Manholes

##### 1. Standard Precast Concrete Manholes:

- a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
- b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
- c. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
- d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
- e. Riser Sections: 4-inch (102-mm) minimum thickness, and lengths to provide depth indicated.
- f. 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.
- g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
- h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
- i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing



- rods encased in ASTM D 4101, PP, **as directed**, 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
- j. 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.
- OR**
- Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) 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.
2. Designed Precast Concrete Manholes:
- a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
- b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
- c. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
- d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
- e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
- f. 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.
- OR**
- Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, to match diameter of manhole frame and cover, and of height required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
- a. Description: ASTM D 3753.
- b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
- c. Ballast: Increase thickness of concrete base as required to prevent flotation.
- d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
- e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
- f. 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
- g. 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.
- OR**
- Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) 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.
4. Manhole Frames and Covers:



- a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch- (102-mm-) minimum width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
- b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.

#### T. Concrete

1. General: Cast-in-place concrete according to ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
  - a. Cement: ASTM C 150, Type II.
  - b. Fine Aggregate: ASTM C 33, sand.
  - c. Coarse Aggregate: ASTM C 33, crushed gravel.
  - d. Water: Potable.
2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
  - a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
  - b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
  - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - 1) Invert Slope: **1 OR 2, as directed**, percent through manhole.
  - b. Benches: Concrete, sloped to drain into channel.
    - 1) Slope: **4 OR 8, as directed**, percent.
4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
  - a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
  - b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

#### U. Polymer-Concrete, Channel Drainage Systems

1. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of precast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include quantity of units required to form total lengths indicated.
2. Sloped-Invert, Polymer-Concrete Systems:
  - a. Channel Sections:
    - 1) Interlocking-joint, precast, modular units with end caps.
    - 2) 4-inch (102-mm) inside width and deep, rounded bottom, with built-in invert slope of 0.6 percent and with outlets in quantities, sizes, and locations indicated.
    - 3) Extension sections necessary for required depth.
    - 4) Frame: Include gray-iron or steel frame for grate.
  - b. Grates:
    - 1) Manufacturer's designation "Heavy **OR** "Medium, **as directed**, Duty," with slots or perforations that fit recesses in channels.
    - 2) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.
  - c. Covers: Solid gray iron if indicated.
  - d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
3. Narrow-Width, Level-Invert, Polymer-Concrete Systems:
  - a. Channel Sections:
    - 1) Interlocking-joint, precast, modular units with end caps.



- 2) 5-inch (127-mm) inside width and 9-3/4-inch- (248-mm-) deep, rounded bottom, with level invert and with NPS 4 (DN 100) outlets in quantities, sizes, and locations indicated.
    - b. Grates:
      - 1) Slots or perforations that fit recesses in channels.
      - 2) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.
    - c. Covers: Solid gray iron if indicated.
    - d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
  4. Wide-Width, Level-Invert, Polymer-Concrete Systems:
    - a. Channel Sections:
      - 1) Interlocking-joint, precast, modular units with end caps.
      - 2) 8-inch (203-mm) inside width and 13-3/4-inch- (350-mm-) deep, rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.
    - b. Grates:
      - 1) Slots or other openings that fit recesses in channels.
      - 2) Material: Fiberglass **OR** Gray iron, **as directed**.
    - c. Covers: Solid gray iron if indicated.
    - d. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
  5. Drainage Specialties: Precast, polymer-concrete units.
    - a. Large Catch Basins:
      - 1) 24-by-12-inch (610-by-305-mm) polymer-concrete body, with outlets in quantities and sizes indicated.
      - 2) Gray-iron slotted grate.
      - 3) Frame: Include gray-iron or steel frame for grate.
    - b. Small Catch Basins:
      - 1) 19- to 24-inch by approximately 6-inch (483- to 610-mm by approximately 150-mm) polymer-concrete body, with outlets in quantities and sizes indicated.
      - 2) Gray-iron slotted grate.
      - 3) Frame: Include gray-iron or steel frame for grate.
    - c. Oil Interceptors:
      - 1) Polymer-concrete body with interior baffle and four steel support channels and two 1/4-inch- (6.4-mm-) thick, steel-plate covers.
      - 2) Steel-plate covers.
      - 3) Capacity: 140 gal. (530 L) **OR** 200 gal. (757 L) **OR** 260 gal. (984 L), **as directed**.
      - 4) Inlet and Outlet: NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**.
    - d. Sediment Interceptors:
      - 1) 27-inch- (686-mm-) square, polymer-concrete body, with outlets in quantities and sizes indicated.
      - 2) 24-inch- (610-mm-) square, gray-iron frame and slotted grate.
  6. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
  7. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

#### V. Plastic, Channel Drainage Systems

1. General Requirements for Plastic, Channel Drainage Systems:
  - a. Modular system of plastic channel sections, grates, and appurtenances.
  - b. Designed so grates fit into frames without rocking or rattling.
  - c. Number of units required to form total lengths indicated.
2. Fiberglass Systems:
  - a. Channel Sections:
    - 1) Interlocking-joint, fiberglass modular units, with built-in invert slope of approximately 1 percent and with end caps.
    - 2) Rounded or inclined inside bottom surface, with outlets in quantities, sizes, and locations indicated.



- 3) Width: 6 inches (150 mm) **OR** 6 or 8 inches (150 or 203 mm) **OR** 8 inches (203 mm), **as directed**.
- b. Factory- or field-attached frames that fit channel sections and grates.
  - 1) Material: Galvanized steel **OR** Stainless steel **OR** Manufacturer's standard metal, **as directed**.
- c. Grates with slots or perforations that fit frames.
  - 1) Material: Fiberglass **OR** Galvanized steel **OR** Gray iron **OR** Stainless steel, **as directed**.
- d. Covers: Solid gray iron if indicated.
- e. Drainage Specialties:
  - 1) Large Catch Basins: 24-inch- (610-mm-) square plastic body, with outlets in quantities and sizes indicated. Include gray-iron frame and slotted grate.
  - 2) Small Catch Basins: 12-by-24-inch (305-by-610-mm) plastic body, with outlets in quantities and sizes indicated. Include gray-iron frame and slotted grate.
3. PE Systems:
  - a. Channel Sections: Interlocking-joint, PE modular units, 4 inches (102 mm) wide, with end caps. Include rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.
  - b. Grates: PE, ladder shaped; with stainless-steel screws.
  - c. Color: Gray unless otherwise indicated.
  - d. Drainage Specialties: Include the following PE components:
    - 1) Drains: 4-inch- (102-mm-) diameter, round, slotted top; with NPS 4 (DN 100) bottom outlet.  
**OR**  
Drains: 8-inch- (203-mm-) diameter, round, slotted top; with NPS 6 (DN 150) bottom outlet.  
**OR**  
Drains: 4-inch- (102-mm-) square, slotted top; with NPS 3 (DN 80) bottom outlet.  
**OR**  
Drains: 8-inch- (203-mm-) square, slotted top; with NPS 6 (DN 150) bottom outlet.  
**OR**  
Catch Basins: 12-inch- (305-mm-) square plastic body, with outlets in quantities and sizes indicated. Include PE slotted grate 11-3/4 inches (298 mm) square by 1-1/8 inches (28.6 mm) thick.
4. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
5. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

#### W. Catch Basins

1. Standard Precast Concrete Catch Basins:
  - a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  - b. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (102-mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
  - c. Riser Sections: 4-inch (102-mm) minimum thickness, 48-inch (1200-mm) diameter, and lengths to provide depth indicated.
  - d. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
  - e. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
  - f. 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.  
**OR**  
Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.





- g. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).
        - h. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
  - 2. Designed Precast Concrete Catch Basins: ASTM C 913, precast, reinforced concrete; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for joint sealants.
    - a. Joint Sealants: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
    - b. 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.  
**OR**  
Grade Rings: Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 225-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and grate.
    - c. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of catch basin to finished grade is less than 60 inches (1500 mm).
    - d. Pipe Connectors: ASTM C 923 (ASTM C 923M), resilient, of size required, for each pipe connecting to base section.
  - 3. Frames and Grates (for rectangular structures): ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include flat grate with small square or short-slotted drainage openings.
    - a. Size: 24 by 24 inches (610 by 610 mm) minimum unless otherwise indicated.
    - b. Grate Free Area: Approximately 50 percent unless otherwise indicated.
  - 4. Frames and Grates (for round, manhole-type structures): ASTM A 536, Grade 60-40-18, ductile iron designed for A-16, structural loading. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch (102-mm) minimum width flange, and 26-inch- (660-mm-) diameter flat grate with small square or short-slotted drainage openings.
    - a. Grate Free Area: Approximately 50 percent unless otherwise indicated.

X. Stormwater Inlets

  - 1. Curb Inlets: Made with vertical curb opening, of materials and dimensions according to utility standards.
  - 2. Gutter Inlets: Made with horizontal gutter opening, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
  - 3. Combination Inlets: Made with vertical curb and horizontal gutter openings, of materials and dimensions according to utility standards. Include heavy-duty frames and grates.
  - 4. Frames and Grates: Heavy duty, according to utility standards.

Y. Stormwater Detention Structures

  - 1. Cast-in-Place Concrete, Stormwater Detention Structures: Constructed of reinforced-concrete bottom, walls, and top; designed according to ASTM C 890 for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, dimensions, and appurtenances indicated.
    - a. Ballast: Increase thickness of concrete as required to prevent flotation.
    - b. Grade Rings (if required): Include two or three reinforced-concrete rings, of 6- to 9-inch (150- to 229-mm) total thickness, that match 24-inch- (610-mm-) diameter frame and cover.



- c. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps; FRP ladder; or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**, 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of structure to finished grade is less than 60 inches (1500 mm).
- 2. Manhole Frames and Covers: ASTM A 536, Grade 60-40-18, ductile-iron castings designed for heavy-duty service. Include 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser with 4-inch (102-mm) minimum width flange, and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."

#### Z. Pipe Outlets

- 1. Head Walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- 2. Riprap Basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
  - a. Average Size: NSSGA No. R-3, screen opening 2 inches (51 mm).
  - b. Average Size: NSSGA No. R-4, screen opening 3 inches (76 mm).
  - c. Average Size: NSSGA No. R-5, screen opening 5 inches (127 mm).
- 3. Filter Stone: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average-size graded stone.
- 4. Energy Dissipaters: According to NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton (2721-kg) average weight armor stone, unless otherwise indicated.

#### AA. Dry Wells

- 1. Description: ASTM C 913, precast, reinforced, perforated concrete rings. Include the following:
  - a. Floor: Cast-in-place concrete.
  - b. Cover: Liftoff-type concrete cover with cast-in lift rings.
  - c. Wall Thickness: 4 inches (102 mm) minimum with 1-inch (25-mm) diameter or 1-by-3-inch- (25-by-76-mm-) maximum slotted perforations arranged in rows parallel to axis of ring.
    - 1) Total Free Area of Perforations: Approximately 15 percent of ring interior surface.
    - 2) Ring Construction: Designed to be self-aligning.
  - d. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.

##### **OR**

Description: Manufactured PE side panels and top cover that assemble into 50-gal. (190-L) storage capacity units.

- a. Side Panels: With knockout ports for piping and seepage holes.
- b. Top Cover: With knockout port for drain.
- c. Filter Fabric: As recommended by unit manufacturer.
- d. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.

##### **OR**

Description: Constructed-in-place aggregate type. Include the following:

- a. Lining: Clay or concrete bricks.
  - OR**
  - Lining: Concrete blocks or precast concrete rings with notches or weep holes.
- b. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
- c. Cover: Precast, reinforced-concrete slab, designed for structural loading according to ASTM C 890 and made according to ASTM C 913. Include slab dimensions that will extend 12 inches (300 mm) minimum beyond edge of excavation, with bituminous coating over entire surface. Cast cover with opening for manhole in center.
- d. Manhole: 24-inch- (610-mm-) diameter, reinforced-concrete access lid with steel lift rings. Include bituminous coating over entire surface.

**BB. Stormwater Disposal Systems****1. Chamber Systems:**

- a. 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.
- b. Filtering Material: ASTM D 448, Size No. 24, 3/4- to 2-1/2-inch (19- to 63-mm) washed, crushed stone or gravel.
- c. Filter Mat: Geotextile woven or spun filter fabric, in one or more layers, for minimum total unit weight of 4 oz./sq. yd. (135 g/sq. m).

**OR**

Pipe Systems: Perforated manifold, header, and lateral piping complying with AASHTO M 252M for NPS 10 (DN 250) and smaller, AASHTO M 294M for NPS 12 to NPS 60 (DN 300 to DN 1500). Include proprietary fittings, couplings, seals, and filter fabric.

**1.3 EXECUTION****1.4 EARTHWORK**

A. Excavation, trenching, and backfilling are specified in Division 02 Section "Earthwork".

**B. Piping Installation**

1. 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.
2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
4. 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.
5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure drainage piping according to the following:
  - a. Install piping pitched down in direction of flow.
  - b. Install piping NPS 6 (DN 150) 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.
  - c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
  - d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - f. Install ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
  - g. Install corrugated steel piping according to ASTM A 798/A 798M.
  - h. Install corrugated aluminum piping according to ASTM B 788/B 788M.
  - i. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
  - j. Install PE corrugated sewer piping according to ASTM D 2321.
  - k. Install PVC cellular-core piping according to ASTM D 2321 and ASTM F 1668.
  - l. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
  - m. Install PVC profile gravity sewer piping according to ASTM D 2321 and ASTM F 1668.



- n. Install PVC water-service piping according to ASTM D 2321 and ASTM F 1668.
- o. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
- p. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
- q. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
- 7. Install force-main pressure piping according to the following:
  - a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place concrete supports or anchors.
  - b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
  - c. Install **ductile**-iron pressure piping according to AWWA C600 or AWWA M41.
  - d. Install ductile-iron special fittings according to AWWA C600.
  - e. Install PVC pressure piping according to AWWA M23, or ASTM D 2774 and ASTM F 1668.
  - f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
- 8. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
  - a. Hub-and-spigot, cast-iron soil pipe and fittings.
  - b. Hubless cast-iron soil pipe and fittings.
  - c. Ductile-iron pipe and fittings.
  - d. Expansion joints and deflection fittings.

#### C. Pipe Joint Construction

- 1. Join gravity-flow, nonpressure drainage piping according to the following:
  - a. Join hub-and-spigot, cast-iron soil piping with gasketed joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
  - c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
  - d. Join ductile-iron culvert piping according to AWWA C600 for push-on joints.
  - e. Join ductile-iron piping and special fittings according to AWWA C600 or AWWA M41.
  - f. Join corrugated steel sewer piping according to ASTM A 798/A 798M.
  - g. Join corrugated aluminum sewer piping according to ASTM B 788/B 788M.
  - h. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
  - i. Join corrugated PE piping according to ASTM D 3212 for push-on joints.
  - j. Join PVC cellular-core piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
  - k. Join PVC corrugated sewer piping according to ASTM D 2321 for elastomeric-seal joints.
  - l. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasketed joints.
  - m. Join PVC profile gravity sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
  - n. Join fiberglass sewer piping according to ASTM D 3839 for elastomeric-seal joints.
  - o. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
  - p. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasketed joints.
  - q. Join dissimilar pipe materials with nonpressure-type flexible couplings.
- 2. Join force-main pressure piping according to the following:
  - a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.



- b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
  - c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
  - d. Join PVC water-service piping according to ASTM D 2855 for solvent-cemented joints.
  - e. Join dissimilar pipe materials with pressure-type couplings.
- D. Backwater Valve Installation
  - 1. Install horizontal-type backwater valves in piping where indicated.
  - 2. Install combination horizontal and manual gate-valve type in piping and in manholes where indicated.
  - 3. Install terminal-type backwater valves on end of piping and in manholes where indicated.
- E. Cleanout Installation
  - 1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
    - a. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
    - b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
    - c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
    - d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
    - e. Set cleanout frames and covers in earth in cast-in-place concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding earth grade.
    - f. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.
- F. Drain Installation
  - 1. Install type of drains in locations indicated.
    - a. Use Light-Duty, top-loading classification drains in earth or unpaved foot-traffic areas.
    - b. Use Medium-Duty, top-loading classification drains in paved foot-traffic areas.
    - c. Use Heavy-Duty, top-loading classification drains in vehicle-traffic service areas.
    - d. Use Extra-Heavy-Duty, top-loading classification drains in roads.
  - 2. Embed drains in 4-inch (102-mm) minimum concrete around bottom and sides.
  - 3. Fasten grates to drains if indicated.
  - 4. Set drain frames and covers with tops flush with pavement surface.
  - 5. Assemble trench sections with flanged joints.
  - 6. Embed trench sections in 4-inch (102-mm) minimum concrete around bottom and sides.
- G. Manhole Installation
  - 1. General: Install manholes, complete with appurtenances and accessories indicated.
  - 2. Install precast concrete manhole sections with sealants according to ASTM C 891.
  - 3. Where specific manhole construction is not indicated, follow manhole manufacturer's written instructions.
  - 4. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
- H. Catch Basin Installation
  - 1. Construct catch basins to sizes and shapes indicated.
  - 2. Set frames and grates to elevations indicated.
- I. Stormwater Inlet And Outlet Installation
  - 1. Construct inlet head walls, aprons, and sides of reinforced concrete, as indicated.
  - 2. Construct riprap of broken stone, as indicated.
  - 3. Install outlets that spill onto grade, anchored with concrete, where indicated.
  - 4. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
  - 5. Construct energy dissipaters at outlets, as indicated.

**J. Dry Well Installation**

1. Excavate hole to diameter of at least 6 inches (150 mm) greater than outside of dry well. Do not extend excavation into ground-water table.
2. Install precast, concrete-ring dry wells according to the following:
  - a. Assemble rings to depth indicated.
  - b. Extend rings to height where top of cover will be approximately 8 inches (203 mm) below finished grade.
  - c. Backfill bottom of inside of rings with filtering material to level at least 12 inches (300 mm) above bottom.
  - d. Extend effluent inlet pipe 12 inches (300 mm) into rings and terminate into side of tee fitting.
  - e. Backfill around outside of rings with filtering material to top level of rings.
  - f. Install cover over top of rings.
3. Install manufactured, PE dry wells according to manufacturer's written instructions and the following:
  - a. Assemble and install panels and cover.
  - b. Backfill bottom of inside of unit with filtering material to level at least 12 inches (300 mm) above bottom.
  - c. Extend effluent inlet pipe 12 inches (300 mm) into unit and terminate into side of tee fitting.
  - d. Install filter fabric around outside of unit.
  - e. Install filtering material around outside of unit.
4. Install constructed-in-place dry wells according to the following:
  - a. Install brick lining material dry and laid flat, with staggered joints for seepage. Build to diameter and depth indicated.
  - b. Install block lining material dry, with staggered joints and 20 percent minimum of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage. Build to diameter and depth indicated.
  - c. Extend lining material to height where top of manhole will be approximately 8 inches (203 mm) below finished grade.
  - d. Backfill bottom of inside of lining with filtering material to level at least 12 inches (300 mm) above bottom.
  - e. Extend effluent inlet pipe 12 inches (300 mm) into lining and terminate into side of tee fitting.
  - f. Backfill around outside of lining with filtering material to top level of lining.
  - g. Install manhole over top of dry well. Support cover on undisturbed soil. Do not support cover on lining.

**K. Concrete Placement**

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

**L. Channel Drainage System Installation**

1. Install with top surfaces of components, except piping, flush with finished surface.
2. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
3. Embed channel sections and drainage specialties in 4-inch (102-mm) minimum concrete around bottom and sides.
4. Fasten grates to channel sections if indicated.
5. Assemble channel sections with flanged or interlocking joints.
6. Embed channel sections in 4-inch (102-mm) minimum concrete around bottom and sides.

**M. Stormwater Disposal System Installation**

1. Chamber Systems: Excavate trenches of width and depth, and install system and backfill according to chamber manufacturer's written instructions. Include storage and leaching chambers, filtering material, and filter mat.

**OR**



Piping Systems: Excavate trenches of width and depth, and install piping system, filter fabric, and backfill, according to piping manufacturer's written instructions.

N. Connections

1. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 15 Section "Storm Drainage Piping".
2. Connect force-main piping to building's storm drainage force mains specified in Division 15 Section "Storm Drainage Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
  - a. 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 (150-mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) 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 (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
    - 1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
    - 2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - d. 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.
4. Connect to sediment interceptors specified in Division 02 Section "Interceptors".
5. 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.
  - a. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - 1) Unshielded **OR** Shielded, **as directed**, flexible couplings for same or minor difference OD pipes.
    - 2) Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
    - 3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
  - b. Use pressure-type pipe couplings for force-main joints.

O. Closing Abandoned Storm Drainage Systems

1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
  - b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
  - a. Remove manhole or structure and close open ends of remaining piping.



- b. Remove top of manhole or structure down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
3. Backfill to grade according to Division 02 Section "Earthwork".

P. Identification

1. Materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
  - a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
  - b. Use detectable warning tape over nonferrous piping and over edges of underground structures.

Q. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (610 mm) of backfill is in place, and again at completion of Project.
  - a. Submit separate reports for each system inspection.
  - b. Defects requiring correction include the following:
    - 1) Alignment: Less than full diameter of inside of pipe is visible between structures.
    - 2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - 3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - 4) Infiltration: Water leakage into piping.
    - 5) Exfiltration: Water leakage from or around piping.
  - c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - a. Do not enclose, cover, or put into service before inspection and approval.
  - b. Test completed piping systems according to requirements of authorities having jurisdiction.
  - c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - d. Submit separate report for each test.
  - e. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - 1) Exception: Piping with soiltight joints unless required by authorities having jurisdiction.
    - 2) Option: Test plastic piping according to ASTM F 1417.
    - 3) Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).
  - f. Force-Main Storm Drainage Piping: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
    - 1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    - 2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
3. Leaks and loss in test pressure constitute defects that must be repaired.
4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

R. Cleaning

1. Clean interior of piping of dirt and superfluous materials. Flush with potable water **OR** Flush with water, **as directed**.





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END OF SECTION 02452



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## SECTION 02459 - WATER DISTRIBUTION

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for water distribution. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes water-distribution piping and related components outside the building for water service **OR** fire-service mains **OR** combined water service and fire-service mains, **as directed**.
2. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

#### C. Definitions

1. EPDM: Ethylene propylene diene terpolymer rubber.
2. LLDPE: Linear, low-density polyethylene plastic.
3. PA: Polyamide (nylon) plastic.
4. PE: Polyethylene plastic.
5. PP: Polypropylene plastic.
6. PVC: Polyvinyl chloride plastic.
7. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
8. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

#### D. Submittals

1. Product Data: For each type of product indicated.
2. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
  - a. Wiring Diagrams: Power, signal, and control wiring for alarms.
3. Field quality-control test reports.
4. Operation and Maintenance Data.

#### E. Quality Assurance

1. Regulatory Requirements:
  - a. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
  - b. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
  - c. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
2. Piping materials shall bear label, stamp, or other markings of specified testing agency.
3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
4. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
5. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
6. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
7. NSF Compliance:



- a. Comply with NSF 14 for plastic potable-water-service piping. Include marking "NSF-pw" on piping.
- b. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

F. Delivery, Storage, And Handling

1. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
  - a. Ensure that valves are dry and internally protected against rust and corrosion.
  - b. Protect valves against damage to threaded ends and flange faces.
  - c. Set valves in best position for handling. Set valves closed to prevent rattling.
2. During Storage: Use precautions for valves, including fire hydrants, according to the following:
  - a. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
  - b. 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.
3. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
4. 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.
5. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
6. Protect flanges, fittings, and specialties from moisture and dirt.
7. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

G. Project Conditions

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

H. Coordination

1. Coordinate connection to water main with utility company.

## 1.2 PRODUCTS

A. Copper Tube And Fittings

1. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**, water tube, annealed temper.
  - a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
  - b. Copper, Pressure-Seal Fittings:
    - 1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
    - 2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
2. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**, water tube, drawn temper.
  - a. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
  - b. Copper, Pressure-Seal Fittings:



- 1) NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
- 2) NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Ductile-Iron Pipe And Fittings

1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
  - a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
  - b. Gaskets: AWWA C111, rubber.
3. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
  - a. Grooved-End, Ductile-Iron Pipe Appurtenances:
    - 1) Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
    - 2) Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
4. Flanges: ASME 16.1, Class 125, cast iron.

C. PE Pipe And Fittings

1. PE, ASTM Pipe: ASTM D 2239, SDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OE** 200 psig (1380 kPa), **as directed**.
  - a. Insert Fittings for PE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
  - b. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
2. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
  - a. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**.
3. PE, Fire-Service Pipe: ASTM F 714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150 and Class 200.
  - a. Molded PE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

D. PVC Pipe And Fittings

1. PVC, Schedule 40 Pipe: ASTM D 1785.
  - a. PVC, Schedule 40 Socket Fittings: ASTM D 2466.
2. PVC, Schedule 80 Pipe: ASTM D 1785.
  - a. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
  - b. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.
3. PVC, AWWA Pipe: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell end with gasket, and with spigot end.
  - a. Comply with UL 1285 for fire-service mains if indicated.



- b. PVC Fabricated Fittings: AWWA C900, Class 150 **OR** Class 200, **as directed**, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - c. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
  - d. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - 1) Gaskets: AWWA C111, rubber.
  - e. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - 1) Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- E. Fiberglass Pipe And Fittings
- 1. AWWA RTRP: AWWA C950, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, Type I **OR** II, **as directed**, Grade 1, epoxy **OR** Grade 2, polyester, **as directed**, with bell-and-spigot ends for bonded **OR** with gasket or seal for gasketed, **as directed**, joints. Liner is optional, unless otherwise indicated.
    - a. RTRF: AWWA C950, similar to pipe in material, pressure class, and joining method.
  - 2. UL RTRP: UL 1713, Class 150 **OR** Class 200 **OR** Class 250, **as directed**, with bell-and-spigot ends with gasket or seal for gasketed joints. Liner is optional, unless otherwise indicated.
    - a. RTRF: Similar to pipe in material, pressure class, and joining method.
- F. Special Pipe Fittings
- 1. Ductile-Iron Rigid Expansion Joints:
    - a. Description: Three-piece, ductile-iron assembly consisting of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      - 1) Pressure Rating: 250 psig (1725 kPa) minimum.
      - 2) Expansion Required: As directed by the manufacturer or as directed by the Owner.
  - 2. Ductile-Iron Flexible Expansion Joints:
    - a. Description: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      - 1) Pressure Rating: 250 psig (1725 kPa) minimum.
      - 2) Offset: As directed by the manufacturer or as directed by the Owner.
      - 3) Expansion Required: As directed by the manufacturer or as directed by the Owner.
  - 3. Ductile-Iron Deflection Fittings:
    - a. Description: Compound, ductile-iron coupling fitting with sleeve and 1 or 2 flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      - 1) Pressure Rating: 250 psig (1725 kPa) minimum.
- G. Joining Materials
- 1. Refer to Division 02 Section "Piped Utilities -basic Materials And Methods" for commonly used joining materials.
  - 2. Brazing Filler Metals: AWS A5.8, BCuP Series.
  - 3. Bonding Adhesive for Fiberglass Piping: As recommended by fiberglass piping manufacturer.
  - 4. Plastic Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- H. Piping Specialties



1. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.
2. Tubular-Sleeve Pipe Couplings:
  - a. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.
    - 1) Standard: AWWA C219.
    - 2) Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
    - 3) Gasket Material: Natural or synthetic rubber.
    - 4) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
    - 5) Metal Component Finish: Corrosion-resistant coating or material.
3. Split-Sleeve Pipe Couplings:
  - a. Description: Metal, bolted, split-sleeve-type, reducing or transition coupling with sealing pad and closure plates, O-ring gaskets, and bolt fasteners.
    - 1) Standard: AWWA C219.
    - 2) Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel, **as directed**.
    - 3) Sleeve Dimensions: Of thickness and width required to provide pressure rating.
    - 4) Gasket Material: O-rings made of EPDM rubber, unless otherwise indicated.
    - 5) Pressure Rating: 150 psig (1035 kPa) **OR** 200 psig (1380 kPa), **as directed**, minimum.
    - 6) Metal Component Finish: Corrosion-resistant coating or material.
4. Flexible Connectors:
  - a. 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.
  - b. 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.
5. Dielectric Fittings: Combination of copper alloy and ferrous; threaded, solder, or plain end types; and matching piping system materials.
  - a. Dielectric Unions: Factory-fabricated union assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material that isolates dissimilar metals and ends with inside threads according to ASME B1.20.1.
  - b. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
  - c. Dielectric-Flange Insulation Kits: Field-assembled companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
    - 1) Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure to suit system pressures.
  - d. Dielectric Couplings: Galvanized-steel couplings with inert and noncorrosive thermoplastic lining, with threaded ends and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  - e. Dielectric Nipples: Electroplated steel nipples with inert and noncorrosive thermoplastic lining, with combination of plain, threaded, or grooved end types, and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- I. Corrosion-Protection Piping Encasement
  1. Encasement for Underground Metal Piping:
    - a. Standards: ASTM A 674 or AWWA C105.
    - b. Form: Sheet **OR** Tube, **as directed**.
    - c. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.
    - d. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness, or high-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.



- e. Material: High-density, crosslaminated PE film of 0.004-inch (0.10-mm) minimum thickness.
- f. Color: Black **OR** Natural, **as directed**.

## J. Gate Valves

### 1. AWWA, Cast-Iron Gate Valves:

- a. Nonrising-Stem, Metal-Seated Gate Valves:
  - 1) Description: Gray- or ductile-iron body and bonnet; with cast-iron or bronze double-disc gate, bronze gate rings, bronze stem, and stem nut.
    - a) Standard: AWWA C500.
    - b) Minimum Pressure Rating: 200 psig (1380 kPa).
    - c) End Connections: Mechanical joint.
    - d) Interior Coating: Complying with AWWA C550.
- b. Nonrising-Stem, Resilient-Seated Gate Valves:
  - 1) Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
    - a) Standard: AWWA C509.
    - b) Minimum Pressure Rating: 200 psig (1380 kPa).
    - c) End Connections: Mechanical joint.
    - d) Interior Coating: Complying with AWWA C550.
- c. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
  - 1) Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
    - a) Standard: AWWA C509.
    - b) Minimum Pressure Rating: 250 psig (1725 kPa).
    - c) End Connections: Push on or mechanical joint.
    - d) Interior Coating: Complying with AWWA C550.
- d. OS&Y, Rising-Stem, Metal-Seated Gate Valves:
  - 1) Description: Cast- or ductile-iron body and bonnet, with cast-iron double disc, bronze disc and seat rings, and bronze stem.
    - a) Standard: AWWA C500.
    - b) Minimum Pressure Rating: 200 psig (1380 kPa).
    - c) End Connections: Flanged.
- e. OS&Y, Rising-Stem, Resilient-Seated Gate Valves:
  - 1) Description: Cast- or ductile-iron body and bonnet, with bronze or gray- or ductile-iron gate, resilient seats, and bronze stem.
    - a) Standard: AWWA C509.
    - b) Minimum Pressure Rating: 200 psig (1380 kPa).
    - c) End Connections: Flanged.

### 2. UL/FMG, Cast-Iron Gate Valves:

- a. UL/FMG, Nonrising-Stem Gate Valves:
  - 1) Description: Iron body and bonnet with flange for indicator post, bronze seating material, and inside screw.
    - a) Standards: UL 262 and FMG approved.
    - b) Minimum Pressure Rating: 175 psig (1207 kPa).
    - c) End Connections: Flanged.
- b. OS&Y, Rising-Stem Gate Valves:
  - 1) Description: Iron body and bonnet and bronze seating material.
    - a) Standards: UL 262 and FMG approved.
    - b) Minimum Pressure Rating: 175 psig (1207 kPa).
    - c) End Connections: Flanged.

### 3. Bronze Gate Valves:

- a. OS&Y, Rising-Stem Gate Valves:
  - 1) Description: Bronze body and bonnet and bronze stem.
    - a) Standards: UL 262 and FMG approved.





- b) Minimum Pressure Rating: 175 psig (1207 kPa).
      - c) End Connections: Threaded.
    - b. Nonrising-Stem Gate Valves:
      - 1) Description: Class 125, Type 1, bronze with solid wedge, threaded ends, and malleable-iron handwheel.
        - a) Standard: MSS SP-80.
- K. Gate Valve Accessories And Specialties
  - 1. Tapping-Sleeve Assemblies:
    - a. Description: Sleeve and valve compatible with drilling machine.
      - 1) Standard: MSS SP-60.
      - 2) 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.
      - 3) Valve: AWWA, cast-iron, nonrising-stem, metal **OR** resilient, **as directed**, -seated gate valve with one raised face flange mating tapping-sleeve flange.
  - 2. 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 (125 mm) in diameter.
    - a. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.
  - 3. Indicator Posts: UL 789, FMG-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.
- L. Check Valves
  - 1. AWWA Check Valves:
    - a. Description: Swing-check type with resilient seat. Include interior coating according to AWWA C550 and ends to match piping.
      - 1) Standard: AWWA C508.
      - 2) Pressure Rating: 175 psig (1207 kPa).
  - 2. UL/FMG, Check Valves:
    - a. Description: Swing-check type with pressure rating; rubber-face checks, unless otherwise indicated; and ends matching piping.
      - 1) Standards: UL 312 and FMG approved.
      - 2) Pressure Rating: 175 psig (1207 kPa) **OR** 250 psig (1725 kPa), **as directed**.
- M. Detector Check Valves
  - 1. Detector Check Valves:
    - a. Description (with water meter): Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
      - 1) Standards: UL 312 and FMG approved.
      - 2) Pressure Rating: 175 psig (1207 kPa).
      - 3) Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.
    - b. Description (without water meter): Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.
      - 1) Standards: UL 312 and FMG approved.
      - 2) Pressure Rating: 175 psig (1207 kPa).
- N. Butterfly Valves
  - 1. AWWA Butterfly Valves:



- a. Description: Rubber seated.
      - 1) Standard: AWWA C504.
      - 2) Body: Cast or ductile iron.
      - 3) Body Type: Wafer **OR** Flanged, **as directed**.
      - 4) Pressure Rating: 150 psig (1035 kPa).
  2. UL Butterfly Valves:
    - a. Description: Metal on resilient material seating.
      - 1) Standards: UL 1091 and FMG approved.
      - 2) Body: Cast or ductile iron.
      - 3) Body Type: Wafer **OR** Flanged, **as directed**.
      - 4) Pressure Rating: 175 psig (1207 kPa).
- O. Plug Valves
  1. Plug Valves:
    - a. Description: Resilient-seated eccentric.
      - 1) Standard: MSS SP-108.
      - 2) Body: Cast iron.
      - 3) Pressure Rating: 175-psig (1207-kPa) minimum CWP.
      - 4) Seat Material: Suitable for potable-water service.
- P. Corporation Valves And Curb Valves
  1. Service-Saddle Assemblies: Comply with AWWA C800. Include saddle and valve compatible with tapping machine.
    - a. Service Saddle: Copper alloy with seal and AWWA C800, threaded outlet for corporation valve.
    - b. Corporation Valve: Bronze body and ground-key plug, with AWWA C800, threaded inlet and outlet matching service piping material.
    - c. Manifold (if utility company requires multiple connections): Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.
  2. Curb Valves: Comply with AWWA C800. Include bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.
  3. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches (75 mm) in diameter.
    - a. Shutoff Rods: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.
- Q. Water Meters
  1. Water meters will be furnished by utility company.

NOTE: If water meters are specified in this Section, delete paragraph above and retain and edit paragraphs and subparagraphs below.

  2. Displacement-Type Water Meters:
    - a. Description: With bronze main case.
      - 1) Standard: AWWA C700.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
  3. Turbine-Type Water Meters:
    - a. Description:
      - 1) Standard: AWWA C701.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
  4. Compound-Type Water Meters:
    - a. Description:
      - 1) Standard: AWWA C702.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.



5. Remote Registration System:
    - a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      - 1) Standard: AWWA C706.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
  6. Remote Registration System:
    - a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      - 1) Standard: AWWA C707.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      - 3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.**OR**  
Visible Display Units: Comply with utility company requirements for type and quantity.
- R. Detector-Type Water Meters
1. Detector-Type Water Meters
  2. Description: Main line, proportional meter with second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
    - a. Standards: AWWA C703, UL listed, and FMG approved.
    - b. Pressure Rating: 150 psig (1035 kPa).
    - c. Bypass Meter: AWWA C701, turbine **OR** AWWA C702, compound, **as directed**, -type, bronze case.
      - 1) Size: At least one-half nominal size of main-line meter.
  3. Description: Main-line turbine meter with strainer and second meter on bypass. Register flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
    - a. Standards: AWWA C703, UL listed, and FMG approved.
    - b. Pressure Rating: 175 psig (1207 kPa).
    - c. Bypass Meter: AWWA C701, turbine-type, bronze case.
      - 1) Size: At least NPS 2 (DN 50).
  4. Remote Registration System:
    - a. Description: Utility company standard; direct-reading type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      - 1) Standard: AWWA C706.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
  5. Remote Registration System:
    - a. Description: Utility company standard; encoder type. Include meter modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly.
      - 1) Standard: AWWA C707.
      - 2) Registration: Flow in gallons (liters) **OR** cubic feet (cubic meters), **as directed**.
      - 3) Data-Acquisition Units: Comply with utility company requirements for type and quantity.**OR**  
Visible Display Units: Comply with utility company requirements for type and quantity.
- S. Pressure-Reducing Valves
1. Water Regulators:
    - a. Standard: ASSE 1003.
    - b. Pressure Rating: Initial pressure of 150 psig (1035 kPa).
    - c. Size: As directed by the manufacturer or as directed by the Owner.
    - d. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
    - e. Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
    - f. Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.



- g. Body: Bronze with chrome-plated finish, **as directed**, for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved, **as directed**, for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
- h. Valves for Booster Heater Water Supply: Include integral bypass.
- i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
- 2. Water Control Valves:
  - a. Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping.
    - 1) Pressure Rating: Initial pressure of 150 psig (1035 kPa) minimum.
    - 2) Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
      - a) Size: As directed by the manufacturer or as directed by the Owner.
      - b) Pattern: Angle **OR** Globe, **as directed**, -valve design.
      - c) Trim: Stainless steel.
    - 3) Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
    - 4) Design Inlet Pressure: As directed by the manufacturer or as directed by the Owner.
    - 5) Design Outlet Pressure Setting: As directed by the manufacturer or as directed by the Owner.
    - 6) End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.

#### T. Relief Valves

- 1. Air-Release Valves:
  - a. Description: Hydromechanical device to automatically release accumulated air.
    - 1) Standard: AWWA C512.
    - 2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
    - 3) Body Material: Cast iron, **as directed**.
    - 4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
    - 5) Water Inlet Size: As directed by the manufacturer or as directed by the Owner.
    - 6) Air Outlet Size: As directed by the manufacturer or as directed by the Owner.
    - 7) Orifice Size: As directed by the manufacturer or as directed by the Owner.
    - 8) Design Air-Release Capacity: As directed by the manufacturer or as directed by the Owner.
- 2. Air/Vacuum Valves:
  - a. Description: Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.
    - 1) Standard: AWWA C512.
    - 2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
    - 3) Body Material: Cast iron, **as directed**.
    - 4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
    - 5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
    - 6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
    - 7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.
- 3. Combination Air Valves:
  - a. Description: Float-operated, hydromechanical device to automatically release accumulated air or to admit air.
    - 1) Standard: AWWA C512.
    - 2) Pressure Rating: 300 psig (2070 kPa), **as directed**.
    - 3) Body Material: Cast iron, **as directed**.
    - 4) Trim Material: Stainless steel, brass, or bronze, **as directed**.
    - 5) Inlet and Outlet Size: As directed by the manufacturer or as directed by the Owner.
    - 6) Orifice Size: As directed by the manufacturer or as directed by the Owner.
    - 7) Design Air Capacity: As directed by the manufacturer or as directed by the Owner.



## U. Vacuum Breakers

1. Pressure Vacuum Breaker Assembly:
  - a. Standard: ASSE 1020.
  - b. Operation: Continuous-pressure applications.
  - c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
  - d. Size: As directed by the manufacturer or as directed by the Owner.
  - e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
  - g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - h. Accessories: Ball valves on inlet and outlet.

## V. Backflow Preventers

1. Reduced-Pressure-Principle Backflow Preventers:
  - a. Standard: ASSE 1013 **OR** AWWA C511, **as directed**.
  - b. Operation: Continuous-pressure applications.
  - c. Pressure Loss: 12 psig (83 kPa), **as directed**, maximum, through middle 1/3 of flow range.
  - d. Size: As directed by the manufacturer or as directed by the Owner.
  - e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
  - g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
  - h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
  - i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.
  - j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
  - k. Accessories:
    - 1) Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
    - 2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
2. Double-Check, Backflow-Prevention Assemblies:
  - a. Standard: ASSE 1015 **OR** AWWA C510, **as directed**.
  - b. Operation: Continuous-pressure applications, unless otherwise indicated.
  - c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
  - d. Size: As directed by the manufacturer or as directed by the Owner.
  - e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
  - g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.for NPS 2 (DN 50) and smaller; As directed by the manufacturer or as directed by the Owner.for NPS 2-1/2 (DN 65) and larger.
  - h. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** steel with interior lining complying with AWWA C550 or that is FDA approved **OR** stainless steel, **as directed**, for NPS 2-1/2 (DN 65) and larger.
  - i. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged, **as directed**, for NPS 2-1/2 (DN 65) and larger.



- j. Configuration: Designed for horizontal, straight through, **as directed**, flow.
- k. Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
- 3. Reduced-Pressure-Detector, Fire-Protection Backflow Preventer Assemblies:
  - a. Standards: ASSE 1047 and UL listed or FMG approved.
  - b. Operation: Continuous-pressure applications.
  - c. Pressure Loss: 12 psig (83 kPa), **as directed**, maximum, through middle 1/3 of flow range.
  - d. Size: As directed by the manufacturer or as directed by the Owner. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - e. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
  - f. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - g. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
  - h. End Connections: Flanged.
  - i. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
  - j. Accessories:
    - 1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
    - 2) Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
    - 3) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- 4. Double-Check, Detector-Assembly Backflow Preventers:
  - a. Standards: ASSE 1048 and UL listed or FMG approved.
  - b. Operation: Continuous-pressure applications.
  - c. Pressure Loss: 5 psig (35 kPa), **as directed**, maximum, through middle 1/3 of flow range.
  - d. Size: As directed by the manufacturer or as directed by the Owner.
  - e. Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - f. Selected Unit Flow Range Limits: As directed by the manufacturer or as directed by the Owner.
  - g. Pressure Loss at Design Flow Rate: As directed by the manufacturer or as directed by the Owner.
  - h. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved **OR** Steel with interior lining complying with AWWA C550 or that is FDA approved **OR** Stainless steel, **as directed**.
  - i. End Connections: Flanged.
  - j. Configuration: Designed for horizontal, straight through **OR** vertical inlet, horizontal center section, and vertical outlet **OR** vertical, **as directed**, flow.
  - k. Accessories:
    - 1) Valves: UL 262, FMG-approved, OS&Y gate type with flanged ends on inlet and outlet.
    - 2) Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- 5. Backflow Preventer Test Kits:
  - a. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

#### W. Water Meter Boxes

- 1. Description: 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. Description: 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. Description: Polymer-concrete body and cover for disc-type water meter, with lettering "WATER" 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 (6800 kg minimum over 254 by 254 mm) square.
  - a. Use of this meter box is permitted in walks or unpaved areas away from traffic; do not use in roadways.

X. Concrete Vaults

1. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
  - a. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
  - b. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
    - 1) Dimension: 24-inch (610-mm) minimum diameter, unless otherwise indicated.
  - c. Manhole: ASTM A 536, Grade 60-40-18, ductile-iron traffic frame and cover.
    - 1) Dimension: 24-inch- (610-mm-) minimum diameter, unless otherwise indicated.
  - d. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

Y. Protective Enclosures

1. Freeze-Protection Enclosures:
  - a. Description: Insulated enclosure designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C).
    - 1) Standard: ASSE 1060.
    - 2) Class I: For equipment or devices other than pressure or atmospheric vacuum breakers.
    - 3) Class I-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
      - a) Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.
        - i. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
        - ii. Drain opening for units with drain connection.
        - iii. Access doors with locking devices.
        - iv. Insulation inside housing.
        - v. Anchoring devices for attaching housing to concrete base.
      - b) Electric heating cable or heater with self-limiting temperature control.
2. Weather-Resistant Enclosures:
  - a. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.
    - 1) Standard: ASSE 1060.
    - 2) Class III: For equipment or devices other than pressure or atmospheric vacuum breakers.
    - 3) Class III-V: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
      - i. Housing: Reinforced-aluminum **OR** -fiberglass, **as directed**, construction.
      - ii. Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
      - iii. Drain opening for units with drain connection.



- iv. Access doors with locking devices.
  - v. Anchoring devices for attaching housing to concrete base.
- 3. Expanded-Metal Enclosures:
  - a. Description: Enclosure designed to protect aboveground water piping, equipment, or specialties from damage.
    - 1) Material: ASTM F 1267, expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
    - 2) Type: Type I, expanded **OR** II, expanded and flattened, **as directed**.
    - 3) Class: Class 1, uncoated carbon steel **OR** 2, hot-dip, zinc-coated carbon steel **OR** 3, corrosion-resisting steel, **as directed**.
    - 4) Finish: Manufacturer's enamel paint.
    - 5) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
    - 6) Locking device.
    - 7) Lugs or devices for securing enclosure to base.
- 4. Enclosure Bases:
  - a. Description: 4-inch- (100-mm-) **OR** 6-inch- (150-mm-), **as directed**, minimum thickness precast concrete, of dimensions required to extend at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

## Z. Fire Hydrants

- 1. Dry-Barrel Fire Hydrants:
  - a. Description (for AWWA dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
    - 1) Standard: AWWA C502.
    - 2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
    - 3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
    - 4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
    - 5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
    - 6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
  - b. Description (for UL/FMG, dry-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
    - 1) Standards: UL 246, FMG approved.
    - 2) Pressure Rating: 150 psig (1035 kPa) minimum **OR** 250 psig (1725 kPa), **as directed**.
    - 3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
    - 4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
    - 5) Direction of Opening: Open hydrant valve by turning operating nut to left or counterclockwise.
    - 6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
- 2. Wet-Barrel Fire Hydrants:
  - a. Description (for AWWA wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550.
    - 1) Standard: AWWA C503.





- 2) Pressure Rating: 150 psig (1035 kPa) minimum.
- 3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
- 4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
- 5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
- 6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
- b. Description (for UL/FMG, wet-barrel fire hydrants): Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.
  - 1) Standards: UL 246 and FMG approved.
  - 2) Pressure Rating: 150 psig (1035 kPa) minimum.
  - 3) Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
  - 4) Operating and Cap Nuts: Pentagon, 1-1/2 inches (38 mm) point to flat.
  - 5) Direction of Opening: Open hydrant valves by turning operating nut to left or counterclockwise.
  - 6) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.

#### AA. Flushing Hydrants

1. Post-Type Flushing Hydrants:
  - a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
    - 1) Pressure Rating: 150 psig (1035 kPa) minimum.
    - 2) Outlet: One, with horizontal discharge.
    - 3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
    - 4) Barrel: Cast-iron or steel pipe with breakaway feature.
    - 5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
    - 6) Security: Locking device for padlock.
    - 7) Exterior Finish: Red alkyd-gloss enamel paint, unless otherwise indicated.
    - 8) Inlet: NPS 2 (DN 50) minimum.
    - 9) Operating Wrench: One for each unit.
2. Ground-Type Flushing Hydrants:
  - a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
    - 1) Pressure Rating: 150 psig (1035 kPa) minimum.
    - 2) Outlet: One, with vertical **OR** angle, **as directed**, discharge.
    - 3) Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast-iron cap with brass chain.
    - 4) Barrel: Cast-iron or steel pipe.
    - 5) Valve: Bronze body with bronze-ball or plunger closure, and automatic draining.
    - 6) Inlet: NPS 2 (DN 50) minimum.
    - 7) Hydrant Box: Cast iron with cover, for ground mounting.
    - 8) Operating Wrench: One for each unit.
3. Post-Type Sampling Station:
  - a. Description: Nonfreeze and drainable, of length required for shutoff valve installation below frost line.
    - 1) Pressure Rating: 100 psig (690 kPa) minimum.
    - 2) Sampling Outlet: One unthreaded nozzle with handle.
    - 3) Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
    - 4) Drain: Tubing with separate manual vacuum pump.
    - 5) Inlet: NPS 3/4 (DN 20) minimum.
    - 6) Housing: Weatherproof material with locking device. Include anchor device.
    - 7) Operating Wrench: One for each unit.



## BB. Fire Department Connections

### 1. Fire Department Connections:

- a. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch- (460-mm-) high brass sleeve; and round escutcheon plate.
  - 1) Standard: UL 405.
  - 2) Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**, outlet.
  - 3) Connections: Three **OR** Four, **as directed**, NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet.
  - 4) Connections: Six NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) **OR** NPS 8 (DN 200), **as directed**, outlet.
  - 5) Inlet Alignment: Inline, horizontal **OR** Square, **as directed**.
  - 6) Finish Including Sleeve: Polished chrome-plated **OR** Rough chrome-plated **OR** Polished bronze, **as directed**.
  - 7) Escutcheon Plate Marking: "AUTO SPKR" **OR** "STANDPIPE" **OR** "AUTO SPKR & STANDPIPE."

## CC. Alarm Devices

1. Alarm Devices, General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.
2. Water-Flow Indicators (can be used with wet-barrel fire hydrants): Vane-type water-flow detector, rated for 250-psig (1725-kPa) working pressure; designed for horizontal or vertical installation; with 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.
3. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position. Mount on stem of OS&Y gate valves and on indicator posts.
4. Pressure Switches: Single pole, double throw; designed to signal increase in pressure. Mount on barrel of dry-barrel fire hydrants.

## 1.3 EXECUTION

### A. Earthwork

1. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

### B. Piping Applications

1. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
2. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
3. Do not use flanges or unions for underground piping.
4. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
5. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following, **as directed**:
  - a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
  - b. PE, ASTM pipe; insert fittings for PE pipe; and clamped **OR** molded PE fittings; and heat-fusion, **as directed**, joints.
  - c. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.



- d. NPS 1 to NPS 3 (DN 25 to DN 80) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
- e. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
- 6. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following, **as directed**:
  - a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.
  - b. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
  - c. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.
  - d. PVC, Schedule 40 pipe; PVC, Schedule 40 **OR** Schedule 80 pipe; PVC, Schedule 80, **as directed**, socket fittings; and solvent-cemented joints.
  - e. NPS 4 and NPS 6 (DN 100 and DN 150): NPS 6 (DN 150) PVC, AWWA Class 150 pipe; PVC, AWWA Class 150 fabricated **OR** molded, **as directed**, fittings; and gasketed joints.
  - f. NPS 8 (DN 200): PVC, AWWA Class 200 pipe; PVC, AWWA Class 200 fabricated **OR** push-on-joint, ductile-iron **OR** mechanical-joint, ductile-iron, **as directed**, fittings; and gasketed joints.
  - g. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
- 7. Water Meter Box Water-Service Piping NPS 3/4 to NPS 2 (DN 20 to DN 50), **as directed**, shall be same as underground water-service piping.
- 8. Aboveground and Vault, **as directed**, Water-Service Piping NPS 3/4 to NPS 3 (DN 20 to DN 80), **as directed**, shall be selected from the following:

NOTE: Water-service piping materials listed in subparagraphs below are for potable-water service. They may not be suitable for fire-service mains.

- a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed **OR** copper, pressure-seal fittings; and pressure-sealed, **as directed**, joints.
- b. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.
- c. NPS 1 to NPS 2 (DN 25 to DN 50) fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
- 9. Aboveground and vault, **as directed**, water-service piping NPS 4 to NPS 8 (DN 100 to DN 200), **as directed**, shall be selected from the following:
  - a. Hard copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) **OR** ASTM B 88, Type L (ASTM B 88M, Type B), **as directed**; wrought-copper, solder-joint fittings; and brazed joints.
  - b. Ductile-iron, grooved-end pipe; ductile-iron, grooved-end appurtenances; and grooved joints.
  - c. PVC, Schedule 80 pipe; PVC, Schedule 80 socket fittings; and solvent-cemented **OR** threaded fittings; and threaded, **as directed**, joints.
  - d. Fiberglass, AWWA RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and bonded joints.
- 10. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be selected from the following:

NOTE: Fire-service-main piping materials listed in subparagraphs below are for fire-protection water service. They may not be suitable for potable-water service.

- a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
- b. PE, Class 150 **OR** 200, **as directed**, fire-service pipe; molded PE fittings; and heat-fusion joints.



- c. PVC, AWWA Class 150 pipe listed for fire-protection service; PVC Class 150 fabricated or molded fittings; and gasketed joints.
- d. PVC, AWWA Class 200 pipe listed for fire-protection service; PVC Class 200 fabricated fittings; and gasketed joints.
- e. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
- f. Fiberglass, UL RTRP, Class 150 **OR** 200 **OR** 250, **as directed**; RTRF; and gasketed joints.
- 11. Aboveground and Vault, **as directed**, Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.
- 12. Underground Combined Water-Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be selected from the following:
  - a. Ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings; and gasketed **OR** mechanical-joint pipe; ductile-iron, mechanical-joint fittings; and mechanical **OR** grooved-end pipe; ductile-iron-pipe appurtenances; and grooved, **as directed**, joints.
  - b. PVC, AWWA Class 150 **OR** 200, **as directed**, pipe listed for fire-protection service; PVC fabricated or molded fittings of same class as pipe; and gasketed joints.
  - c. Fiberglass, AWWA, FMG-approved RTRP, Class 150 **OR** 200, **as directed**; RTRF; and gasketed joints.
- 13. Aboveground and Vault, **as directed**, Combined Water Service and Fire-Service-Main Piping NPS 6 to NPS 12 (DN 150 to DN 300), **as directed**, shall be ductile-iron, grooved-end pipe; ductile-iron-pipe appurtenances; and grooved joints.

#### C. Valve Applications

- 1. General Application: Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.
- 2. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - a. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast-iron, nonrising-stem, metal **OR** resilient **OR** high-pressure, resilient, **as directed**, seated gate valves with valve box.
  - b. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
  - c. Use the following for valves in vaults and aboveground:
    - 1) Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, nonrising **OR** rising, **as directed**, stem.
    - 2) Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, OS&Y rising stem, metal seated **OR** AWWA, cast iron, OS&Y rising stem, resilient seated **OR** UL/FMG, cast iron, OS&Y rising stem, **as directed**.
    - 3) Check Valves: AWWA C508 **OR** UL/FMG, **as directed**, swing type.
  - d. Pressure-Reducing Valves: Use for water-service piping in vaults and aboveground to control water pressure.
  - e. Relief Valves: Use for water-service piping in vaults and aboveground.
    - 1) Air-Release Valves: To release accumulated air.
    - 2) Air/Vacuum Valves: To release or admit large volume of air during filling of piping.
    - 3) Combination Air Valves: To release or admit air.
  - f. Detector Check Valves: Use for water-service piping in vaults and aboveground to detect unauthorized use of water.

#### D. Piping Systems - Common Requirements

- 1. See Division 15 Section "Common Work Results For Plumbing" for piping-system common requirements.

**E. Piping Installation**

1. Water-Main Connection (if tap is made by utility company): Arrange with utility company for tap of size and in location indicated in water main.
2. Water-Main Connection (if tap is made by Contractor): Tap water main according to requirements of water utility company and of size and in location indicated.
3. Make connections larger than NPS 2 (DN 50) with tapping machine according to the following:
  - a. Install tapping sleeve and tapping valve according to MSS SP-60.
  - b. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
  - c. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
  - d. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.
4. Make connections NPS 2 (DN 50) and smaller with drilling machine according to the following:
  - a. Install service-saddle assemblies and corporation valves in size, quantity, and arrangement required by utility company standards.
  - b. Install service-saddle assemblies on water-service pipe to be tapped. Position outlets for corporation valves.
  - c. Use drilling machine compatible with service-saddle assemblies and corporation valves. Drill hole in main. Remove drilling machine and connect water-service piping.
  - d. Install corporation valves into service-saddle assemblies.
  - e. Install manifold for multiple taps in water main.
  - f. Install curb valve in water-service piping with head pointing up and with service box.
5. Comply with NFPA 24 for fire-service-main piping materials and installation.
  - a. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
  - b. Install copper tube and fittings according to CDA's "Copper Tube Handbook."
6. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
  - a. If required, install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
7. Install PE pipe according to ASTM D 2774 and ASTM F 645.
8. Install PVC, AWWA pipe according to ASTM F 645 and AWWA M23.
9. Install fiberglass AWWA pipe according to AWWA M45.
10. Bury piping with depth of cover over top at least 30 inches (750 mm), **as directed**, with top at least 12 inches (300 mm), **as directed**, below level of maximum frost penetration, and according to the following:
  - a. Under Driveways: With at least 36 inches (910 mm), **as directed**, cover over top.
  - b. Under Railroad Tracks: With at least 48 inches (1220 mm), **as directed**, cover over top.
  - c. In Loose Gravelly Soil and Rock: With at least 12 inches (300 mm), **as directed**, additional cover.
11. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
12. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
  - a. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.
13. Sleeves are specified in Division 15 Section "Common Work Results For Plumbing".
14. Mechanical sleeve seals are specified in Division 15 Section "Common Work Results For Plumbing".
15. For piping with gasketed joints: Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
16. See Division 15 Section "Common Work Results For Fire Suppression" for fire-suppression-water piping inside the building.
17. See Division 15 Section "Common Work Results For Plumbing" for potable-water piping inside the building.

**F. Joint Construction**

1. See Division 15 Section "Common Work Results For Plumbing" for basic piping joint construction.
2. Make pipe joints according to the following:
  - a. Copper-Tubing, Pressure-Sealed Joints: Use proprietary crimping tool and procedure recommended by copper, pressure-seal-fitting manufacturer.
  - b. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
  - c. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
  - d. Ductile-Iron Piping, Grooved Joints: Cut-groove pipe. Assemble joints with grooved-end, ductile-iron-piping couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
  - e. PE Piping Insert-Fitting Joints: Use plastic insert fittings and fasteners according to fitting manufacturer's written instructions.
  - f. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
  - g. Fiberglass Piping Bonded Joints: Use adhesive and procedure recommended by piping manufacturer.
  - h. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 15 Section "Common Work Results For Plumbing" for joining piping of dissimilar metals.

**G. Anchorage Installation**

1. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
  - a. Concrete thrust blocks.
  - b. Locking mechanical joints.
  - c. Set-screw mechanical retainer glands.
  - d. Bolted flanged joints.
  - e. Heat-fused joints.
  - f. Pipe clamps and tie rods.
2. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
  - a. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
  - b. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
  - c. Bonded-Joint Fiberglass, Water-Service Piping: According to AWWA M45.
  - d. Fire-Service-Main Piping: According to NFPA 24.
3. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

**H. Valve Installation**

1. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.
2. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
3. UL/FMG, 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.
4. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.
5. MSS Valves: Install as component of connected piping system.
6. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
7. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass, **as directed**.
8. Relief Valves: Comply with AWWA C512. Install aboveground with shutoff valve on inlet.

**I. Detector-Check Valve Installation**



1. Install in vault or aboveground.
  2. Install for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
  3. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.
- J. Water Meter Installation
1. If water meters are provided by the Contractor: Install water meters, piping, and specialties according to utility company's written instructions.
  2. Water Meters: Install displacement **OR** turbine, **as directed**, -type water meters, NPS 2 (DN 50) 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. Water Meters: Install compound **OR** turbine, **as directed**, -type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
  4. Water Meters: Install detector-type water meters in meter vault according to AWWA M6. Include shutoff valves on water meter inlets and outlets and full-size valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.
- K. Roughing-In For Water Meters
1. If Contractor is to rough-in for water meters to be installed by utility company: Rough-in piping and specialties for water meter installation according to utility company's written instructions.
- L. Vacuum Breaker Assembly Installation
1. Install pressure vacuum breaker assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
  2. Do not install pressure vacuum breaker assemblies in vault or other space subject to flooding.
- M. Backflow Preventer Installation
1. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
  2. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
  3. Do not install bypass piping around backflow preventers.
  4. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.
- N. Water Meter Box Installation
1. Install water meter boxes in paved areas flush with surface.
  2. Install water meter boxes in grass or earth areas with top 2 inches (50 mm), **as directed**, above surface.
- O. Concrete Vault Installation
1. Install precast concrete vaults according to ASTM C 891.
- P. Protective Enclosure Installation
1. Install concrete base level and with top approximately 2 inches (50 mm), **as directed**, above grade.
  2. Install protective enclosure over valves and equipment.
  3. Anchor protective enclosure to concrete base.
- Q. Fire Hydrant Installation
1. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.



2. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.
  3. AWWA Fire Hydrants: Comply with AWWA M17.
  4. UL/FMG Fire Hydrants: Comply with NFPA 24.
- R. Flushing Hydrant Installation
1. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.
  2. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
  3. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.
- S. Fire Department Connection Installation
1. Install ball drip valves at each check valve for fire department connection to mains.
  2. Install protective pipe bollards on two sides of **OR** on three sides of, **as directed**, each fire department connection. Pipe bollards are specified in Division 05 Section "Metal Fabrications".
- T. Alarm Device Installation
1. General: Comply with NFPA 24 for devices and methods of valve supervision. Underground valves with valve box do not require supervision.
  2. Supervisory Switches: Supervise valves in open position.
    - a. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.
    - b. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.
  3. Locking and Sealing: Secure unsupervised valves as follows:
    - a. Valves: Install chain and padlock on open OS&Y gate valve.
    - b. Post Indicators: Install padlock on wrench on indicator post.
  4. Pressure Switches: Drill and thread hole in exposed barrel of fire hydrant. Install switch.
  5. Water-Flow Indicators: Install in water-service piping in vault. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.
  6. Connect alarm devices to building fire alarm system. Wiring and fire-alarm devices are specified in Division 13.
- U. Connections
1. Piping installation requirements are specified in other Division 02. Drawings indicate general arrangement of piping, fittings, and specialties.
  2. See Division 15 Section "Common Work Results For Plumbing" for piping connections to valves and equipment.
  3. Connect water-distribution piping to utility water main **OR** existing water main, **as directed**. Use tapping sleeve and tapping valve **OR** service clamp and corporation valve, **as directed**.
  4. Connect water-distribution piping to interior domestic water **OR** fire-suppression, **as directed**, piping.
  5. Connect waste piping from concrete vault drains to sanitary sewerage system. See Division 02 for connection to sanitary-sewer **OR** storm-drainage system. See Division 02 for connection to storm-sewer, **as directed**, piping.
  6. Ground equipment according to Division 16 Section "Grounding And Bonding".
  7. Connect wiring according to Division 16 Section "Conductors And Cables".
- V. Field Quality Control
1. 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.
  2. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.





- a. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
3. Prepare reports of testing activities.

W. Identification

1. Install continuous underground detectable, **as directed**, warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Division 02 Section "Earthwork".
2. Permanently attach equipment nameplate or marker indicating plastic water-service piping, on main electrical meter panel. See Division 15 Section "Common Work Results For Plumbing" for identifying devices.

NOTE: Delete paragraph above if metallic water-service piping without electrically insulated fittings will be used.

X. Cleaning

1. Clean and disinfect water-distribution piping as follows:
  - a. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  - b. If fire-protection-water piping is not connected to potable-water supply, 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.
  - c. If fire-protection-water piping is connected to potable-water supply, 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:
    - 1) 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 **OR** Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours, **as directed**.
    - 2) After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
    - 3) Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
2. Prepare reports of purging and disinfecting activities.

END OF SECTION 02459



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**SECTION 02459a - GROUND-LOOP HEAT-PUMP PIPING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for ground-loop, heat-pump piping. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. This Section includes piping for horizontal or vertical, direct-buried, ground-loop, heat-pump systems that operate between 23 and 104 deg F (minus 5 and plus 40 deg C).

**C. Performance Requirements**

1. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
  - a. Ground-Loop, Heat-Pump Piping: 160 psig (1100 kPa) **OR** 200 psig (1380 kPa), **as directed**

**D. Submittals**

1. Product Data: For the following:
  - a. Pipe and fittings.
  - b. Joining method and equipment.
  - c. Propylene glycol solution.
2. Field quality-control test reports.

**1.2 PRODUCTS****A. Pipes And Fittings**

1. PE Pipe: ASTM D 2239, SDR Numbers 5.3, 7, 9, or 11.5; with PE compound number required to achieve required system working pressure.
  - a. Molded PE Fittings: ASTM D 2683 or ASTM D 3261, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.
2. U-Bend Assembly: Factory fabricated with embossed depth stamp every 24 inches (600 mm) **OR** 36 inches (900 mm), **as directed** from U-bend.

**B. Borehole Backfill**

1. Surface Seal: Bentonite **OR** Cement, **as directed**, with thermal conductivity greater than 1.2 Btu/h x sq. ft. x deg F (0.7 W/sq. m x K).
2. Backfill below Surface Seal: Natural or manufactured sand specified in Division 02 Section "Earthwork".

**C. Antifreeze Solution**

1. Propylene Glycol: Minimum 99 percent propylene glycol with corrosion inhibitors and environmental stabilizer additives to be mixed with water to protect the piping circuit and connected equipment from physical damage from freezing or corrosion.
2. Quantity: Sufficient solution for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
3. Dilution Water: Chloride content shall be less than 25 ppm, sulfate less than 25 ppm, and hardness less than 100 ppm.



### 1.3 EXECUTION

#### A. Earthwork

1. Excavating, trenching, warning tape, and backfilling are specified in Division 02 Section "Earthwork".

#### B. Horizontal Piping Installation

1. Separate trenches by 10 feet (3 m) minimum, unless otherwise indicated. Remove rocks in trenches that could contact pipe.
2. Backfill to 24 inches (600 mm) above pipe with mud developed from excavated rock-free soil or with sand, pea gravel, or fly ash. Backfill from slurry level to grade with excavated soil, compacting as specified for pipe burial in Division 02 Section "Earthwork".
3. Extend pipe from trench onto the bottom of the body of water at an elevation that is at least 12 inches (300 mm) below frost line. Seal membrane or impervious liner under the body of water after installing piping.
4. Install PE piping in trenches according to ASTM D 2774 or ASTM F 645.
  - a. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
5. Purge, flush, and pressure test piping before backfilling trenches.
6. Install continuous detectable warning tape for underground piping. Locate tape a minimum of 24 inches (600 mm) below finished grade, directly over piping. Underground warning tapes are specified in Division 02 Section "Earthwork".
7. Common piping installation requirements are specified in Division 15 Section "Common Work Results For Hvac".

#### C. Vertical Piping Installation

1. Install PE piping in boreholes according to ASTM D 2774 or ASTM F 645.
  - a. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.
2. Purge, flush, and pressure test piping before backfilling boreholes.
3. After installation of loop pipe in borehole, fill piping loop with water or antifreeze solution, and pump backfill into borehole to discharge at base of borehole.
4. Fill borehole with backfill to a point at least 60 inches (1524 mm) below grade and backfill remainder with surface seal material.
5. Extend piping and connect to water-source, ground-loop, heat-pump piping systems at outside face of building wall in locations and pipe sizes indicated.
  - a. Terminate water-service piping at building wall until building water-source, ground-loop, heat-pump piping systems are installed. Terminate piping with caps. Make connections to building water-source, ground-loop, heat-pump piping systems when those systems are installed.
6. Wall sleeves are specified in Division 15 Section "Common Work Results For Hvac".
7. Mechanical sleeve seals are specified in Division 15 Section "Common Work Results For Plumbing".

#### D. Antifreeze Solution Fill

1. Fill system with required quantity of propylene glycol and water to provide minus 10 deg F (minus 23 deg C) freezing temperature.
2. Test the dilute solution using gas chromatography to verify concentration of propylene glycol, and forward report to the Owner.

#### E. Connections

1. Drawings indicate general arrangement of piping, fittings, and specialties.

#### F. Field Quality Control



1. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.
2. Hydrostatic Tests: Test at not less than 1-1/2 times the pipe working-pressure rating allowing for static pressure of borehole depth.
  - a. Increase pressure in 50-psig (345-kPa) increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig (207 kPa). Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.
3. Prepare reports of testing activity.

END OF SECTION 02459a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02459	02242	Piped Utilities Basic Materials And Methods
02459	02213	Subdrainage
02459	02452	Storm Drainage



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## SECTION 02511 - SANITARY SEWERAGE

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for sanitary sewerage. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. Section Includes:
  - a. Pipe and fittings.
  - b. Nonpressure and pressure couplings.
  - c. Expansion joints and deflection fittings.
  - d. Backwater valves.
  - e. Cleanouts.
  - f. Encasement for piping.
  - g. Manholes.

#### C. Definitions

1. FRP: Fiberglass-reinforced plastic.

#### D. Submittals

1. Product Data: For the following:
  - a. Expansion joints and deflection fittings.
  - b. Backwater valves.
2. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.
3. Coordination Drawings: Show pipe sizes, locations, and elevations. Show other piping in same trench and clearances from sewer system piping. Indicate interface and spatial relationship between manholes, piping, and proximate structures.
4. Profile Drawings: Show system piping in elevation. Draw profiles to horizontal scale of not less than 1 inch equals 50 feet (1:500) and to vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing system piping.
5. Product Certificates: For each type of cast-iron soil pipe and fitting, from manufacturer.
6. Field quality-control reports.

#### E. Delivery, Storage, And Handling

1. Do not store plastic manholes, pipe, and fittings in direct sunlight.
2. Protect pipe, pipe fittings, and seals from dirt and damage.
3. Handle manholes according to manufacturer's written rigging instructions.

#### F. Project Conditions

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



## 1.2 PRODUCTS

- A. Hub-And-Spigot, Cast-Iron Soil Pipe And Fittings
  1. Pipe and Fittings: ASTM A 74, Service class **OR** Service and Extra-Heavy classes **OR** Extra-Heavy class, **as directed**.
  2. Gaskets: ASTM C 564, rubber.
  3. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.
- B. Hubless Cast-Iron Soil Pipe And Fittings
  1. Pipe and Fittings: ASTM A 888 or CISPI 301.
  2. CISPI-Trademark, Shielded Couplings:
    - a. Description: ASTM C 1277 and CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  3. Heavy-Duty, Shielded Couplings:
    - a. Description: ASTM C 1277 and ASTM C 1540, with stainless-steel shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  4. Cast-Iron, Shielded Couplings:
    - a. Description: ASTM C 1277 with ASTM A 48/A 48M, two-piece, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.
  5. Unshielded Couplings:
    - a. Description: ASTM C 1277 and ASTM C 1461, rigid, sleeve-type, reducing- or transition-type mechanical coupling, with integral, center pipe stop, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
- C. Ductile-Iron, Gravity Sewer Pipe And Fittings
  1. Pipe: ASTM A 746, for push-on joints.
  2. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
  3. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
  4. Gaskets: AWWA C111, rubber.
- D. Ductile-Iron, Pressure Pipe And Fittings
  1. Push-on-Joint Piping:
    - a. Pipe: AWWA C151.
    - b. Standard Fittings: AWWA C110, ductile or gray iron.
    - c. Compact Fittings: AWWA C153.
    - d. Gaskets: AWWA C111, rubber, of shape matching pipe and fittings.
  2. Mechanical-Joint Piping:
    - a. Pipe: AWWA C151, with bolt holes in bell.
    - b. Standard Fittings: AWWA C110, ductile or gray iron, with bolt holes in bell.
    - c. Compact Fittings: AWWA C153, with bolt holes in bells.
    - d. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
    - e. Gaskets: AWWA C111, rubber, of shape matching pipe, fittings, and glands.
- E. ABS Pipe And Fittings
  1. ABS Sewer Pipe and Fittings: ASTM D 2751, with bell-and-spigot ends for gasketed joints.
    - a. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
    - b. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.
  2. Gaskets: ASTM F 477, elastomeric seals.
- F. PVC Pipe And Fittings



1. PVC Cellular-Core Sewer Piping:
  - a. Pipe: ASTM F 891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
  - b. Fittings: ASTM D 3034, SDR 35, PVC socket-type fittings.
2. PVC Corrugated Sewer Piping:
  - a. Pipe: ASTM F 949, PVC corrugated pipe with bell-and-spigot ends for gasketed joints.
  - b. Fittings: ASTM F 949, PVC molded or fabricated, socket type.
  - c. Gaskets: ASTM F 477, elastomeric seals.
3. PVC Profile Sewer Piping:
  - a. Pipe: ASTM F 794, PVC profile, gravity sewer pipe with bell-and-spigot ends for gasketed joints.
  - b. Fittings: ASTM D 3034, PVC with bell ends.
  - c. Gaskets: ASTM F 477, elastomeric seals.
4. PVC Type PSM Sewer Piping:
  - a. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
  - b. Fittings: ASTM D 3034, PVC with bell ends.
  - c. Gaskets: ASTM F 477, elastomeric seals.
5. PVC Gravity Sewer Piping:
  - a. Pipe and Fittings: ASTM F 679, T-1 **OR** T-2, **as directed**, wall thickness, PVC gravity sewer pipe with bell-and-spigot ends and with integral ASTM F 477, elastomeric seals for gasketed joints.
6. PVC Pressure Piping:
  - a. Pipe: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell-and-spigot ends for gasketed joints.
  - b. Fittings: AWWA C900, Class 100 **OR** Class 150 **OR** Class 200, **as directed**, PVC pipe with bell ends.
  - c. Gaskets: ASTM F 477, elastomeric seals.
7. PVC Water-Service Piping:
  - a. Pipe: ASTM D 1785, Schedule 40 **OR** Schedule 80, **as directed**, PVC, with plain ends for solvent-cemented joints.
  - b. Fittings: ASTM D 2466, Schedule 40 **OR** ASTM D 2467, Schedule 80, **as directed**, PVC, socket type.
- G. Fiberglass Pipe And Fittings
  1. Fiberglass Sewer Pipe: ASTM D 3262, RTRP, for gasketed joints fabricated with Type 2, polyester **OR** Type 4, epoxy, **as directed**, resin.
    - a. Liner: Reinforced thermoset **OR** Nonreinforced thermoset **OR** Thermoplastic **OR** No liner, **as directed**.
    - b. Grade: Reinforced, surface layer matching pipe resin **OR** Nonreinforced, surface layer matching pipe resin **OR** No surface layer, **as directed**.
    - c. Stiffness: 9 psig (62 kPa) **OR** 18 psig (124 kPa) **OR** 36 psig (248 kPa) **OR** 72 psig (496 kPa), **as directed**.
  2. Fiberglass Nonpressure Fittings: ASTM D 3840, RTRF, for gasketed joints.
    - a. Laminating Resin: Type 1, polyester **OR** Type 2, epoxy, **as directed**, resin.
    - b. Reinforcement: Grade with finish compatible with resin.
  3. Gaskets: ASTM F 477, elastomeric seals.
- H. Concrete Pipe And Fittings
  1. Nonreinforced-Concrete Sewer Pipe and Fittings: ASTM C 14 (ASTM C 14M), Class 1 **OR** Class 2 **OR** Class 3, **as directed**, with bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints with ASTM C 443 (ASTM C 443M), rubber gaskets.
  2. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76 (ASTM C 76M).
    - a. Bell-and-spigot **OR** tongue-and-groove, **as directed**, ends for gasketed joints, with ASTM C 443 (ASTM C 443M), rubber gaskets.
    - b. Class II, Wall A **OR** Wall B **OR** Wall C, **as directed**.



- c. Class III, Wall A **OR** Wall B **OR** Wall C, **as directed**.
  - d. Class IV, Wall A **OR** Wall B **OR** Wall C, **as directed**.
  - e. Class V, Wall A **OR** Wall B, **as directed**.
- I. Nonpressure-Type Transition Couplings
- 1. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 2. Sleeve Materials:
    - a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
    - b. For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
    - c. For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - d. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
    - e. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  - 3. Unshielded, Flexible Couplings:
    - a. Description: Elastomeric sleeve, with stainless-steel shear ring, **as directed**, and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 4. Shielded, Flexible Couplings:
    - a. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 5. Ring-Type, Flexible Couplings:
    - a. Description: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
  - 6. Nonpressure-Type, Rigid Couplings:
    - a. Description: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling, molded from ASTM C 1440, TPE material; with corrosion-resistant-metal tension band and tightening mechanism on each end.
- J. Pressure-Type Pipe Couplings
- 1. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.
  - 2. Metal, bolted, sleeve-type, reducing or transition coupling, for joining underground pressure piping. Include 150-psig (1035-kPa) **OR** 200-psig (1380-kPa), **as directed**, minimum pressure rating and ends of same sizes as piping to be joined.
  - 3. Center-Sleeve Material: Manufacturer's standard **OR** Carbon steel **OR** Stainless steel **OR** Ductile iron **OR** Malleable iron, **as directed**.
  - 4. Gasket Material: Natural or synthetic rubber.
  - 5. Metal Component Finish: Corrosion-resistant coating or material.
- K. Expansion Joints And Deflection Fittings
- 1. Ductile-Iron, Flexible Expansion Joints:
    - a. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig (1725-kPa) minimum working pressure and for offset and expansion indicated.
  - 2. Ductile-Iron Expansion Joints:
    - a. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for expansion indicated.
  - 3. Ductile-Iron Deflection Fittings:



- a. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include rating for 250-psig (1725-kPa) minimum working pressure and for up to 15 degrees of deflection.
- L. Backwater Valves
  - 1. Cast-Iron Backwater Valves:
    - a. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.
    - b. Horizontal type; with swing check valve and hub-and-spigot ends.
    - c. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
    - d. Terminal type; with bronze seat, swing check valve, and hub inlet.
  - 2. PVC Backwater Valves:
    - a. Description: Horizontal type; with PVC body, PVC removable cover, and PVC swing check valve.
- M. Cleanouts
  - 1. Cast-Iron Cleanouts:
    - a. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
    - b. Top-Loading Classification(s): Light Duty **OR** Medium Duty **OR** Heavy Duty **OR** Extra-Heavy Duty, **as directed**.
    - c. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
  - 2. PVC Cleanouts:
    - a. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
- N. Encasement For Piping
  - 1. Standard: ASTM A 674 or AWWA C105.
  - 2. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) **OR** high-density, cross-laminated polyethylene film of 0.004-inch (0.10-mm), **as directed**, minimum thickness.
  - 3. Form: Sheet **OR** Tube, **as directed**.
  - 4. Color: Black **OR** Natural, **as directed**.
- O. Manholes
  - 1. Standard Precast Concrete Manholes:
    - a. Description: ASTM C 478 (ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
    - b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
    - c. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
    - d. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
    - e. Riser Sections: 4-inch (100-mm) minimum thickness, of length to provide depth indicated.
    - f. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
    - g. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
    - h. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
    - i. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
- j. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.  
**OR**  
Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
2. Designed Precast Concrete Manholes:
- a. Description: ASTM C 913; designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
  - b. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
  - c. Joint Sealant: ASTM C 990 (ASTM 990M), bitumen or butyl rubber.
  - d. Resilient Pipe Connectors: ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
  - e. Steps: Individual FRP steps or FRP ladder **OR** Individual FRP steps, FRP ladder, or ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP **OR** ASTM A 615/A 615M, deformed, 1/2-inch (13-mm) steel reinforcing rods encased in ASTM D 4101, PP, **as directed**; 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
  - f. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.  
**OR**  
Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
3. Fiberglass Manholes:
- a. Description: ASTM D 3753.
  - b. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.
  - c. Ballast: Increase thickness of concrete base as required to prevent flotation.
  - d. Base Section: Concrete, 6-inch (150-mm) minimum thickness.
  - e. Resilient Pipe Connectors (if required): ASTM C 923 (ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
  - f. 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 (300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches (1500 mm).
  - g. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.  
**OR**  
Grade Rings: Reinforced-concrete rings, 6- to 9-inch (150- to 225-mm) total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.
4. Manhole Frames and Covers:



- a. Description: Ferrous; 24-inch (610-mm) ID by 7- to 9-inch (175- to 225-mm) riser, with 4-inch- (100-mm-) minimum-width flange and 26-inch- (660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
    - b. Material: ASTM A 536, Grade 60-40-18 ductile **OR** ASTM A 48/A 48M, Class 35 gray, **as directed**, iron unless otherwise indicated.
  - 5. Manhole-Cover Inserts:
    - a. Description: Manufactured, plastic form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.
    - b. Type: Solid **OR** Drainage with vent holes **OR** Valve, **as directed**.
- P. Concrete
- 1. General: Cast-in-place concrete complying with ACI 318, ACI 350/350R (ACI 350M/350RM), and the following:
    - a. Cement: ASTM C 150, Type II.
    - b. Fine Aggregate: ASTM C 33, sand.
    - c. Coarse Aggregate: ASTM C 33, crushed gravel.
    - d. Water: Potable.
  - 2. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
    - a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
    - b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.
  - 3. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
    - a. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      - 1) Invert Slope: **1 OR 2, as directed**, percent through manhole.
    - b. Benches: Concrete, sloped to drain into channel.
      - 1) Slope: **4 OR 8, as directed**, percent.
  - 4. Ballast and Pipe Supports: Portland cement design mix, 3000 psi (20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
    - a. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
    - b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

### 1.3 EXECUTION

#### A. Earthwork

- 1. Excavating, trenching, and backfilling are specified in Division 02 Section "Earthwork".

#### B. Piping Installation

- 1. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer 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.
- 2. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.
- 3. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- 4. 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.



5. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
6. Install gravity-flow, nonpressure, drainage piping according to the following:
  - a. Install piping pitched down in direction of flow, at minimum slope of 1 **OR** 2, **as directed**, percent unless otherwise indicated.
  - b. Install piping NPS 6 (DN 150) 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.
  - c. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
  - d. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - e. Install hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - f. Install ductile-iron, gravity sewer piping according to ASTM A 746.
  - g. Install ABS sewer piping according to ASTM D 2321 and ASTM F 1668.
  - h. Install PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 1668.
  - i. Install PVC corrugated sewer piping according to ASTM D 2321 and ASTM F 1668.
  - j. Install PVC profile sewer piping according to ASTM D 2321 and ASTM F 1668.
  - k. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
  - l. Install PVC gravity sewer piping according to ASTM D 2321 and ASTM F 1668.
  - m. Install fiberglass sewer piping according to ASTM D 3839 and ASTM F 1668.
  - n. Install nonreinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
  - o. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."
7. Install force-main, pressure piping according to the following:
  - a. Install piping with restrained joints at tee fittings and at horizontal and vertical changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
  - b. Install piping with 36-inch (915-mm) **OR** 48-inch (1220-mm) **OR** 60-inch (1520-mm) **OR** 72-inch (1830-mm), **as directed**, minimum cover.
  - c. Install ductile-iron pressure piping according to AWWA C600 or AWWA M41.
  - d. Install ductile-iron special fittings according to AWWA C600.
  - e. Install PVC pressure piping according to AWWA M23 or to ASTM D 2774 and ASTM F 1668.
  - f. Install PVC water-service piping according to ASTM D 2774 and ASTM F 1668.
8. If required to provide protection for metal piping, install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
  - a. Hub-and-spigot, cast-iron soil pipe.
  - b. Hubless cast-iron soil pipe and fittings.
  - c. Ductile-iron pipe and fittings.
  - d. Expansion joints and deflection fittings.
9. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

#### C. Pipe Joint Construction

1. Join gravity-flow, nonpressure, drainage piping according to the following:
  - a. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - b. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.
  - c. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.





- d. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
  - e. Join ABS sewer piping according to ASTM D 2321 and ASTM D 2751 for elastomeric-seal joints.
  - f. Join PVC cellular-core sewer piping according to ASTM D 2321 and ASTM F 891 for solvent-cemented joints.
  - g. Join PVC corrugated sewer piping according to ASTM D 2321.
  - h. Join PVC profile sewer piping according to ASTM D 2321 for elastomeric-seal joints or ASTM F 794 for gasketed joints.
  - i. Join PVC Type PSM sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
  - j. Join PVC gravity sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
  - k. Join fiberglass sewer piping according to ASTM D 4161 for elastomeric-seal joints.
  - l. Join nonreinforced-concrete sewer piping according to ASTM C 14 (ASTM C 14M) and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
  - m. Join reinforced-concrete sewer piping according to ACPA's "Concrete Pipe Installation Manual" for rubber-gasket joints.
  - n. Join dissimilar pipe materials with nonpressure-type, flexible **OR** rigid, **as directed**, couplings.
2. Join force-main, pressure piping according to the following:
- a. Join ductile-iron pressure piping according to AWWA C600 or AWWA M41 for push-on joints.
  - b. Join ductile-iron special fittings according to AWWA C600 or AWWA M41 for push-on joints.
  - c. Join PVC pressure piping according to AWWA M23 for gasketed joints.
  - d. Join PVC water-service piping according to ASTM D 2855.
  - e. Join dissimilar pipe materials with pressure-type couplings.
3. 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.
- a. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
    - 1) Unshielded **OR** Shielded, **as directed**, flexible **OR** rigid, **as directed**, couplings for pipes of same or slightly different OD.
    - 2) Unshielded, increaser/reducer-pattern, flexible **OR** rigid, **as directed**, couplings for pipes with different OD.
    - 3) Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
  - b. Use pressure pipe couplings for force-main joints.
- D. Manhole Installation
- 1. General: Install manholes complete with appurtenances and accessories indicated.
  - 2. Install precast concrete manhole sections with sealants according to ASTM C 891.
  - 3. Install FRP manholes according to manufacturer's written instructions.
  - 4. Form continuous concrete channels and benches between inlets and outlet.
  - 5. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches (76 mm) above finished surface elsewhere unless otherwise indicated.
  - 6. Install manhole-cover inserts in frame and immediately below cover.
- E. Concrete Placement
- 1. Place cast-in-place concrete according to ACI 318.
- F. Backwater Valve Installation
- 1. Install horizontal-type backwater valves in piping manholes or pits.
  - 2. Install combination horizontal and manual gate valves in piping and in manholes.
  - 3. Install terminal-type backwater valves on end of piping and in manholes. Secure units to sidewalls.

**G. Cleanout Installation**

1. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
  - a. Use Light-Duty, top-loading classification cleanouts in earth **OR** unpaved foot-traffic, **as directed**, areas.
  - b. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
  - c. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
  - d. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.
2. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set with tops 1 inch (25 mm) above surrounding grade.
3. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

**H. Connections**

1. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 15 Section "Sanitary Waste And Vent Piping".
2. Connect force-main piping to building's sanitary force mains specified in Division 15 Section "Sanitary Waste And Vent Piping". Terminate piping where indicated.
3. Make connections to existing piping and underground manholes.
  - a. 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 (150-mm) overlap with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - b. Make branch connections from side into existing piping, NPS 4 to NPS 20 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).
  - c. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches (76 mm) of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches (150 mm) of concrete for minimum length of 12 inches (300 mm) to provide additional support of collar from connection to undisturbed ground.
    - 1) Use concrete that will attain a minimum 28-day compressive strength of 3000 psi (20.7 MPa) unless otherwise indicated.
    - 2) Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
  - d. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
4. Connect to grease **OR** oil **OR** sand, **as directed**, interceptors specified in Division 02 Section "Interceptors".

**I. Closing Abandoned Sanitary Sewer Systems**

1. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
  - a. Close open ends of piping with at least 8-inch- (203-mm-) thick, brick masonry bulkheads.
  - b. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
2. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
  - a. Remove manhole and close open ends of remaining piping.



- b. Remove top of manhole down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
  3. Backfill to grade according to Division 02 Section "Earthwork".

J. Identification

1. Materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes.
  - a. Use warning tape **OR** detectable warning tape, **as directed**, over ferrous piping.
  - b. Use detectable warning tape over nonferrous piping and over edges of underground manholes.

K. Field Quality Control

1. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches (600 mm) of backfill is in place, and again at completion of Project.
  - a. Submit separate report for each system inspection.
  - b. Defects requiring correction include the following:
    - 1) Alignment: Less than full diameter of inside of pipe is visible between structures.
    - 2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - 3) Damage: Crushed, broken, cracked, or otherwise damaged piping.
    - 4) Infiltration: Water leakage into piping.
    - 5) Exfiltration: Water leakage from or around piping.
  - c. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - d. Reinspect and repeat procedure until results are satisfactory.
2. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
  - a. Do not enclose, cover, or put into service before inspection and approval.
  - b. Test completed piping systems according to requirements of authorities having jurisdiction.
  - c. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  - d. Submit separate report for each test.
  - e. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
    - 1) Fill sewer piping with water. Test with pressure of at least 10-foot (3-m) head of water, and maintain such pressure without leakage for at least 15 minutes.
    - 2) Close openings in system and fill with water.
    - 3) Purge air and refill with water.
    - 4) Disconnect water supply.
    - 5) Test and inspect joints for leaks.

**OR**

Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

    - 6) Option: Test plastic gravity sewer piping according to ASTM F 1417.
    - 7) Option: Test concrete gravity sewer piping according to ASTM C 924 (ASTM C 924M).
  - f. Force Main: Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psig (1035 kPa).
    - 1) Ductile-Iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
    - 2) PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.
  - g. Manholes: Perform hydraulic test according to ASTM C 969 (ASTM C 969M).
3. Leaks and loss in test pressure constitute defects that must be repaired.



4. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

L. Cleaning

1. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 02511



## SECTION 02511a - SEPTIC TANK SYSTEMS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for septic tank systems. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes the following:
  - a. Septic tanks.
  - b. Distribution boxes.
  - c. Pipe and fittings.
  - d. Absorption systems

#### C. Submittals

1. Product Data: For each type of product indicated.
  - a. Include construction details, material descriptions, dimensions of individual components, and profiles.
  - b. Include manhole openings, covers, and pipe connections.
2. Shop Drawings: For [trench absorption systems] [bed absorption systems].
  - a. Include manhole openings, covers, pipe connections, and accessories.
  - b. Include piping with sizes and invert elevations.
  - c. Include underground structures.
  - d. Include other utilities.

### 1.2 PRODUCTS

#### A. Septic Tanks

1. Precast Concrete Septic Tanks: ASTM C 1227, single-chamber **OR** two-chamber, **as directed**, precast, reinforced-concrete tank with internal baffle, **as directed**, and covers.
  - a. Design: For A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed**, traffic loading according to ASTM C 890.
  - b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed**, minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings. Include manhole in center of each septic tank compartment top.
  - c. Filter Access: Reinforced-concrete access hole, large enough to remove filter, over filter position.
  - d. Inlet and Outlet Access: 12-inch- (300-mm-) minimum diameter, reinforced-concrete access lids with steel lift rings. Include access centered over inlet and outlet.
  - e. Resilient Connectors: ASTM C 923 (ASTM C 923M), of size required for piping, fitted into inlet and outlet openings.
2. Fiberglass Septic Tanks: UL 1316, single-chamber, FRP construction; fabricated for septic tank application with at least one access riser and manhole.
  - a. Manholes: 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed**, minimum diameter opening with FRP access risers to grade and cover.
  - b. Filter Access: Include access hole, large enough to remove filter, over filter position.
  - c. Resilient Connectors: ASTM C 923 (ASTM C 923M) or other watertight seal, of size required for piping, fitted into inlet and outlet openings.
3. Polyethylene Septic Tanks: Single-chamber, molded, HDPE or PE construction; fabricated for septic tank application, with baffle, **as directed**, and at least one access riser and manhole.



4. Polyethylene Septic Tanks: Two-chamber, molded, HDPE or PE construction; fabricated for septic tank application, with access risers and manholes.
    - a. Manholes: 18-inch- (457-mm-) **OR** 20-inch- (508-mm-) **OR** 22-inch- (559-mm-), **as directed**, minimum diameter opening with HDPE or PE access risers to grade and cover.
    - b. Filter Access: Include access hole, large enough to remove filter, over filter position.
    - c. Resilient Connectors: ASTM C 923 (ASTM C 923M) or other watertight seal, of size required for piping, fitted into inlet and outlet openings.
- B. Filters
1. Description: Removable, septic-tank-outlet filter that restricts discharge solids to 1/8 inch (3.2 mm).
    - a. Housing: HDPE or PVC.
    - b. Outlet Size: NPS 4 (DN 100) **OR** NPS 6 (DN 150), **as directed**.
- C. Dosing Tanks
1. Dosing Tanks: Comply with ASTM C 913 for precast, reinforced-concrete tank and cover; designed for structural loading according to ASTM C 890.
    - a. Design: For effluent pump, **OR** automatic siphon, **as directed**, installation and A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed**, traffic loading according to ASTM C 890.
    - b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed**, minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings. Include manhole in center of each septic tank compartment top.
    - c. Resilient Connectors: ASTM C 923 (ASTM C 923M), of size required for piping, fitted into inlet and outlet openings.
- D. Automatic Siphons
1. Description: Manufactured siphon assembly of molded-HDPE trap, pipe, and bell, with PVC vent piping and stainless-steel bolts.
- E. Distribution Boxes
1. Description: Precast concrete, single-chamber box and cover.
    - a. Design: Made according to ASTM C 913, and for A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed**, traffic loading according to ASTM C 890. Include baffle opposite inlet.
    - b. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed**, minimum diameter opening with reinforced-concrete risers to grade and cover with steel lift rings in center of distribution box cover.
    - c. Pipe Connections: ASTM C 923 (ASTM C 923M) resilient connectors, of size required for piping, fitted into inlet and outlet openings. Include watertight plugs in outlets not required.
  2. Description: Molded-HDPE or -PE, single-chamber box and cover.
    - a. Manholes: 18-inch- (457-mm-) **OR** 20-inch- (508-mm-) **OR** 22-inch- (559-mm-), **as directed**, minimum diameter opening with HDPE or PE access risers to grade and cover. Access for PE distribution boxes may be a removable plastic cover and is usually small.  
**OR**  
Manufacturer's standard cover or other access opening of size that permits access to distribution-box inlet and outlets.
    - b. Pipe Connections: With seal that prevents leakage. Include watertight plugs in outlets not required.
- F. Leaching Pipes And Fittings
1. Pipe: PE, complying with ASTM F 810, perforated.
    - a. Fittings: ASTM D 2729 PVC for loose joints; ASTM D 3034, PVC for gasketed joints; or ASTM D 2751, ABS for gasketed joints.



2. Tube and Fittings: PE, complying with ASTM F 405, perforated corrugated tube with solid-wall fittings.
    - a. Couplings: PE band, matching tube and fitting dimensions.
  3. Pipe and Fittings: PVC, complying with ASTM D 2729, perforated, for solvent-cement joints.
    - a. Solvent Cement: ASTM D 2564. Include primer according to ASTM F 656
  4. Drainage Tile: Clay drain tile, complying with ASTM C 4, Standard class, drain tile with regular and smooth ends, for open joints.
- G. Nonpressure-Type Pipe Couplings
1. Description: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - a. Sleeve Materials:
      - 1) For Concrete Pipes: ASTM C 443 (ASTM C 443M), rubber.
      - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      - 3) For Vitrified-Clay Pipes: ASTM C 425, rubber.
      - 4) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- H. Leaching Chambers
1. Description: Arched, molded-PE structures with solid top, perforated sides, open ends, and open bottom.
    - a. End Pieces: Solid and solid with pipe opening types.
    - b. Effluent Distribution Piping: PE or PVC pipe, with holes or slots along pipe, attached to underside of top of chambers.
- I. Trench **OR** Bed, **as directed**, Absorption-System Materials
1. Filtering Material: ASTM D 448, Size No. 24, 3/4 to 2-1/2 inches (19 to 63 mm), washed, crushed stone or gravel; or broken, hard-burned clay brick.
  2. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m) **OR** Untreated building paper or similar porous material, **as directed**.
  3. Cover for Distribution Pipe: Geotextile woven filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m).
  4. Fill Material: Soil removed from trench.
- J. Mound Absorption-System Materials
1. Sand Filtering Material: 25 percent or more of very coarse, coarse, or medium sand or combination; maximum of 50 percent fine or very fine sand or combination; and silt and clay combination not to exceed 25 percent. If clay exceeds 60 percent in combination with silt, mixture cannot exceed 15 percent of sand filtering material.
  2. Aggregate Filtering Material: Coarse, 1/2 to 2-1/2 inches (13 to 63 mm).
  3. Cap: Clay, silt, or combination of clay and silt.
  4. Topsoil: Good quality, free of stones, metal, and glass.
  5. Vegetation Cover: Grass compatible with adjacent ground cover. No shrubs or trees.
  6. Filter Mat: Geotextile woven or spun filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m) **OR** Untreated building paper or similar porous material, **as directed**.
  7. Cover for Distribution Pipe: Geotextile woven filter fabric, in 1 or more layers, for minimum total unit weight of 3 oz./sq. yd. (101 g/sq. m).
- K. Chamber Absorption-System Materials
1. Chamber: Arched, molded-PE structures with solid top, perforated sides, open ends, and open bottom.
  2. End Pieces: Blank without opening for distribution pipe at end of last chamber in row, and with opening for distribution pipe where pipe penetrates chamber.



3. Retain first paragraph below to run piping through chambers to improve distribution.
4. Effluent Distribution Piping: PE or PVC pipe, with holes or slots along pipe, attached to underside of top of chambers.

L. Seepage Pit Absorption-System Materials

1. Constructed-in-Place-Type Seepage Pit: Include the following materials.
  - a. Pit Lining: ASTM C 62, Type SW, clay bricks; ASTM C 55, concrete bricks; ASTM C 90, hollow, concrete masonry units; or precast concrete rings with notches or weep holes.
  - b. Filtering Material: ASTM D 448, Size No. 24, 3/4 to 2-1/2 inches (19 to 63 mm), washed, crushed stone or gravel; or broken, hard-burned clay brick.
  - c. Cover: Precast concrete slab; designed for A-8 (H10-44) **OR** A-12 (HS15-44) **OR** A-16 (HS20-44), **as directed**, traffic loading according to ASTM C 890 and made according to ASTM C 913. Include slab dimensions that will extend minimum of 12 inches (300 mm) beyond edge of excavation. Cast cover with opening for manhole in center.
  - d. Manholes: 20-inch- (508-mm-) **OR** 22-inch- (559-mm-) **OR** 24-inch- (610-mm-), **as directed**, minimum diameter opening with reinforced-concrete risers to grade and access lid with steel lift rings.

### 1.3 EXECUTION

A. Earthwork

1. Excavating, trenching, and backfilling for piping and seepage pits are specified in Division 02 Section "Earthwork".
  - a. Stockpile topsoil for reuse in finish grading without intermixing with other excavated material. Stockpile materials away from edge of excavation and do not store within drip line of remaining trees.
  - b. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
2. Excavating and Backfilling for Septic and Dosing Tanks:
  - a. Excavate sufficient width and length for tanks to depth determined by tank inlet elevation. Provide level bottom.
  - b. Backfill with excavated soil, mounding soil above original grade without compacting.
3. Excavating and Backfilling for Trench **OR** Bed, **as directed**, Absorption Fields:
  - a. Excavate for trench absorption fields 30 inches (760 mm) wide and 24 inches (600 mm) deep, minimum.
  - b. Backfill trench absorption fields with excavated soil, mounding soil above original grade without compacting.
  - c. Excavate for bed absorption fields of width indicated and 24 inches (600 mm) deep, minimum.
  - d. Backfill bed absorption fields with excavated soil, mounding soil above original grade without compacting.

B. Excavating and Backfilling for Chamber Absorption Systems:

1. Excavate for trench-type chamber absorption systems **30 inches (762 mm)** wide and **24 inches (610 mm)** deep, minimum.
2. Excavate for bed-type chamber absorption systems of width indicated and **24 inches (610 mm)** deep, minimum.
3. Backfill chamber absorption systems with excavated soil, mounding soil above original grade without compacting.

C. Excavating and Backfilling for Seepage-Pit Absorption Systems:

1. Excavate sufficient hole diameter for pits to depth determined by tank inlet and bottom elevations. Provide level bottom.
2. Backfill with excavated soil, mounding soil above original grade without compacting.





- D. Septic Tank Installation
1. Install precast concrete septic tanks level according to ASTM C 891.
  2. Install septic tanks level.
  3. Connect septic tank to concrete ballast pad.
  4. Install filter in septic tank outlet. Secure filter to septic tank wall. Make direct connections to distribution piping.
  5. Install insulation on exterior sides and top of septic tank.
  6. Fill septic tank with water.
- E. Dosing Tank Installation
1. Install dosing tanks level and according to ASTM C 891.
  2. Install automatic siphons embedded in precast concrete dosing tank. Make direct connections to distribution piping.
  3. Set submersible effluent pumps on dosing tank floor. Make direct connections to distribution piping.
  4. Fill dosing tanks with water.
- F. Distribution Box Installation
1. Install precast concrete distribution boxes according to ASTM C 891 and at invert elevations indicated. Set level and plumb.
  2. Install PE distribution boxes at invert elevations indicated and according to manufacturer's written instructions. Set level and plumb.
- G. Piping Installation
1. Install leaching piping according to the following:
    - a. Use perforated pipe and fittings for trench **OR** bed **OR** mound, **as directed**, absorption fields with perforations at bottom.
    - b. PE Tube and Fittings: ASTM F 481.
    - c. PVC Sewer Pipe and Fittings: ASTM F 481.
- H. Pipe Joint Construction
1. Basic piping joint construction is specified in Division 02 Section "Piped Utilities -basic Materials And Methods". Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
  2. Join distribution piping with or according to the following:
    - a. Install leaching pipe and fittings for trench **OR** bed **OR** mound, as directed, absorption fields with closed joints, unless otherwise indicated.
    - b. PE Tube and Fittings: With PE band couplings.
    - c. PVC Sewer Pipe and Fittings: With solvent-cemented joints according to ASTM F 402 and ASTM D 2321.
  3. Join dissimilar pipe materials according to ASTM D 5926, with couplings and gaskets compatible with pipe materials being joined.
- I. Cleanout Installation
1. Install cleanouts according to the following:
    - a. Inlet and Outlet of Septic Tanks: Cast-iron cleanouts.
    - b. Inlet and Outlet of Dosing Tanks: Cast-iron cleanouts.
    - c. Inlet and Outlet of Distribution Boxes: Cast-iron **OR** PVC cleanouts.
    - d. At Each Change in Direction of Sewer Piping: Cast-iron **OR** PVC cleanouts.
    - e. At Ends of Each Row and at Each Change in Direction of Distribution Piping: Cast-iron **OR** PVC cleanouts.
  2. Cast-Iron Cleanouts: Install with PVC fitting riser from distribution and leaching piping to cast-iron cleanout housing at grade. Use NPS 4 (DN 100) PVC sewer pipe and fittings with solvent-cemented joints for risers. Attach riser to cleanout housing with rubber gasket or coupling.



3. PVC Cleanouts: Install with PVC riser from distribution and leaching piping to PVC cleanout at grade. Use NPS 4 (DN 100) PVC sewer pipe and fittings with solvent-cemented joints for risers and cleanout fitting.
4. Cleanout Support: Set cleanouts in concrete blocks 18 by 18 by 12 inches (457 by 457 by 305 mm) deep, unless location is in concrete pavement. Formwork, reinforcement, and concrete are specified in Division 03 Section "Cast-in-place Concrete".
5. Set top of cleanout 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, above surrounding rough grade, or set flush with grade if installed in pavement.

J. Trench **OR** Bed **OR** Absorption-Field, **as directed**, Installation

1. Filtering Material: Place supporting layer of filtering material over the compacted trench **OR** bed, **as directed**, base to a compacted depth not less than 6 inches (150 mm) below bottom of pipe.
2. Refer to Part 1.3 "Piping Installation" and "Pipe Joint Construction" articles for specific piping material installation.
3. Install distribution piping at minimum slope of 1 percent and maximum slope of 2 percent.
4. Install leaching piping solidly bedded in filtering material, with full bearing for each pipe section throughout its length. Maintain pipe alignment with no slope.
  - a. Install perforated pipe with perforations down and joints tightly closed. Install collars and couplings as required.
  - b. Install open-joint pipe with 1/2-inch (13-mm) space, maximum, between ends, unless otherwise indicated. Cover top two-thirds of joint opening with joint cover, and tie with corrosion-resistant wire. Commercial joint-cover assemblies may be provided.
  - c. Install elbow fittings with tight joints.
  - d. Place additional filtering material around sides to a minimum compacted depth of 8 inches (200 mm) above the top of leaching piping.
5. Install filter mat over filter material before backfilling.
6. Install leaching chambers with no slope in bottom of trench **OR** bed, **as directed**.
  - a. Install leaching chamber distribution piping with tight joints throughout chambers.
7. Backfill according to Part 1.3 "Earthwork" Article.

K. Mound Absorption-Field Installation

1. Plow top 6 inches (150 mm) of surface.
2. Place layers of sand, aggregate, **as directed**, cap, and topsoil above plowed area. Provide grass topping to match adjacent vegetation. Provide side slope not steeper than 3:1. Tie slope toe smoothly into existing grade.
3. Refer to Part 1.3 "Piping Installation" and "Pipe Joint Construction" articles for specific piping material installation.
4. Provide solid vent pipe with vent cap extending 12 inches (300 mm) above top of mounds.
5. Install distribution piping with no slope for pressurized effluent system.
6. Install distribution piping at a minimum slope of 1 percent and a maximum slope of 2 percent for gravity effluent system.
7. Install leaching piping solidly bedded in filtering material, with full bearing for each pipe section throughout its length. Maintain pipe alignment with no slope.
  - a. Install perforated pipe with perforations down and joints tightly closed. Install collars and couplings as required.
  - b. Install open-joint pipe with 1/2-inch (13-mm) space, maximum, between ends, unless otherwise indicated. Cover top two-thirds of joint opening with joint cover, and tie with corrosion-resistant wire. Commercial joint-cover assemblies may be provided.
  - c. Install elbow fittings with tight joints.
8. Install leaching chambers with no slope above plowed area.
  - a. Install leaching chamber distribution piping with tight joints throughout chambers.
9. Provide adequate grading around mound absorption field to prevent storm runoff from washing away a portion of mound absorption field and to prevent exposing pipes.

L. Seepage Pit Installation



1. Excavate hole to minimum diameter of 6 inches (150 mm) greater than outside of pit lining.
2. Do not extend pit depth into ground-water table.
3. Install constructed-in-place seepage pits according to the following procedure if no requirements of authorities having jurisdiction apply:
  - a. Install brick pit lining material dry and laid flat with staggered joints for seepage.
  - b. Install block pit lining material dry with staggered joints and a minimum of 20 percent of blocks on side for seepage. Install precast concrete rings with notches or weep holes for seepage.
  - c. Extend pit lining material so top of manhole will be approximately 8 inches (200 mm) below finished grade.
  - d. Backfill bottom of inside of pit with filtering material at least 12 inches (300 mm) above bottom of lining material.
  - e. Extend effluent inlet pipe 12 inches (300 mm) into seepage pit and terminate into side of tee fitting.
  - f. Backfill around outside of pit lining with filtering material to top of lining.
  - g. Install manhole risers from top of pit to grade. Support cover on undisturbed soil. Do not support cover on pit lining.

M. Identification

1. Identification materials and their installation are specified in Division 02 Section "Earthwork". Arrange for installation of green warning tape directly over piping (including absorption-field piping), at outside edges of underground structures, and at outside edges of absorption fields.
2. Use detectable warning tape over piping, over edges of underground structures, and over edges of absorption fields.

N. Field Quality Control

1. System Tests: Perform testing of completed septic tank system piping and structures according to authorities having jurisdiction.
2. Additional Tests: Fill underground structures with water and let stand overnight. If water level recedes, locate and repair leaks and retest. Repeat tests and repairs until no leaks exist.

O. Cleaning

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

END OF SECTION 02511a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02511	01204	No Specification Required
02511	02242	Piped Utilities Basic Materials And Methods
02511	02213	Subdrainage
02511	02452	Storm Drainage
02512	02242	Piped Utilities Basic Materials And Methods
02512	02213	Subdrainage
02520	02242	Piped Utilities Basic Materials And Methods
02520	02452	Storm Drainage
02520	02242b	Sewage Treatment Lagoons



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## SECTION 02522 - SAND DRAINS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of sand drains. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

- A. Galvanized Perforated Corrugated Metal Pipe: AASHTO M36.
- B. Perforated Polyvinyl Chloride (PVC) Plastic Pipe: ASTM D 1784.
- C. Aggregate shall be sand, gravel, crushed rock, or chat that is clean, sound, and of a good quality. Gradation shall conform to the following table:

Retained on the 1-inch sieve	0%
Retained on the 3/8-inch sieve	0-15%
Retained on the No. 8 sieve	40-60%
Retained on the No. 30 sieve	70-95%
Retained on the No. 100 sieve	98-100%

### 1.3 EXECUTION

- A. Pipe Bedding: Aggregate shall be placed in uniform layers on level excavation.
- B. Perforated Pipe shall be installed with securely aligned joints to lines and grades, which will allow proper drainage.
- C. Perforated Pipe shall be embedded with a minimum coverage of two feet of aggregate or as directed.

END OF SECTION 02522



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02522	02242	Piped Utilities Basic Materials And Methods
02522	02452	Storm Drainage

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## SECTION 02525 - CULVERTS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for culverts. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

#### C. Delivery, Storage, And Handling

1. Delivery and Storage: Materials delivered to site shall be inspected for damage, unloaded, and stored with a minimum of handling. Materials shall not be stored directly on the ground. The inside of pipes and fittings shall be kept free of dirt and debris. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. The Contractor shall have a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the the Owner. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install plastic pipe shall be stored in accordance with the manufacturer's recommendations and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.
2. Handling: Materials shall be handled in a manner that ensures delivery to the trench in sound, undamaged condition. Pipe shall be carried to the trench, not dragged.

### 1.2 PRODUCTS

#### A. Pipe For Culverts

1. Pipe for culverts and storm drains shall be of the sizes indicated and shall conform to the requirements specified.
2. Concrete Pipe
  - a. ASTM C76/ASTM C76M, Class I **OR II OR III OR IV OR V, as directed**, or ASTM C655 D-Load. Note: D-load is defined as the minimum required three-edge test load on a pipe to produce a 0.01 inch crack and/or ultimate failure in pounds per linear foot per foot (no metric definition) of inside diameter.
  - b. Reinforced Arch Culvert and Storm Drainpipe: ASTM C506/ASTM C506M, Class A-II **OR A-III OR A-IV, as directed**.
  - c. Reinforced Elliptical Culvert and Storm Drainpipe: ASTM C507/ASTM C507M. Horizontal elliptical pipe shall be Class HE-A **OR HE-I OR HE-II OR HE-III OR HE-IV, as directed**. Vertical elliptical pipe shall be Class VE-II **OR VE-III OR VE-IV OR VE-V OR VE-VI, as directed**.
  - d. Nonreinforced Pipe: ASTM C14/ASTM C14M, Class 1 **OR 2 OR 3, as directed**.
    - 1) Cast-In-Place Nonreinforced Conduit: ACI 346, except that testing shall be the responsibility of and at the expense of the Contractor. In the case of other conflicts between ACI 346 and project specifications, requirements of ACI 346 shall govern.  
NOTE: This type conduit should not be used beneath structures, for drain crossings, adjacent to paved areas, or under high fills.
3. Clay Pipe: Standard or extra strength, as indicated, conforming to ASTM C700.  
NOTE: "Bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the stainless steel parts of the couplings used for plain-end piping.



4. Corrugated Steel Pipe
    - a. ASTM A760/A760M, zinc or aluminum (Type 2) coated pipe of either:
      - 1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
      - 2) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
    - b. Fully Bituminous Coated
      - 1) AASHTO M190 Type A and ASTM A760/A 760M zinc or aluminum (Type 2) coated pipe of either:
        - a) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
        - b) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
    - c. Half Bituminous Coated, Part Paved: AASHTO M190 Type B and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
    - d. Fully Bituminous Coated, Part Paved: AASHTO M190 Type C and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
    - e. Fully Bituminous Coated, Fully Paved: AASHTO M190 Type D and ASTM A760/A 760M zinc or aluminum (Type 2) coated Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
    - f. Concrete-Lined: ASTM A760/A760M zinc coated Type I corrugated steel pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations and a concrete lining in accordance with ASTM A849.
    - g. Polymer Precoated: ASTM A 762/A 762M corrugated steel pipe fabricated from ASTM A742/A742M Grade 250/250 10/10 polymer precoated sheet of either:
      - 1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
      - 2) Type IR **OR** IIR, **as directed**, pipe with helical 3/4 by 3/4 by 7-1/2 inch (19 by 19 by 190 mm) corrugations.
    - h. Polymer Precoated, Part Paved: ASTM A762/A762M Type I **OR** II, **as directed**, corrugated steel pipe and AASHTO M190 Type B (modified) paved invert only, fabricated from ASTM A742/A742M Grade 250/250 10/10 polymer precoated sheet with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
    - i. Polymer Precoated, Fully Paved: ASTM A762/A762M Type I **OR** II, **as directed**, corrugated steel pipe and AASHTO M190 Type D (modified), fully paved only, fabricated from ASTM A 742/A 742M Grade 250/250 10/10 polymer precoated sheet with annular **OR** helical, **as directed**, 2-2/3 by 1/2 inch (68 by 13 mm) corrugations.
  5. Corrugated Aluminum Alloy Pipe: ASTM B745/B745M corrugated aluminum alloy pipe of either:
    - 1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
    - 2) Type IA **OR** IR **OR** IIA **OR** IIR, **as directed**, pipe with helical corrugations.
  - b. Aluminum Fully Bituminous Coated: Bituminous coating shall conform to ASTM A849. Piping shall conform to AASHTO M190 Type A and ASTM B745/B745M corrugated aluminum alloy pipe of either:
    - 1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
    - 2) Type IA **OR** IR **OR** IIA **OR** IIR, **as directed**, pipe with helical corrugations.
  - c. Aluminum Fully Bituminous Coated, Part Paved: Bituminous coating shall conform to ASTM A849. Piping shall conform to AASHTO M190 Type C and ASTM B 745/B 745M corrugated aluminum alloy pipe of either:
    - 1) Type I **OR** II, **as directed**, pipe with annular **OR** helical, **as directed**, corrugations.
    - 2) Type IR **OR** IIR, **as directed**, pipe with helical corrugations.
6. Structural Plate, Steel Pipe, Pipe Arches and Arches



- a. Assembled with galvanized steel nuts and bolts, from galvanized corrugated steel plates conforming to AASHTO M167. Pipe coating, when required, shall conform to the requirements of AASHTO M190 Type A **OR** AASHTO M243, **as directed**.
- b. Thickness of plates shall be as indicated.
7. Structural Plate, Aluminum Pipe, Pipe Arches and Arches
  - a. Assembled with either aluminum alloy, aluminum coated steel, stainless steel or zinc coated steel nuts and bolts. Nuts and bolts, and aluminum alloy plates shall conform to AASHTO M219. Pipe coating, when required, shall conform to the requirements of AASHTO M190, Type A **OR** AASHTO M 243, **as directed**.
  - b. Thickness of plates shall be as indicated.
8. Ductile Iron Culvert Pipe: ASTM A716.
9. Cast-Iron Soil Piping: Cast-Iron Soil Pipe shall conform to ASTM A74, service-weight; gaskets shall be compression-type rubber conforming to ASTM C564.
10. PVC Pipe
  - a. The pipe manufacturer's resin certification, indicating the cell classification of PVC used to manufacture the pipe, shall be submitted prior to installation of the pipe.
  - b. Type PSM PVC Pipe: ASTM D3034, Type PSM, maximum SDR 35, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
  - c. Profile PVC Pipe: ASTM F794, Series 46, produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
  - d. Smooth Wall PVC Pipe: ASTM F679 produced from PVC certified by the compounder as meeting the requirements of ASTM D1784, minimum cell class 12454-B.
  - e. Corrugated PVC Pipe: ASTM F949 produced from PVC certified by the compounder as meeting the requirements of ASTM D 1784, minimum cell class 12454-B.
11. PE Pipe
  - a. The pipe manufacturer's resin certification indicating the cell classification of PE used to manufacture the pipe shall be submitted prior to installation of the pipe. The minimum cell classification for polyethylene plastic shall apply to each of the seven primary properties of the cell classification limits in accordance with ASTM D3350.
  - b. Smooth Wall PE Pipe: ASTM F714, maximum DR of 21 for pipes 3 to 24 inches (80 to 600 mm) in diameter and maximum DR of 26 for pipes 26 to 48 inches (650 to 1200 mm) in diameter. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.
  - c. Corrugated PE Pipe: AASHTO M294, Type S or D, for pipes 12 to 48 inches (300 to 1200 mm) and AASHTO MP 7, Type S or D, for pipes 54 to 60 inches (1350 to 1500 mm) produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class in accordance with AASHTO M294. Pipe walls shall have the following properties:

NOTE: Corrugated PE pipe culverts and storm drains shall not be installed beneath airfield pavements, Class A, B, or C roads, or road pavements with a design index of 6 or greater. Type S pipe has a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Type C pipe has a full circular cross-section, with a corrugated surface both inside and outside. Corrugations may be either annular or helical.

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Minimum Moment of Inertia of Wall Section (in to the 4th/in)
12	1.50	0.024
15	1.91	0.053
18	2.34	0.062
24	3.14	0.116
30	3.92	0.163
36	4.50	0.222
42	4.69	0.543



48	5.15	0.543
54	5.67	0.800
60	6.45	0.800
Nominal Size (mm)	Minimum Wall Area (square mm/m)	Minimum Moment of Inertia of Wall Section (mm to the 4th/mm)
300	3200	390
375	4000	870
450	4900	1020
600	6600	1900
750	8300	2670
900	9500	3640
1050	9900	8900
1200	10900	8900
1350	12000	13110
1500	13650	13110

- d. Profile Wall PE Pipe: ASTM F894, RSC 160, produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 334433C. Pipe walls shall have the following properties:

Nominal Size (in.)	Minimum Wall Area (square in/ft)	Cell Class 334433C	Cell Class 335434C
18	2.96	0.052	0.038
21	4.15	0.070	0.051
24	4.66	0.081	0.059
27	5.91	0.125	0.091
30	5.91	0.125	0.091
33	6.99	0.161	0.132
36	8.08	0.202	0.165
42	7.81	0.277	0.227
48	8.82	0.338	0.277

Nominal Size (mm)	Minimum Wall Area (square mm/m)	Cell Class 334433C	Cell Class 335434C
450	6300	850	620
525	8800	1150	840
600	9900	1330	970
675	12500	2050	1490
750	12500	2050	1490



825	14800	2640	2160
900	17100	3310	2700
1050	16500	4540	3720
1200	18700	5540	4540

B. Drainage Structures

1. Flared End Sections: Sections shall be of a standard design fabricated from zinc coated steel sheets meeting requirements of ASTM A929/A929M.
2. Precast Reinforced Concrete Box: Four-sided box section with open ends to be monolithically cast of reinforced concrete, smooth inside surfaces. Each box section shall be manufactured with chamfered inside corners. Design and manufacture shall conform to ASTM C890.
  - a. Design References: ACI 318.
    - 1) Boxes subjected to highway loadings shall conform to requirements of AASHTO M259 or M273, as applicable, and ASTM C789, C850, C1433, and PS62.
    - 2) Boxes subjected to aircraft loadings shall conform to requirements of FAA specifications.
    - 3) Boxes subjected to railway loadings shall conform to requirements of AREMA specifications.
  - b. Concrete: 5,000 psi @ 30 days, unless otherwise directed.
  - c. Entrained Air: 5 to 9 percent.
  - d. Steel Reinforcing: ASTM A185, A615, A616, Grade 60, 60 ksi.
  - e. Design Loading: AASHTO HS-20-44 or HS-25-44 with 30 percent impact and equivalent soil pressure of 130 psf. Floatation forces not accounted for.
  - f. Joints: Each section shall have a male and female end with no less than 1-1/2-inch of concrete overlap and shall include a 1-inch square neoprene gasket, cemented to male surface of section during manufacture.
  - g. End Sections: As required for the individual installation, provide:
    - 1) Doweled end for 1-inch diameter x 12-inch deep steel dowels, keyway slot.
    - 2) Keyway slot, a shear connection between the precast and field cast sections.
    - 3) Plain end, for use where wing and end walls act independently of precast box.
  - h. Lifting Pins: Each section shall be equipped with 4 OSHA approved lifting pins.
  - i. For multi-cell installations, fill 1-inch spacing between cells with granular material to assume proper load distribution.
3. Three-Sided Structures for Culverts or Short Span Bridge System
  - a. Structures shall conform to requirements of ASTM C1504 and ACI 318. For structures subjected to roadway loadings, conform to requirements of AASHTO specifications.

C. Miscellaneous Materials

1. Concrete
  - a. Unless otherwise specified, concrete and reinforced concrete shall conform to the requirements concrete under Division 03 Section "Cast-in-place Concrete". The concrete mixture shall have air content by volume of concrete, based on measurements made immediately after discharge from the mixer, of 5 to 7 percent when maximum size of coarse aggregate exceeds 1-1/2 inches (37.5 mm).
  - b. Air content shall be determined in accordance with ASTM C231. The concrete covering over steel reinforcing shall not be less than 1 inch (25 mm) thick for covers and not less than 1-1/2 inches (40 mm) thick for walls and flooring. Concrete covering deposited directly against the ground shall have a thickness of at least 3 inches (75 mm) between steel and ground.
  - c. Expansion-joint filler material shall conform to ASTM D1751, or ASTM D1752, or shall be resin-impregnated fiberboard conforming to the physical requirements of ASTM D1752.
2. Mortar: Mortar for pipe joints, connections to other drainage structures, and brick or block construction shall conform to ASTM C270, Type M, except that the maximum placement time shall be 1 hour. The quantity of water in the mixture shall be sufficient to produce a stiff workable mortar. Water shall be clean and free of harmful acids, alkalies, and organic impurities. The mortar shall be used within 30 minutes after the ingredients are mixed with water. The inside of



- the joint shall be wiped clean and finished smooth. The mortar head on the outside shall be protected from air and sun with a proper covering until satisfactorily cured.
3. Precast Concrete Segmental Blocks: Precast concrete segmental block shall conform to ASTM C139, not more than 8 inches (200 mm) thick, not less than 8 inches (200 mm) long, and of such shape that joints can be sealed effectively and bonded with cement mortar.
  4. Brick
    - a. Brick shall conform to ASTM C62, Grade SW; ASTM C55, Grade S-I or S-II; or ASTM C32, Grade MS. Mortar for jointing and plastering shall consist of one part portland cement and two parts fine sand. Lime may be added to the mortar in a quantity not more than 25 percent of the volume of cement.
    - b. The joints shall be filled completely and shall be smooth and free from surplus mortar on the inside of the structure. Brick structures shall be plastered with 1/2 inch (10 mm) of mortar over the entire outside surface of the walls. For square or rectangular structures, brick shall be laid in stretcher courses with a header course every sixth course. For round structures, brick shall be laid radially with every sixth course a stretcher course.
  5. Precast Reinforced Concrete Manholes
    - a. Precast reinforced concrete manholes shall conform to ASTM C478/ASTM C478M.
    - b. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall be smoothed to a uniform surface on both interior and exterior of the structure **OR** made with flexible watertight, rubber-type gaskets meeting the requirements of paragraph JOINTS, **as directed**.
  6. Prefabricated Corrugated Metal Manholes
    - a. Manholes shall be of the type and design recommended by the manufacturer.
    - b. Manholes shall be complete with frames and cover, or frames and gratings.
  7. Frame and Cover for Gratings
    - a. Frame and cover for gratings shall be cast gray iron, ASTM A48/A48M,
    - b. Class 35B; cast ductile iron, ASTM A536, Grade 65-45-12; or cast aluminum, ASTM B26M/B26, Alloy 356.OT6. Weight, shape, size, and waterway openings for grates and curb inlets shall be as indicated on the plans.
  8. Joints
    - a. Flexible Watertight Joints
      - 1) Materials: Flexible watertight joints shall be made with plastic or rubber-type gaskets for concrete pipe and with factory-fabricated resilient materials for clay pipe. The design of joints and the physical requirements for plastic gaskets shall conform to AASHTO M198, and rubber-type gaskets shall conform to ASTM C443/ASTM C443M. Factory-fabricated resilient joint materials shall conform to ASTM C425. Gaskets shall have not more than one factory-fabricated splice, except that two factory-fabricated splices of the rubber-type gasket are permitted if the nominal diameter of the pipe being gasketed exceeds 54 inches (1.35 m).
      - 2) Test Requirements: Watertight joints shall be tested and shall meet test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS. Rubber gaskets shall comply with the oil resistant gasket requirements of ASTM C443/ASTM C443M. Certified copies of test results shall be delivered to the the Owner before gaskets or jointing materials are installed. Alternate types of watertight joint may be furnished, if specifically approved.
    - b. External Sealing Bands: Requirements for external sealing bands shall conform to ASTM C877/ASTM C877M.
    - c. Flexible Watertight, Gasketed Joints
      - 1) Gaskets: When infiltration or exfiltration is a concern for pipe lines, the couplings may be required to have gaskets. The closed-cell expanded rubber gaskets shall be a continuous band approximately 7 inches (178 mm) wide and approximately 3/8 inch (10 mm) thick, meeting the requirements of ASTM D1056, Type 2 A1 **OR** B3, **as directed**, and shall have a quality retention rating of not less than 70 percent when tested for weather resistance by ozone chamber exposure, Method B of ASTM D1171. Rubber O-ring gaskets shall be 13/16 inch (21 mm) in diameter for pipe





diameters of 36 inches (914 mm) or smaller and 7/8 inch (22 mm) in diameter for larger pipe having 1/2 inch (13 mm) deep end corrugation. Rubber O-ring gaskets shall be 1-3/8 inches (35 mm) in diameter for pipe having 1 inch (25 mm) deep end corrugations. O-rings shall meet the requirements of AASHTO M198 or ASTM C443/ASTM C443M. Flexible plastic gaskets shall conform to requirements of AASHTO M198, Type B.

- 2) Connecting Bands: Connecting bands shall be of the type, size and sheet thickness of band, and the size of angles, bolts, rods and lugs as indicated or where not indicated as specified in the applicable standards or specifications for the pipe. Exterior rivet heads in the longitudinal seam under the connecting band shall be countersunk or the rivets shall be omitted and the seam welded. Watertight joints shall be tested and shall meet the test requirements of paragraph HYDROSTATIC TEST ON WATERTIGHT JOINTS.

- d. PVC Plastic Pipes: Joints shall be solvent cement or elastomeric gasket type in accordance with the specification for the pipe and as recommended by the pipe manufacturer.
- e. Smooth Wall PE Plastic Pipe: Pipe shall be joined using butt fusion method as recommended by the pipe manufacturer.
- f. Corrugated PE Plastic Pipe: Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to the requirements in AASHTO HB-17, Division II, Section 26.4.2.4.(e) for soil tightness and shall be as recommended by the pipe manufacturer.
- g. Profile Wall PE Plastic Pipe: Joints shall be gasketed or thermal weld type with integral bell in accordance with ASTM F894.
- h. Ductile Iron Pipe: Couplings and fittings shall be as recommended by the pipe manufacturer.

D. Steel Ladder

1. Steel ladder shall be provided where the depth of the manhole exceeds 12 feet (3.66 m). These ladders shall be not less than 16 inches (406 mm) in width, with 3/4 inch (19 mm) diameter rungs spaced 12 inches (305 mm) apart. The two stringers shall be a minimum 3/8 inch (10 mm) thick and 2-1/2 inches (63 mm) wide. Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

E. Resilient Connectors

1. Flexible, watertight connectors used for connecting pipe to manholes and inlets shall conform to ASTM C923/ASTM C923M.

F. Hydrostatic Test On Watertight Joints

1. Concrete, Clay, PVC and PE Pipe: A hydrostatic test shall be made on the watertight joint types as proposed. Only one sample joint of each type needs testing; however, if the sample joint fails because of faulty design or workmanship, an additional sample joint may be tested. During the test period, gaskets or other jointing material shall be protected from extreme temperatures which might adversely affect the performance of such materials. Performance requirements for joints in reinforced and nonreinforced concrete pipe shall conform to AASHTO M198 or ASTM C443M ASTM C443. Test requirements for joints in clay pipe shall conform to ASTM C425. Test requirements for joints in PVC and PE plastic pipe shall conform to ASTM D3212.
2. Corrugated Steel and Aluminum Pipe: A hydrostatic test shall be made on the watertight joint system or coupling band type proposed. The moment strength required of the joint is expressed as 15 percent of the calculated moment capacity of the pipe on a transverse section remote from the joint by the AASHTO HB-17 (Division II, Section 26). The pipe shall be supported for the hydrostatic test with the joint located at the point which develops 15 percent of the moment capacity of the pipe based on the allowable span in meters feet for the pipe flowing full or 40,000 foot-pounds (54,233 Newton meters), whichever is less. Performance requirements shall be met



at an internal hydrostatic pressure of 10 psi (69 kPa) for a 10 minute period for both annular corrugated metal pipe and helical corrugated metal pipe with factory reformed ends.

G. Erosion Control Riprap

1. Provide nonerodible rock not exceeding 15 inches (375 mm) in its greatest dimension and choked with sufficient small rocks to provide a dense mass with a minimum thickness of 8 inches (200 mm) or as indicated.

1.3 EXECUTION

A. Excavation for Pipe Culverts and Drainage Structures

1. Excavation of trenches, and for appurtenances and backfilling for culverts and storm drains, shall be in accordance with the applicable portions of Division 02 Section "Earthwork" and the requirements specified below.
2. Trenching: The width of trenches at any point below the top of the pipe shall be not greater than the outside diameter of the pipe plus 12-inches (300 mm) each side of pipe to permit satisfactory jointing and thorough tamping of the bedding material under and around the pipe. Sheet piling and bracing, where required, shall be placed within the trench width as specified. Contractor shall not overexcavate. Where trench widths are exceeded, redesign with a resultant increase in cost of stronger pipe or special installation procedures will be necessary. Cost of this redesign and increased cost of pipe or installation shall be borne by the Contractor without additional cost to the Owner.
3. Removal of Rock: Rock in either ledge or boulder formation shall be replaced with suitable materials to provide a compacted earth cushion having a thickness between unremoved rock and the pipe of at least 8 inches (200 mm) or 1/2 inch (13 mm) for each meter foot of fill over the top of the pipe, whichever is greater, but not more than three-fourths the nominal diameter of the pipe. Where bell-and-spigot pipe is used, the cushion shall be maintained under the bell as well as under the straight portion of the pipe. Rock excavation shall be as specified and defined in Division 02 Section "Earthwork".
4. Removal of Unstable Material: Where wet or otherwise unstable soil incapable of properly supporting the pipe, as determined by the the Owner, is unexpectedly encountered in the bottom of a trench, such material shall be removed to the depth required and replaced to the proper grade with select granular material, compacted as provided in paragraph BACKFILLING. When removal of unstable material is due to the fault or neglect of the Contractor while performing shoring and sheet piling, water removal, or other specified requirements, such removal and replacement shall be performed at no additional cost to the Owner.

B. Bedding

1. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.
2. Concrete Pipe Requirements: When no bedding class is specified or detailed on the drawings, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform to the lowest one-fourth of the outside portion of circular pipe or to the lower curved portion of pipe arch for the entire length of the pipe or pipe arch. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall be not more than the length, depth, and width required for properly making the particular type of joint.
3. Clay Pipe Requirements: Bedding for clay pipe shall be as specified by ASTM C12.
4. Corrugated Metal Pipe: Bedding for corrugated metal pipe and pipe arch shall be in accordance with ASTM A798/A798M. It is not required to shape the bedding to the pipe geometry. However, for pipe arches, the Contractor shall either shape the bedding to the relatively flat bottom arc or fine grade the foundation to a shallow v-shape. Bedding for corrugated structural plate pipe shall meet requirements of ASTM A807/A807M.
5. Ductile Iron and Cast-Iron Pipe: Bedding for ductile iron and cast-iron pipe shall be as shown on the drawings.



6. Plastic Pipe: Bedding for PVC and PE pipe shall meet the requirements of ASTM D2321. Bedding, haunching, and initial backfill shall be either Class IB or II material.

C. Placing Pipe

1. Each pipe shall be thoroughly examined before being laid; defective or damaged pipe shall not be used. Plastic pipe shall be protected from exposure to direct sunlight prior to laying, if necessary to maintain adequate pipe stiffness and meet installation deflection requirements. Pipelines shall be laid to the grades and alignment indicated. Proper facilities shall be provided for lowering sections of pipe into trenches. Lifting lugs in vertically elongated metal pipe shall be placed in the same vertical plane as the major axis of the pipe. Pipe shall not be laid in water, and pipe shall not be laid when trench conditions or weather are unsuitable for such work. Diversion of drainage or dewatering of trenches during construction shall be provided as necessary. Deflection of installed flexible pipe shall not exceed the following limits:

TYPE OF PIPE	MAXIMUM ALLOWABLE DEFLECTION (%)
Corrugated Steel and Aluminum Alloy	5
Concrete-Lined Corrugated Steel	3
Ductile Iron Culvert	3
Plastic	7.5

Not less than 30 days after the completion of backfilling, the Owner may perform a deflection test on the entire length of installed flexible pipe using a mandrel or other suitable device. Installed flexible pipe showing deflections greater than those indicated above shall be retested by a run from the opposite direction. If the retest also fails, the suspect pipe shall be replaced.

2. Concrete, Clay, PVC, Ribbed PVC, Ductile Iron and Cast-Iron Pipe: Laying shall proceed upgrade with spigot ends of bell-and-spigot pipe and tongue ends of tongue-and-groove pipe pointing in the direction of the flow.
3. Elliptical and Elliptical Reinforced Concrete Pipe: The manufacturer's reference lines, designating the top of the pipe, shall be within 5 degrees of a vertical plane through the longitudinal axis of the pipe, during placement. Damage to or misalignment of the pipe shall be prevented in all backfilling operations.
4. Corrugated PE Pipe: Laying shall be with the separate sections joined firmly on a bed shaped to line and grade and shall follow manufacturer's recommendations.
5. Corrugated Metal Pipe and Pipe Arch: Laying shall be with the separate sections joined firmly together, with the outside laps of circumferential joints pointing upstream, and with longitudinal laps on the sides. Part paved pipe shall be installed so that the centerline of bituminous pavement in the pipe, indicated by suitable markings on the top at each end of the pipe sections, coincides with the specified alignment of pipe. Fully paved steel pipe or pipe arch shall have a painted or otherwise applied label inside the pipe or pipe arch indicating sheet thickness of pipe or pipe arch. Any unprotected metal in the joints shall be coated with bituminous material as specified in AASHTO M190 or AASHTO M243. Interior coating shall be protected against damage from insertion or removal of struts or tie wires. Lifting lugs shall be used to facilitate moving pipe without damage to exterior or interior coatings. During transportation and installation, pipe or pipe arch and coupling bands shall be handled with care to preclude damage to the coating, paving or lining. Damaged coatings, pavings and linings shall be repaired in accordance with the manufacturer's recommendations prior to placing backfill. Pipe on which coating, paving or lining has been damaged to such an extent that satisfactory field repairs cannot be made shall be removed and replaced. Vertical elongation, where indicated, shall be accomplished by factory elongation. Suitable markings or properly placed lifting lugs shall be provided to ensure placement of factory elongated pipe in a vertical plane.
6. Structural-Plate Steel: Structural plate shall be installed in accordance with ASTM A807/A807M. Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are tightened to meet the torque requirements of 200 foot-pounds (270 Newton meters) plus or minus 50 foot-pounds (68 Newton meters). Any power wrenches used shall be checked by the use of hand torque



wrenches or long-handled socket or structural wrenches for amount of torque produced. Power wrenches shall be checked and adjusted frequently as needed, according to type or condition, to ensure proper adjustment to supply the required torque.

7. **Structural-Plate Aluminum:** Structural plate shall be assembled in accordance with instructions furnished by the manufacturer. Instructions shall show the position of each plate and the order of assembly. Bolts shall be tightened progressively and uniformly, starting at one end of the structure after all plates are in place. The operation shall be repeated to ensure that all bolts are torqued to a minimum of 100 foot-pounds (136 Newton meters) on aluminum alloy bolts and a minimum of 150 foot-pounds (203 Newton meters) on galvanized steel bolts. Any power wrenches used shall be checked by the use of hand torque wrenches or long-handled socket or structural wrenches for the amount of torque produced. Power wrenches shall be checked and adjusted as frequently as needed, according to type or condition, to ensure that they are in proper adjustment to supply the required torque.
8. **Multiple Culverts:** Where multiple lines of pipe are installed, adjacent sides of pipe shall be at least half the nominal pipe diameter or 1 meter 3 feet apart, whichever is less.
9. **Jacking Pipe Through Fills:** Methods of operation and installation for jacking pipe through fills shall conform to requirements specified in Volume 1, Chapter 1, Part 4 of AREMA Manual.

#### D. Jointing

##### 1. Concrete and Clay Pipe

- a. **Cement-Mortar Bell-and-Spigot Joint:** The first pipe shall be bedded to the established gradeline, with the bell end placed upstream. The interior surface of the bell shall be thoroughly cleaned with a wet brush and the lower portion of the bell filled with mortar as required to bring inner surfaces of abutting pipes flush and even. The spigot end of each subsequent pipe shall be cleaned with a wet brush and uniformly matched into a bell so that sections are closely fitted. After each section is laid, the remainder of the joint shall be filled with mortar, and a bead shall be formed around the outside of the joint with sufficient additional mortar. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint shall be wrapped or bandaged with cheesecloth to hold mortar in place.
- b. **Cement-Mortar Oakum Joint for Bell-and-Spigot Pipe:** A closely twisted gasket shall be made of jute or oakum of the diameter required to support the spigot end of the pipe at the proper grade and to make the joint concentric. Joint packing shall be in one piece of sufficient length to pass around the pipe and lap at top. This gasket shall be thoroughly saturated with neat cement grout. The bell of the pipe shall be thoroughly cleaned with a wet brush, and the gasket shall be laid in the bell for the lower third of the circumference and covered with mortar. The spigot of the pipe shall be thoroughly cleaned with a wet brush, inserted in the bell, and carefully driven home. A small amount of mortar shall be inserted in the annular space for the upper two-thirds of the circumference. The gasket shall be lapped at the top of the pipe and driven home in the annular space with a caulking tool. The remainder of the annular space shall be filled completely with mortar and beveled at an angle of approximately 45 degrees with the outside of the bell. If mortar is not sufficiently stiff to prevent appreciable slump before setting, the outside of the joint thus made shall be wrapped with cheesecloth. Placing of this type of joint shall be kept at least five joints behind laying operations.
- c. **Cement-Mortar Diaper Joint for Bell-and-Spigot Pipe:** The pipe shall be centered so that the annular space is uniform. The annular space shall be caulked with jute or oakum. Before caulking, the inside of the bell and the outside of the spigot shall be cleaned.
  - 1) **Diaper Bands:** Diaper bands shall consist of heavy cloth fabric to hold grout in place at joints and shall be cut in lengths that extend one-eighth of the circumference of pipe above the spring line on one side of the pipe and up to the spring line on the other side of the pipe. Longitudinal edges of fabric bands shall be rolled and stitched around two pieces of wire. Width of fabric bands shall be such that after fabric has been securely stitched around both edges on wires, the wires will be uniformly spaced not less than 200 mm 8 inches apart. Wires shall be cut into



- lengths to pass around pipe with sufficient extra length for the ends to be twisted at top of pipe to hold the band securely in place; bands shall be accurately centered around lower portion of joint.
- 2) Grout: Grout shall be poured between band and pipe from the high side of band only, until grout rises to the top of band at the spring line of pipe, or as nearly so as possible, on the opposite side of pipe, to ensure a thorough sealing of joint around the portion of pipe covered by the band. Silt, slush, water, or polluted mortar grout forced up on the lower side shall be forced out by pouring, and removed.
  - 3) Remainder of Joint: The remaining unfilled upper portion of the joint shall be filled with mortar and a bead formed around the outside of this upper portion of the joint with a sufficient amount of additional mortar. The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind actual laying of pipe. No backfilling around joints shall be done until joints have been fully inspected and approved.
- d. Cement-Mortar Tongue-and-Groove Joint: The first pipe shall be bedded carefully to the established gradeline with the groove upstream. A shallow excavation shall be made underneath the pipe at the joint and filled with mortar to provide a bed for the pipe. The grooved end of the first pipe shall be thoroughly cleaned with a wet brush, and a layer of soft mortar applied to the lower half of the groove. The tongue of the second pipe shall be cleaned with a wet brush; while in horizontal position, a layer of soft mortar shall be applied to the upper half of the tongue. The tongue end of the second pipe shall be inserted in the grooved end of the first pipe until mortar is squeezed out on interior and exterior surfaces. Sufficient mortar shall be used to fill the joint completely and to form a bead on the outside.
  - e. Cement-Mortar Diaper Joint for Tongue-and-Groove Pipe: The joint shall be of the type described for cement-mortar tongue-and-groove joint in this paragraph, except that the shallow excavation directly beneath the joint shall not be filled with mortar until after a gauze or cheesecloth band dipped in cement mortar has been wrapped around the outside of the joint. The cement-mortar bead at the joint shall be at least 1/2 inch (15 mm), thick and the width of the diaper band shall be at least 8 inches (200 mm). The diaper shall be left in place. Placing of this type of joint shall be kept at least five joints behind the actual laying of the pipe. Backfilling around the joints shall not be done until the joints have been fully inspected and approved.
  - f. Plastic Sealing Compound Joints for Tongue-and-Grooved Pipe: Sealing compounds shall follow the recommendation of the particular manufacturer in regard to special installation requirements. Surfaces to receive lubricants, primers, or adhesives shall be dry and clean. Sealing compounds shall be affixed to the pipe not more than 3 hours prior to installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Sealing compounds shall be inspected before installation of the pipe, and any loose or improperly affixed sealing compound shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pulled together. If, while making the joint with mastic-type sealant, a slight protrusion of the material is not visible along the entire inner and outer circumference of the joint when the joint is pulled up, the pipe shall be removed and the joint remade. After the joint is made, all inner protrusions shall be cut off flush with the inner surface of the pipe. If nonmastic-type sealant material is used, the "Squeeze-Out" requirement above will be waived.
  - g. Flexible Watertight Joints: Gaskets and jointing materials shall be as recommended by the particular manufacturer in regard to use of lubricants, cements, adhesives, and other special installation requirements. Surfaces to receive lubricants, cements, or adhesives shall be clean and dry. Gaskets and jointing materials shall be affixed to the pipe not more than 24 hours prior to the installation of the pipe, and shall be protected from the sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials shall be inspected before installing the pipe; any loose or improperly affixed gaskets and jointing materials shall be removed and replaced. The pipe shall be aligned with the previously installed pipe, and the joint pushed home. If, while the joint is being made the gasket becomes visibly dislocated the pipe shall be removed and the joint remade.



- h. External Sealing Band Joint for Noncircular Pipe: Surfaces to receive sealing bands shall be dry and clean. Bands shall be installed in accordance with manufacturer's recommendations.
- 2. Corrugated Metal Pipe
  - a. Field Joints: Transverse field joints shall be designed so that the successive connection of pipe sections will form a continuous line free of appreciable irregularities in the flow line. In addition, the joints shall meet the general performance requirements described in ASTM A798/A798M. Suitable transverse field joints which satisfy the requirements for one or more of the joint performance categories can be obtained with the following types of connecting bands furnished with suitable band-end fastening devices: corrugated bands, bands with projections, flat bands, and bands of special design that engage factory reformed ends of corrugated pipe. The space between the pipe and connecting bands shall be kept free from dirt and grit so that corrugations fit snugly. The connecting band, while being tightened, shall be tapped with a soft-head mallet of wood, rubber or plastic, to take up slack and ensure a tight joint. The annular space between abutting sections of part paved, and fully paved pipe and pipe arch, in sizes 30 inches (750 mm) or larger, shall be filled with a bituminous material after jointing. Field joints for each type of corrugated metal pipe shall maintain pipe alignment during construction and prevent infiltration of fill material during the life of the installations. The type, size, and sheet thickness of the band and the size of angles or lugs and bolts shall be as indicated or where not indicated, shall be as specified in the applicable standards or specifications for the pipe.
  - b. Flexible Watertight, Gasketed Joints: Installation shall be as recommended by the gasket manufacturer for use of lubricants and cements and other special installation requirements. The gasket shall be placed over one end of a section of pipe for half the width of the gasket. The other half shall be doubled over the end of the same pipe. When the adjoining section of pipe is in place, the doubled-over half of the gasket shall then be rolled over the adjoining section. Any unevenness in overlap shall be corrected so that the gasket covers the end of pipe sections equally. Connecting bands shall be centered over adjoining sections of pipe, and rods or bolts placed in position and nuts tightened. Band Tightening: The band shall be tightened evenly, even tension being kept on the rods or bolts, and the gasket; the gasket shall seat properly in the corrugations. Watertight joints shall remain uncovered for a period of time designated, and before being covered, tightness of the nuts shall be measured with a torque wrench. If the nut has tended to loosen its grip on the bolts or rods, the nut shall be retightened with a torque wrench and remain uncovered until a tight, permanent joint is assured.

E. Concrete Placement

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

F. Drainage Structures

- 1. Manholes and Inlets: Construction shall be of reinforced concrete, plain concrete, brick, precast reinforced concrete, precast concrete segmental blocks, prefabricated corrugated metal, or bituminous coated corrugated metal; complete with frames and covers or gratings; and with fixed galvanized steel ladders where indicated. Pipe studs and junction chambers of prefabricated corrugated metal manholes shall be fully bituminous-coated and paved when the connecting branch lines are so treated. Pipe connections to concrete manholes and inlets shall be made with flexible, watertight connectors.
- 2. Walls and Headwalls: Construction shall be as indicated.

G. Steel Ladder Installation

- 1. Ladder shall be adequately anchored to the wall by means of steel inserts spaced not more than 6 feet (1.83 m) vertically, and shall be installed to provide at least 6 inches (152 mm) of space between the wall and the rungs. The wall along the line of the ladder shall be vertical for its entire length.



#### H. Backfilling

1. **Backfilling Pipe in Trenches:** After the pipe has been properly bedded, selected material from excavation or borrow, at a moisture content that will facilitate compaction, shall be placed along both sides of pipe in layers not exceeding 6 inches (150 mm) in compacted depth. The backfill shall be brought up evenly on both sides of pipe for the full length of pipe. The fill shall be thoroughly compacted under the haunches of the pipe. Each layer shall be thoroughly compacted with mechanical tampers or rammers. This method of filling and compacting shall continue until the fill has reached an elevation of at least 12 inches (300 mm) above the top of the pipe. The remainder of the trench shall be backfilled and compacted by spreading and rolling or compacted by mechanical rammers or tampers in layers not exceeding 8 inches (200 mm). Tests for density shall be made as necessary to ensure conformance to the compaction requirements specified below. Where it is necessary, in the opinion of the the Owner, that sheeting or portions of bracing used be left in place, the contract will be adjusted accordingly. Untreated sheeting shall not be left in place beneath structures or pavements.
2. **Backfilling Pipe in Fill Sections:** For pipe placed in fill sections, backfill material and the placement and compaction procedures shall be as specified below. The fill material shall be uniformly spread in layers longitudinally on both sides of the pipe, not exceeding 6 inches (150 mm) in compacted depth, and shall be compacted by rolling parallel with pipe or by mechanical tamping or ramming. Prior to commencing normal filling operations, the crown width of the fill at a height of 12 inches (300 mm) above the top of the pipe shall extend a distance of not less than twice the outside pipe diameter on each side of the pipe or 12 feet (4 m), whichever is less. After the backfill has reached at least 12 inches (300 mm) above the top of the pipe, the remainder of the fill shall be placed and thoroughly compacted in layers not exceeding 8 inches (200 mm).
3. **Movement of Construction Machinery:** When compacting by rolling or operating heavy equipment parallel with the pipe, displacement of or injury to the pipe shall be avoided. Movement of construction machinery over a culvert or storm drain at any stage of construction shall be at the Contractor's risk. Any damaged pipe shall be repaired or replaced.
4. **Compaction**
  - a. **General Requirements:** Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands. Cohesive materials include clayey and silty gravels, gravel-silt mixtures, clayey and silty sands, sand-clay mixtures, clays, silts, and very fine sands. When results of compaction tests for moisture-density relations are recorded on graphs, cohesionless soils will show straight lines or reverse-shaped moisture-density curves, and cohesive soils will show normal moisture-density curves.
  - b. **Minimum Density:** Backfill over and around the pipe and backfill around and adjacent to drainage structures shall be compacted at the approved moisture content to the following applicable minimum density, which will be determined as specified below.
    - 1) Under airfield and heliport pavements, paved roads, streets, parking areas, and similar-use pavements including adjacent shoulder areas, the density shall be not less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material, up to the elevation where requirements for pavement subgrade materials and compaction shall control.
    - 2) Under unpaved or turfed traffic areas, density shall not be less than 90 percent of maximum density for cohesive material and 95 percent of maximum density for cohesionless material.
    - 3) Under nontraffic areas, density shall be not less than that of the surrounding material.
5. **Determination of Density:** Testing shall be the responsibility of the Contractor and performed at no additional cost to the Owner. Testing shall be performed by an approved commercial testing laboratory or by the Contractor subject to approval. Tests shall be performed in sufficient number to ensure that specified density is being obtained. Laboratory tests for moisture-density relations shall be made in accordance with ASTM D1557 except that mechanical tampers may be used provided the results are correlated with those obtained with the specified hand tamper. Field density tests shall be determined in accordance with ASTM D2167 or ASTM D2922. When ASTM D2922 is used, the calibration curves shall be checked and adjusted, if necessary, using the sand cone method as described in paragraph Calibration of the referenced publications.



ASTM D2922 results in a wet unit weight of soil and when using this method ASTM D3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D3017 or ASTM D2922. Test results shall be furnished to the Owner. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job on each different type of material encountered and at intervals as directed.

#### I. Pipeline Testing

1. **Leakage Tests:** Lines shall be tested for leakage by low pressure air or water testing or exfiltration tests, as appropriate. Low pressure air testing for vitrified clay pipes shall conform to ASTM C828. Low pressure air testing for concrete pipes shall conform to ASTM C924/ASTM C924M. Low pressure air testing for plastic pipe shall conform to ASTM F1417. Low pressure air testing procedures for other pipe materials shall use the pressures and testing times prescribed in ASTM C828 or ASTM C924/ASTM C924M, after consultation with the pipe manufacturer. Testing of individual joints for leakage by low pressure air or water shall conform to ASTM C1103/ASTM C1103M. Prior to exfiltration tests, the trench shall be backfilled up to at least the lower half of the pipe. If required, sufficient additional backfill shall be placed to prevent pipe movement during testing, leaving the joints uncovered to permit inspection. Visible leaks encountered shall be corrected regardless of leakage test results. When the water table is 600 mm 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Owner. An exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet (600 mm) is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4 hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by the exfiltration test shall not exceed 250 gallons per inch in diameter per mile (60 liters per mm in diameter per kilometer) of pipeline per day **OR** 0.2 gallons per inch in diameter per 100 feet (9 mL per mm in diameter per 100 meters), **as directed**, of pipeline per hour. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished.
2. **Deflection Testing:** Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.
  - a. **Pull-through device:** This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided that the device meets the applicable requirements specified in this paragraph, including those for diameter of the device. Ball, cylinder, or circular sections shall conform to the following:
    - 1) A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
    - 2) A homogeneous material throughout, with a density greater than 1.0 as related to water at 39.2 degrees F (4 degrees C), and a surface Brinell hardness of not less than 150.
    - 3) Center bored and through bolted with a 1/4 inch (6 mm) minimum diameter steel shaft having a yield strength of not less than 70,000 psi (483 MPa), with eyes or loops at each end for attaching pulling cables.
    - 4) Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.





- b. Deflection measuring device: Sensitive to 1.0 percent of the diameter of the pipe being tested and accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved by the the Owner prior to use.
- c. Pull-through device: Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions as specified.
- d. Deflection measuring device procedure: Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, remove pipe which has excessive deflection, replace with new pipe, and completely retest in same manner and under same conditions.
- e. Warranty period test: Pipe found to have a deflection of greater than 5 percent of average inside diameter when deflection test is performed just prior to end of one-year warranty period shall be replaced with new pipe and tested as specified for leakage and deflection.

J. Field Painting

- 1. After installation, clean cast-iron frames, covers, gratings, and steps not buried in masonry or concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint **OR** After installation, clean steel covers and steel or concrete frames not buried in masonry or concrete to bare metal of mortar, dirt, grease, and other deleterious materials. Apply a coat of primer and apply a top coat as specified in Division 09 Section "Exterior Painting", **as directed**. Do not paint surfaces subject to abrasion.

END OF SECTION 02525



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02525	01204	No Specification Required
02525	02242	Piped Utilities Basic Materials And Methods
02525	02511	Sanitary Sewerage
02525	02452	Storm Drainage



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**SECTION 02530 - DEWATERING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for dewatering. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Performance Requirements**

1. 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 ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - a. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - b. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
  - c. Prevent surface water from entering excavations by grading, dikes, or other means.
  - d. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - e. Remove dewatering system when no longer required for construction.

**C. Submittals**

1. Shop Drawings: For dewatering system. 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.
  - a. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
  - b. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise.
2. Delegated-Design Submittal: For dewatering system indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

**D. Quality Assurance**

1. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.
2. Preinstallation Conference: Conduct conference at Project site.

**E. Project Conditions**

1. 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:
  - a. Notify the Owner no fewer than two days in advance of proposed interruption of utility.
  - b. Do not proceed with interruption of utility without the Owner's written permission.
2. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  - a. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Owner if



changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

## 1.2 PRODUCTS (Not Used)

## 1.3 EXECUTION

### A. Preparation

1. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  - a. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
  - b. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
2. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - a. 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.
3. Provide temporary grading to facilitate dewatering and control of surface water.
4. Monitor dewatering systems continuously.
5. Promptly repair damages to adjacent facilities caused by dewatering.
6. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 02 Section "Site Clearing" during dewatering operations.

### B. Installation

1. 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.
  - a. Space well points or wells at intervals required to provide sufficient dewatering.
  - b. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
2. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
3. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - a. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
4. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - a. Maintain piezometric water level a minimum of 24 inches (600 mm) **OR** 60 inches (1500 mm), **as directed**, below surface of excavation.
5. 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. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
6. 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. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.



- a. 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 (900 mm) below overlying construction.
7. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 02530



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02530	02242	Piped Utilities Basic Materials And Methods
02531	02242	Piped Utilities Basic Materials And Methods
02531	02522	Sand Drains
02561	01204	No Specification Required
02561	02242	Piped Utilities Basic Materials And Methods
02561	02511	Sanitary Sewerage
02561	02452	Storm Drainage
02561	02242b	Sewage Treatment Lagoons



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## SECTION 02570 - REPAIR AND MAINTENANCE OF IMHOFF TANKS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for repair and maintenance of sewage treatment plant Imhoff tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Coatings:

1. Epoxy-Filler Compound for concrete surfaces shall comply with Fed. Spec. MMM-A-001993.
2. Coal-Tar Epoxy shall comply with SSPC-PAINT 16.
3. Epoxy Paint shall comply with Mil. Spec. MIL-P-24441.
4. Red-Lead Base Paint shall comply with Fed. Spec. TT-P-86, Type I.
5. Aluminum Finish Paint shall comply with Fed. Spec. TT-P-38.

- #### B. Steel Tank Repair Material for minor leaks shall be a two-component epoxy sealing compound. For badly corroded areas, a steel plate of the same composition and thickness as the original tank shall be used.

- #### C. Pipe and Fittings for replacement shall be equivalent to the existing pipe and fittings.

### 1.3 EXECUTION

- #### A. Preparation: Drain the contents of the tank and dispose of the sludge and sewage.

#### B. Leak Repair:

1. Concrete Tanks: Repair concrete tank leaks by cleaning and chipping or sandblasting the area of the leak and applying two-component epoxy concrete sealant.
2. Steel Tanks: Repair steel tank leaks by cleaning, scraping, chipping, or sandblasting the area of the leak and applying epoxy steel sealant. Repair badly corroded areas of steel tanks by cutting out the corroded area and welding a section of new steel plate in place. Welding shall be in compliance with AWS D1.1.

- #### C. Pipe and Fittings: Replace pipe and fittings as required.

#### D. Cleaning and Coatings:

1. Interior Concrete Surfaces of the tank shall be cleaned with high pressure water or steam to remove dirt and residue, allowed to dry, and brush sandblasted.
2. Holes and Voids in the concrete surfaces left from the blast cleaning shall be filled by means of troweling and squeeze application of epoxy filler. Two coats of coal-tar epoxy shall be applied to the surface after the epoxy has cured.
3. Submerged Ferrous Metal Surfaces such as piping and equipment that are exposed to the sewage shall be sandblasted and coated with two coats of coal-tar epoxy.



4. Exterior Concrete Surfaces of the tank shall be cleaned by means of brush sandblast. The surfaces shall be blown down with air to remove the blasting residue and dust, and two coats of epoxy-polyamide paint shall be applied.
5. Ferrous Metal Surfaces that are not submerged shall be cleaned by means of sandblasting. Coat surfaces with one coat of red-lead base paint. After the base paint has dried sufficiently, apply two coats of aluminum finish paint.

END OF SECTION 02570



## SECTION 02570a - REPAIR AND MAINTENANCE OF SIPHON TANK AND SIPHONS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for the repair and maintenance of sewage treatment plant dosing siphon tanks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

- A. Tank Repair Material shall be epoxy type grout complying with Fed. Spec. MMM-A-001993.

#### B. Concrete Coatings:

1. Outside and Above Grade shall be epoxy type in compliance with Mil. Spec. MIL-P-24441.
2. Inside and Below Grade shall be coal-tar epoxy type in compliance with SSPC-PAINT 16.

- C. Steel Repair Material shall be steel plate or epoxy cement and fiberglass cloth.

- D. Corroded or Defective Siphons: Replace those parts corroded or defective with new parts compatible with the unit, as recommended by the manufacturer.

#### E. Steel Coatings:

1. Red-Lead Base Coat shall comply with Fed. Spec. TT-P-86, Type I.
2. Aluminum Paint shall comply with Fed. Spec. TT-P-38.

### 1.3 EXECUTION

- A. Corroded or Broken Pipe and Fittings: Replace as required.

- B. Minor Leaks: Repair minor leaks in the tank using material and surface preparation and application methods recommended by the material manufacturer.

- C. Spalled Areas: Repair as required.

#### D. Cleaning and Coating:

1. Interior Concrete Surfaces of the tank shall be cleaned with high pressure water or steam to remove all dirt and residue, allowed to dry, and brush sandblasted in compliance with SSPC-SP 7.
2. The Exterior Concrete Surfaces of the tank shall be cleaned by means of brush sandblasting in compliance with SSPC-SP 7. The surfaces shall be blown down with air to remove the blasting residue and dust, and two coats of epoxy-polyamide paint shall be applied.
3. Holes and Voids in the concrete surfaces left from the blast cleaning shall be filled by means of troweling and squeeze application of an epoxy filler. The surfacing material shall be allowed to cure overnight, and then two coats of coal-tar epoxy complying with SSPC-PAINT 16 shall be applied.



4. Submerged Ferrous Metal Surfaces that are exposed to the sewage shall be sandblasted in compliance with SSPC-SP 10 and coated with two coats of coal-tar epoxy.
5. Ferrous Metal Surfaces that are not submerged shall be cleaned by means of sandblasting in compliance with SSPC-SP 6. Surfaces inaccessible to sandblasting shall be power tool cleaned in compliance with SSPC-SP 3. Surfaces shall be coated with one coat of red-lead base paint. After the base paint has dried sufficiently, two coats of aluminum finish paint shall be applied.

END OF SECTION 02570a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02570	01204	No Specification Required
02570	02242	Piped Utilities Basic Materials And Methods

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**SECTION 02611 - CRUSHED STONE PAVING****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of crushed stone paving. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**1.2 PRODUCTS****A. Aggregates:** Aggregates shall consist of crushed stone or slag, crushed gravel, angular sand, or other approved materials. Aggregates shall be durable, sound, and free from foreign material.

1. Coarse Aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 50 percent after 500 revolutions when tested in accordance with ASTM C131. The amount of flat and elongated particles (length to width greater than 3 to 1) shall not exceed 30 percent.
2. Crushed Gravel shall be manufactured from gravel particles with the following gradation:

100% passing	2" sieve
25 - 60% passing	1/4" sieve
5 - 40% passing	#40 sieve
0 - 10%	#200 sieve
3. Crushed Stone shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces for each range of sizes.
4. Slag shall be an air-cooled blast-furnace product having a dry weight of not less than 65 pcf.

**B. Binder Material** shall consist of screenings, angular sand, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.**1.3 EXECUTION****A. Installation:**

1. Mixing and Placing: Materials shall be mixed in such a manner as to obtain a uniform stabilized-aggregate material and a uniform optimum water content for compaction. Mixing and placing procedures shall produce true grades, minimize segregation and degradation, optimize water content, and ensure a satisfactory base course.
2. Compaction: Each layer of stabilized-aggregate paving shall be compacted. Water content shall be maintained at optimum. Areas inaccessible to the rollers shall be compacted, with mechanical tampers and shall be shaped and finished by hand methods.
3. Layer Thickness: No layer shall be in excess of 8 inches nor less than 3 inches in compacted thickness.
4. Proof Rolling: Materials in paving or underlying materials that produce unsatisfactory results by rolling shall be removed and replaced with satisfactory materials and recompacted.
5. Edges of Paving: Approved materials shall be placed along edges of stabilized-aggregate paving course in such quantities as will compact to thickness of the course being constructed, allowing at least a 1-foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of the paving course.
6. Finishing: Finished surface shall be of uniform grade and texture.
7. Thickness Control: Compacted thickness of the stabilized paving course shall be within 1/2 inch of the thickness required.



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END OF SECTION 02611

**SECTION 02611a - CRUSHED STONE****1.1 GENERAL****A. Description Of Work**

1. The work under this section consists of furnishing, placing and compacting crushed stone where called for and as detailed, in conformance with lines, grades and typical as follows or as directed by the Owner.

**1.2 PRODUCTS****A. Materials**

1. Material shall consist of clean, coating free, durable, sharp angled fragments of crushed stone, crushed ledge rock, or blends thereof that conform to the specific requirements of the following table. Shale will not be acceptable.
2. Crushed Stone used in Absorption Beds shall be washed and free of fines.
3. Gradation: Crushed stone sizes shall meet the gradation requirements of Table 1-1.

**TABLE 1-1 (1) GRADATION OF CRUSHED STONE**

Size Designation	4"	3"	2-1/2"	2"	1-1/2"	1"	1/2"	1/4"	1/8"	No.80 Sieve
Screening (2)							100	90-100		
1B								100	90-100	0-15
1A							100	90-100	0-15	
1 <sup>ST</sup>							100	0-15		
1						100	90-100	0-15		
2					100	90-100	0-15			
3A				100	90-100	0-15				
3			100	90-100	5-70	0-15				
4A		100	90-100		0-20					
4	100	90-100		0-15						
5	90-100	0-15								

- a. Percentage by weight passing the following square openings.
  - b. Screenings shall include all of the fine material passing a 1/4-inch screen.
4. All crushing plants shall be fitted with tailing chutes so that no aggregate will reach the bins other than that which passes through the proper screens



- B. Soundness: Material furnished under this item shall be substantially free of shale or other soft, poor durability particles. A visual inspection of particle composition by the Owner will generally be the basis for acceptance. Where the State elects to test for this requirement, a Magnesium Sulfate Soundness Loss exceeding 35 percent will be cause for rejection.
- C. Contamination: Contamination of the crushed stone with any deleterious material, such as silt, clay, mud, ice, snow or organic materials, through any cause whatsoever, shall be corrected by the Contractor by excavation and replacement of the material in the affected areas.
- D. Sampling: Samples and certified gradations shall be furnished by the Contractor to the Owner and approval of these samples must be received prior to delivery or placement of the material.

### 1.3 EXECUTION

- A. Compaction: All material shall be placed in uniform horizontal layers not exceeding 6-inches thickness before compaction. All portions of each layer shall be mechanically compacted to the satisfaction of the Owner. Compaction equipment shall be approved by the Owner.

END OF SECTION 02611a

**SECTION 02611b - SELECT GRAVEL****1.1 GENERAL****A. Description Of Work**

1. The work under this section consists of furnishing, placing and compacting select gravel where called for and as detailed, in conformance with lines, grades and typical sections as provided or directed by the Owner.

**1.2 PRODUCTS****A. Materials**

1. Material shall consist of clean, durable gravel or crushed stone free from coating.
2. Select Gravel used for stone paving shall be manufactured from crushed stone and contain no gravel.
3. Gradation of gravel or stone shall be as follows with percent passing calculated by weight:

Select Gravel	
<u>Sieve</u>	<u>Percent Passing</u>
2"	100
1/4"	30 - 65
No. 40	5 - 40
No. 200	0 - 10

**1.3 EXECUTION**

- A. Soundness: Materials furnished under this item shall be substantially free of shale, organic or other soft, poor durability particles. A visual inspection of particle composition by the Owner will generally be the basis for acceptance. Where the Owner elects to test for this requirement, a Magnesium Sulfate Soundness Loss exceeding 35 percent will be cause for rejection.
- B. Contamination: Contamination of the Select Gravel with any deleterious material, such as silt, clay, mud, ice, snow or organic material, through any cause whatsoever, shall be corrected by the Contractor by excavation and replacement of the material in the affected area.
- C. Sampling: Samples and certified gradations shall be furnished by the Contractor to the Owner and approval of these samples must be received prior to delivery or placement of the material.
- D. Compaction:
  1. All material shall be placed in uniform horizontal layers not exceeding 6-inches thickness before compaction. All portions of each layer shall be mechanically compacted to the percentage of the Standard Proctor Maximum Density (AASHTO T-99) as follows, unless noted otherwise. Compaction equipment approval shall be made by the Owner.
  2. Density determination.
    - a. Structures (entire area within 10 feet outside perimeter) 95%
    - b. Building Slabs and Steps: 95%
    - c. Lawn or Unpaved Areas: 90%
    - d. Pavements and Walkways: 95%
    - e. Pipes and Tunnels: 95%
    - f. Pipe Bedding: 100%



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END OF SECTION 02611b



## SECTION 02612 - SOIL STERILIZATION

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers soil sterilization. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations.

### 1.2 PRODUCTS

- A. Weed Eradication and Soil Fumigation: Products approved by the Environmental Protection Agency.
- B. Liquid and Dry Herbicides:
  1. Bare Ground Herbicides: Bromacil powder mixture or an ammonium sulfamate spray.
  2. Wetting Agents: As required.
- C. Equipment: Equipment shall be appropriate to the application and approved before use by the Owner.

### 1.3 EXECUTION

- A. Soil: After the subgrade has been prepared, all areas to be surfaced shall be treated with a weed eradicator and soil fumigant only in the designated areas.
- B. Wetting Agents may be used as an additive to improve the performance of weed and brush herbicides.

END OF SECTION 02612



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## SECTION 02612a - ASPHALT PAVING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for asphalt paving. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. Section Includes:
  - a. Cold milling of existing hot-mix asphalt pavement.
  - b. Hot-mix asphalt patching.
  - c. Hot-mix asphalt paving.
  - d. Hot-mix asphalt paving overlay.
  - e. Asphalt surface treatments.
  - f. Pavement-marking paint.
  - g. Traffic-calming devices.
  - h. Imprinted asphalt.

#### C. Definition

1. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

#### D. Submittals

1. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
  - a. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
  - b. Job-Mix Designs: For each job mix proposed for the Work.
2. Material Certificates: For each paving material, from manufacturer.

#### E. Quality Assurance

1. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
2. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of State or local DOT for asphalt paving work.
  - a. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
3. Preinstallation Conference: Conduct conference at Project site.

#### F. Delivery, Storage, And Handling

1. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
2. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

#### G. Project Conditions

1. 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:
  - a. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
  - b. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).



- c. Slurry Coat: Comply with weather limitations in ASTM D 3910.
- d. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
- e. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.
- 2. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials **OR** 55 deg F (12.8 deg C) for water-based materials, **as directed**, and not exceeding 95 deg F (35 deg C).
- 3. Imprinted Asphalt Paving: Proceed with coating imprinted pavement only when air temperature is at least 50 deg F (10 deg C) and rising and will not drop below 50 deg F (10 deg C) within 8 hours of coating application. Proceed only if no precipitation is expected within two hours after applying the final layer of coating.

## 1.2 PRODUCTS

### A. Aggregates

- 1. General: Use materials and gradations that have performed satisfactorily in previous installations.
- 2. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- 3. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
  - a. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.
- 4. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

### B. Asphalt Materials

- 1. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22 **OR** PG 58-28 **OR** PG 70-22, **as directed**.
- 2. Asphalt Cement: ASTM D 3381 for viscosity-graded material **OR** ASTM D 946 for penetration-graded material, **as directed**.
- 3. Prime Coat:
  - a. ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70 **OR** MC-250, **as directed**.  
**OR**  
Asphalt emulsion prime coat complying with State or local DOT requirements.
- 4. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- 5. Fog Seal: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397 or AASHTO M 208 cationic emulsified asphalt, slow setting, factory diluted in water, of suitable grade and consistency for application.
- 6. Water: Potable.
- 7. Undersealing Asphalt: ASTM D 3141, pumping consistency.

### C. Auxiliary Materials

- 1. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.
- 2. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- 3. Paving Geotextile: AASHTO M 288, nonwoven polypropylene; resistant to chemical attack, rot, and mildew; and specifically designed for paving applications.



4. Joint Sealant: ASTM D 6690 or AASHTO M 324, Type I **OR** Type II or III **OR** Type IV, **as directed**, hot-applied, single-component, polymer-modified bituminous sealant.
5. Pavement-Marking Paint: Color shall be White **OR** Yellow **OR** Blue, **as directed**.
  - a. Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N **OR** Type F **OR** Type S, **as directed**; colors complying with FS TT-P-1952.  
**OR**  
MPI #32 Alkyd Traffic Marking Paint.  
**OR**  
Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three **OR** 45, **as directed**, minutes.  
**OR**  
MPI #97 Latex Traffic Marking Paint.
6. Glass Beads: AASHTO M 247, Type 1.
7. Wheel Stops:
  - a. Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.  
**OR**  
Solid, integrally colored, 96 percent recycled HDPE or commingled postconsumer and postindustrial recycled plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1800 mm) long. Provide chamfered corners, drainage slots on underside, and holes for anchoring to substrate.
  - b. Dowels: Galvanized steel, 3/4-inch (19-mm) diameter, 10-inch (254-mm) minimum length.
  - c. Adhesive: As recommended by wheel-stop manufacturer for application to asphalt pavement.
- D. Preformed Traffic-Calming Devices
  1. Speed Bumps **OR** Humps **OR** Cushions, **as directed**: Solid, integrally colored, 100 percent postconsumer or commingled postconsumer and postindustrial recycled rubber **OR** plastic, **as directed**; UV stabilized. Provide holes for anchoring to substrate.
    - a. Size: Modular bumps 2 inches (51 mm) high by 10 inches (254 mm) wide by 72 inches (1800 mm) long, with overall length as dimensioned on Drawings.
    - b. Size: Modular assemblies 3 inches (76 mm) high by 12 feet (3.7 m) in overall width **OR** 4 inches (102 mm) high by 14 feet (4.3 m) in overall width, **as directed**, with overall length as dimensioned on Drawings.
    - c. Mounting Hardware: Galvanized-steel spike, 1/2-inch (13-mm) diameter, 10-inch (254-mm) minimum length **OR** lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (203-mm) minimum length **OR** hardware as standard with device manufacturer, **as directed**.
    - d. Adhesive: As recommended by device manufacturer.
- E. Imprinted Asphalt Materials
  1. Templates: Imprinted-asphalt manufacturer's standard flexible templates for imprinting pattern into hot asphalt paving.
    - a. Pattern: Running bond brick **OR** Cobblestone **OR** Custom pattern indicated on Drawings, **as directed**.
  2. Coating System: Imprinted-asphalt manufacturer's standard system formulated for exterior application on asphalt paving surfaces.
    - a. Base Coating: Portland cement and epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
    - b. Top Coating: Epoxy-modified acrylic polymer blended with sand and aggregate, formulated for exterior application on asphalt paving surfaces.
    - c. Colorant: UV-stable pigment blend, added to each coating layer.
    - d. Color: White **OR** Yellow, **as directed**.



3. Precut Marking Material: Imprinted-asphalt manufacturer's standard, reflectorized, thermoplastic, 90-mil (2.3-mm) minimum thickness, formulated for exterior application on asphalt paving surfaces, and matching the imprinted pattern of templates.

#### F. Mixes

1. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
  - a. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - b. Base Course: In accordance with state or local DOT specifications.
  - c. Surface Course: In accordance with state or local DOT specifications.
2. Hot-Mix Asphalt Based on ASTM D 3515 Requirements: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."
  - a. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - b. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:
    - 1) Base Course: 1 inch (25 mm).
    - 2) Surface Course: 1/2 inch (13 mm).
3. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1 **OR** Type 2 **OR** Type 3, **as directed**.

### 1.3 EXECUTION

#### A. Examination

1. Verify that subgrade is dry and in suitable condition to begin paving.
2. 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.
  - a. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
  - b. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
  - c. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
3. Proceed with paving only after unsatisfactory conditions have been corrected.
4. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

#### B. Cold Milling

1. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
  - a. Mill to a depth of 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**.
  - b. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
  - c. Control rate of milling to prevent tearing of existing asphalt course.
  - d. Repair or replace curbs, manholes, and other construction damaged during cold milling.
  - e. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
  - f. Transport milled hot-mix asphalt to asphalt recycling facility.
  - g. Keep milled pavement surface free of loose material and dust.

**C. Patching**

1. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompress existing unbound-aggregate base course to form new subgrade.
2. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.
  - a. Pump hot undersealing asphalt under rocking slab until slab is stabilized or, if necessary, crack slab into pieces and roll to reseal pieces firmly.
  - b. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompress existing unbound-aggregate base course to form new subgrade.
3. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
  - a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
4. Patching:
  - a. Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.  
**OR**  
Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

**D. Repairs**

1. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch (25 mm) in existing pavements.
  - a. Install leveling wedges in compacted lifts not exceeding 3 inches (75 mm) thick.
2. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch (6 mm).
  - a. Clean cracks and joints in existing hot-mix asphalt pavement.
  - b. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.
  - c. Use hot-applied joint sealant to seal cracks and joints more than 1/4 inch (6 mm) wide. Fill flush with surface of existing pavement and remove excess.

**E. Surface Preparation**

1. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
2. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
  - a. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
3. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
  - a. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
  - b. Protect primed substrate from damage until ready to receive paving.
4. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
  - a. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.



- b. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

F. Paving Geotextile Installation

1. Apply tack coat **OR** asphalt binder **OR** asphalt cement, **as directed**, uniformly to existing pavement surfaces at a rate of 0.20 to 0.30 gal./sq. yd. (0.8 to 1.2 L/sq. m).
2. Place paving geotextile promptly according to manufacturer's written instructions. Broom or roll geotextile smooth and free of wrinkles and folds. Overlap longitudinal joints 4 inches (100 mm) and transverse joints 6 inches (150 mm).
  - a. Protect paving geotextile from traffic and other damage and place hot-mix asphalt paving overlay the same day.

G. Hot-Mix Asphalt Placing

1. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  - a. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
  - b. Place hot-mix asphalt surface course in single lift.
  - c. Spread mix at minimum temperature of 250 deg F (121 deg C).
  - d. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
  - e. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
2. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
  - a. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
3. 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.

H. Joints

1. 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.
  - a. Clean contact surfaces and apply tack coat to joints.
  - b. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
  - c. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
  - d. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations" **OR** as shown on Drawings, **as directed**.
  - e. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  - f. Compact asphalt at joints to a density within 2 percent of specified course density.

I. Compaction

1. 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.
  - a. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
2. 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.



3. 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:
    - a. Average Density:
      - 1) 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
    - OR**
    - 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
  4. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
  5. 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.
  6. 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.
  7. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
  8. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.
- J. Asphalt Curbs
1. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).
    - a. Asphalt Mix: Same as pavement surface-course mix.
  2. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.
- K. Asphalt Traffic-Calming Devices
1. Construct hot-mix asphalt speed bumps, humps, cushions, and tables over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F (121 deg C).
    - a. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
    - b. Asphalt Mix: Same as pavement surface-course mix.
    - c. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch (25 mm) from top of pavement to a clean, rough profile.
  2. Place hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.
- L. Installation Tolerances
1. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
    - a. Base Course: Plus or minus 1/2 inch (13 mm).
    - b. Surface Course: Plus 1/4 inch (6 mm), no minus.
  2. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
    - a. Base Course: 1/4 inch (6 mm).
    - b. Surface Course: 1/8 inch (3 mm).
    - c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).



3. Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

M. Surface Treatments

1. Fog Seals: Apply fog seal at a rate of 0.10 to 0.15 gal./sq. yd. (0.45 to 0.7 L/sq. m) to existing asphalt pavement and allow to cure. With fine sand, lightly dust areas receiving excess fog seal.
2. Slurry Seals: Apply slurry coat in a uniform thickness according to ASTM D 3910 and allow to cure.
  - a. Roll slurry seal to remove ridges and provide a uniform, smooth surface.

N. Pavement Marking

1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner.
2. Allow paving to age for 30 **OR** 90, **as directed**, days before starting pavement marking.
3. Sweep and clean surface to eliminate loose material and dust.
4. 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 (0.4 mm).
  - a. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

O. Wheel Stops

1. Install wheel stops in bed of adhesive as recommended by manufacturer.
2. Securely attach wheel stops to pavement with not less than two galvanized-steel dowels embedded at one-quarter to one-third points. Securely install dowels into pavement and bond to wheel stop. Recess head of dowel beneath top of wheel stop.

P. Preformed Traffic-Calming Devices

1. Install preformed speed bumps **OR** humps **OR** cushions, **as directed**, in bed of adhesive as recommended by manufacturer for heavy traffic.
2. Securely attach preformed speed bumps **OR** humps **OR** cushions, **as directed**, to pavement with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

Q. Imprinting Asphalt

1. General: Imprint asphalt according to manufacturer's written instructions, using manufacturer's recommended equipment.
2. Freshly Laid Asphalt: Immediately after asphalt has been laid and compacted but still plastic, begin the surface imprinting process.
  - a. Monitor asphalt surface temperature in compliance with manufacturer's written recommendations to ensure required temperature to perform surface imprinting.
  - b. Reheat asphalt if surface temperature drops below that required.
3. Reheating Asphalt: Soften asphalt pavement surface by heating to a depth of at least 1/2 inch (13 mm) without burning asphalt.
  - a. Heat to a temperature of 300 to 325 deg F (149 to 163 deg C) immediately before applying templates.
  - b. Regularly monitor the pavement temperature to prevent overheating.
  - c. Direct flame heaters are not permitted.
  - d. If pavement is overheated and begins to emit black smoke, remove damaged pavement by milling down 1 inch (25 mm) and replace removed pavement with new, compacted surface course prior to resuming imprinting work.
4. Surface Imprinting: Apply and imprint templates to a minimum depth of 1/4 inch (6 mm) **OR** as required to embed precut marking material flush or barely beneath pavement surface, **as directed**.





5. Coating Application: After imprinted surface has cooled, apply two layers of base coating followed by two layers of top coating **OR** four layers of top coating, **as directed**. Do not allow traffic until coating has completely dried and cured.
  6. Precut Marking Material Application: Position precut marking material aligned with imprinted pattern and slowly heat to a temperature no higher than 325 deg F (163 deg C) until marking material begins to liquefy and flow. Do not allow traffic until installed marking material has cooled to ambient temperature.
- R. Field Quality Control
1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  2. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
  3. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
  4. Traffic-Calming Devices: Finished height of asphalt speed bumps, humps, cushions, and tables above pavement will be measured for compliance with tolerances.
  5. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
    - a. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
    - b. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
      - 1) One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than 3 cores taken.
      - 2) Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
  6. Replace and compact hot-mix asphalt where core tests were taken.
  7. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.
- S. Disposal
1. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.
    - a. Do not allow milled materials to accumulate on-site.

END OF SECTION 02612a



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## SECTION 02612b - BITUMINOUS PAVING-REPAIR AND RESURFACING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials repair and resurfacing of bituminous pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Reports: Copies of test results, within 24 hours after completion of tests.
2. Waybills and Delivery Tickets: Copies of waybills or delivery tickets, during the progress of the work.

### 1.2 PRODUCTS:

#### A. Asphaltic Concrete:

1. Hot-Mixed, Hot-Mixed Asphaltic Concrete and Emulsified asphalt shall comply with requirements of ASTM D 3515.
2. Plant-Mixed, Stockpiled Asphalt Cold Mixes shall comply with the requirements of Asphalt Institute Specification PM-2.

#### B. Bituminous Prime: Bituminous primer shall comply with ASTM D 2027.

#### C. Base Course: Base course material shall comply with State highway department specification for dense-graded, high-quality material.

#### D. Bituminous Tack Coat: Bituminous tack coat shall comply with ASTM D 2027.

### 1.3 EXECUTION:

#### A. Preparation of Areas for Patching:

1. Pot Holes: Trim the perimeter of each hole to a vertical face with a carborundum blade in a square or rectangular pattern at least 18 inches from ragged edge. Remove material to a depth that provides a uniform well-compacted bottom surface. Remove all loose material resulting from trimming or otherwise existing in the hole. If subbase is disturbed, reestablish in a like manner to adjacent substrate. Areas to be repaired shall be dry before repair is started.
2. Alligator-Cracked and Rutted Areas: The pavement shall be sawed or cut with pavement breakers to a smooth vertical face 18 inches outside of the alligator-cracked area. Unsatisfactory material shall be removed in a manner not to disturb the sides of the excavated area.
3. Slippage Areas: Saw a rectangular area around the slippage area that overlaps into the well-bonded material by at least 18 inches. The depth of the saw cut shall be equal to the thickness of the layer of material that is slipping. The surface where slipping is occurring shall be broomed clean and all loose material removed.

#### B. Installation:

1. Application Temperatures: Application temperatures for all asphalt material shall comply with provisions of the Asphalt Institute Publications and the applicable ASTM Standards.



2. Base Course: Place base course material in layers not exceeding a compacted thickness of 6 inches. After placing, compact each layer by mechanical compactors to a density of not less than the density of the corresponding layer of the adjacent pavement structure.
3. Prime Coat: Prime base course with MC-70 liquid asphalt at a rate of 0.20 to 0.30 gallon per sq. yd. Bolt excess prime with sand before the surfacing material is applied.
4. Tack Coat: Give the edges of existing asphaltic concrete or surfaces of Portland cement concrete and asphaltic concrete a tack coat of MC-70 liquid asphalt at a rate of 0.05 to 0.15 gallon per sq. yd. Allow the material to cure before placing the surfacing material.
5. Hot-Mixed Asphaltic Concrete: Place the material in layers not exceeding 2-1/2 inches in thickness and compact to a density equal to the density of the adjacent asphaltic concrete.
6. Stockpiled Cold Mixes: The compacted thickness of each layer of material shall not exceed 2 inches. Before compaction, the material shall be allowed to aerate, if necessary, until the proper amount of cohesion has developed to obtain adequate compaction. When more than one layer is used, each layer shall be thoroughly cured before the succeeding layer is placed.

END OF SECTION 02612b

**SECTION 02612c - ASPHALTIC CONCRETE OVERLAYS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of asphaltic concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Submittals**

1. Product Data: For each type of product indicated.

**1.2 PRODUCTS**

- A. Asphalt Cement: The asphalt cement shall comply with ASTM D 946 penetration grade 85-100 requirements and shall show a negative spot test when tested in compliance with AASHTO T 102.
- B. Mineral Aggregates: Shall comply with ASTM D 3515 for 3/4-inch maximum aggregate mix.
- C. Test Properties: The bituminous mixture shall meet the following requirements when tested in compliance with MIL-STD 620.

Stability minimum, lb	500
Flow maximum, 1/100-in. units	20
Voids total mix, %	3-5
Voids filled with bitumen, %	75-85

**1.3 EXECUTION**

- A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc., to meet the required grade. An asphalt tack coat shall be applied to all contact surfaces in advance of the asphalt concrete overlay placement. The asphalt tack shall be placed at an asphalt residue coverage rate of 0.05 gal/sq yd.
- B. Installation:
  1. Joints: Longitudinal joints of the overlay shall be offset at least 1 foot from existing joints. Transverse joints shall be offset at least 2 feet from existing transverse joints.
  2. All Asphalt Concrete Mixture and Pavement that are contaminated, damaged, or defective shall be removed and replaced by the Contractor. Skin patching of rolled pavement will not be permitted.
  3. Compaction of Mixture: The asphalt concrete mixture shall be rolled until a density of not less than 95 percent and not more than 100 percent of laboratory compacted specimen is obtained.
  4. Surface Smoothness: After final rolling, the pavement surface shall not vary in excess of 1/8 inch from a 10-foot straightedge laid on the surface.

END OF SECTION 02612c



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## SECTION 02614 - CEMENT CONCRETE PAVEMENT

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for cement concrete pavement. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. Section Includes:
  - a. Driveways.
  - b. Roadways.
  - c. Parking lots.
  - d. Curbs and gutters.
  - e. Walks.

#### C. Definitions

1. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

#### D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
  - b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements. For each design mixture submitted, include an equivalent concrete mixture that does not contain portland cement replacements, to determine amount of portland cement replaced.
3. Shop Drawings: Indicate pavement markings, lane separations, and defined parking spaces. Indicate, with international symbol of accessibility, spaces allocated for people with disabilities.
4. Samples: For each type of product or exposed finish, prepared as Samples of size indicated below:
  - a. Exposed Aggregate: 10-lb (4.5-kg) Sample of each mix.
  - b. Wheel Stops: 6 inches (150 mm) long showing cross section; with fasteners.
  - c. Preformed Traffic-Calming Devices: 6 inches (150 mm) long showing cross section; with fasteners.
5. Other Action Submittals:
  - a. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
6. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer and testing agency.
7. Material Certificates: For the following, from manufacturer:
  - a. Cementitious materials.
  - b. Steel reinforcement and reinforcement accessories.
  - c. Fiber reinforcement.
  - d. Admixtures.
  - e. Curing compounds.
  - f. Applied finish materials.



- g. Bonding agent or epoxy adhesive.
- h. Joint fillers.
- 8. Material Test Reports: For each of the following:
  - a. Aggregates. Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.
- 9. Field quality-control reports.

#### E. Quality Assurance

- 1. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.
- 2. 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.
  - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- 3. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
  - a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- 4. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.
- 5. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.
- 6. Preinstallation Conference: Conduct conference at Project site.

#### F. Project Conditions

- 1. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- 2. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials **OR** 55 deg F (12.8 deg C) for water-based materials, **as directed**, and not exceeding 95 deg F (35 deg C).

## 1.2 PRODUCTS

#### A. Forms

- 1. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
  - a. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
- 2. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

#### B. Steel Reinforcement

- 1. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- 2. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel **OR** galvanized-steel, **as directed**, wire into flat sheets.
- 3. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- 4. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.
- 5. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
- 6. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.





7. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
8. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60 (Grade 420), deformed bars; assembled with clips.
9. Plain-Steel Wire: ASTM A 82/A 82M, as drawn **OR** galvanized, **as directed**.
10. Deformed-Steel Wire: ASTM A 496/A 496M.
11. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**.
12. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating, **as directed**. Cut bars true to length with ends square and free of burrs.
13. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
14. Tie Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.  
**OR**  
Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
15. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
  - a. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
  - b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
16. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
17. Zinc Repair Material: ASTM A 780.

C. Concrete Materials

1. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - a. Portland Cement: ASTM C 150, gray **OR** white, **as directed**, portland cement Type I **OR** Type II **OR** Type I/II **OR** Type III **OR** Type V, **as directed**. Supplement with the following, **as directed**:
    - 1) Fly Ash: ASTM C 618, Class C or Class F.
    - 2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
  - b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** Type IP, portland-pozzolan, **as directed**, cement.
2. Normal-Weight Aggregates: ASTM C 33, Class 4S **OR** Class 4M **OR** Class 1N, **as directed**, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials, **as directed**.
  - a. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) **OR** 1 inch (25 mm) **OR** 3/4 inch (19 mm), **as directed**, nominal.
  - b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
3. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
  - a. Aggregate Sizes: 3/4 to 1 inch (19 to 25 mm) **OR** 1/2 to 3/4 inch (13 to 19 mm) **OR** 3/8 to 5/8 inch (10 to 16 mm), **as directed**, nominal.
  - b. Aggregate Source, Shape, and Color: **As required to meet Project requirements**.
4. Water: Potable and complying with ASTM C 94/C 94M.
5. Air-Entraining Admixture: ASTM C 260.



6. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
    - a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
    - b. Retarding Admixture: ASTM C 494/C 494M, Type B.
    - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
    - d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
    - e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
    - f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
  7. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
- D. Fiber Reinforcement
1. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete paving, complying with ASTM C 1116/C 1116M, Type III, 1/2 to 1-1/2 inches (13 to 38 mm) long.
- E. Curing Materials
1. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry or cotton mats.
  2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
  3. Water: Potable.
  4. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
  5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
  6. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.
- F. Related Materials
1. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
  2. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
  3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
  4. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
    - a. Types I and II, non-load bearing **OR** Types IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.
  5. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch (3 to 6 mm).
  6. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
  7. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch (9.5-mm) sieve and 85 percent retained on a No. 8 (2.36-mm) sieve.
- G. Detectable Warning Materials



1. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
    - a. Size of Stamp: One piece matching detectable warning area shown on Drawings **OR** 24 by 24 inches (610 by 610 mm) **OR** 24 by 36 inches (610 by 914 mm) **OR** 24 by 48 inches (610 by 1220 mm) **OR** 26 by 26 inches (660 by 660 mm) **OR** 26 by 36 inches (660 by 914 mm), **as directed**.
  2. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.
- H. Pavement Markings
1. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248, Type N **OR** Type F **OR** Type S, **as directed**; colors complying with FS TT-P-1952.
    - a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
  2. Pavement-Marking Paint: MPI #32 Alkyd Traffic Marking Paint.
    - a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
  3. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than three **OR** 45, **as directed**, minutes.
    - a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
  4. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.
    - a. Color: White **OR** Yellow **OR** Blue **OR** As indicated, **as directed**.
  5. Glass Beads: AASHTO M 247, Type 1 **OR** FS TT-B-1325, Type 1A, **as directed**.
- I. Wheel Stops
1. Wheel Stops: Precast, air-entrained concrete, 2500-psi (17.2-MPa) minimum compressive strength, 4-1/2 inches (115 mm) high by 9 inches (225 mm) wide by 72 inches (1820 mm) long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
    - a. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
  2. Wheel Stops: Solid, integrally colored, 96 percent recycled HDPE, or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized; 4 inches (100 mm) high by 6 inches (150 mm) wide by 72 inches (1820 mm) long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
    - a. Color: Black **OR** Yellow **OR** Gray **OR** Green **OR** Blue, **as directed**.
    - b. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
    - c. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.
- J. Preformed Traffic-Calming Devices
1. Speed Bumps **OR** Humps **OR** Cushions, **as directed**: Solid, integrally colored, 100 percent postconsumer or commingled postconsumer and postindustrial recycled rubber or plastic; UV stabilized. Provide holes for anchoring to substrate.
    - a. Bump Size: Modular 2 inches (50 mm) high by 10 inches (254 mm) wide by 72 inches (1800 mm) long, with overall length as dimensioned on Drawings.
    - b. Hump **OR** Cushion, **as directed**, Size: Modular assemblies 3 inches (75 mm) high by 12 feet (3.7 m) in overall width **OR** 4 inches (100 mm) high by 14 feet (4.3 m) in overall width, **as directed**, with overall length as dimensioned on Drawings.
    - c. Color: Black **OR** Yellow, **as directed**.
    - d. Mounting Hardware: Galvanized-steel lag screw, shield, and washers; 1/2-inch (13-mm) diameter, 8-inch (200-mm) minimum length **OR** hardware as standard with device manufacturer for use with concrete paving, **as directed**.
    - e. Adhesive: As recommended by device manufacturer.



## K. Concrete Mixtures

1. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
  - a. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
  - b. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.
2. Proportion mixtures to provide normal-weight concrete with the following properties:
  - a. Compressive Strength (28 Days): 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
  - b. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45 **OR** 0.50, **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm), **as directed**, plus or minus 1 inch (25 mm).
3. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
  - a. Air Content: 5-1/2 **OR** 4-1/2 **OR** 2-1/2, **as directed**, percent plus or minus 1.5 percent for 1-1/2-inch (38-mm) nominal maximum aggregate size.
  - b. Air Content: 6 **OR** 4-1/2 **OR** 3, **as directed**, percent plus or minus 1.5 percent for 1-inch (25-mm) nominal maximum aggregate size.
  - c. Air Content: 6 **OR** 5 **OR** 3-1/2, **as directed**, percent plus or minus 1.5 percent for 3/4-inch (19-mm) nominal maximum aggregate size.
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 **OR** 0.30, **as directed**, percent by weight of cement.
5. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
  - a. Use water-reducing admixture **OR** high-range, water-reducing admixture **OR** high-range, water-reducing and retarding admixture **OR** plasticizing and retarding admixture, **as directed**, in concrete as required for placement and workability.
  - b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
6. Cementitious Materials: Limit percentage by weight of cementitious materials other than portland cement according to ACI 301 (ACI 301M) requirements for concrete exposed to deicing chemicals **OR** as follows, **as directed**:
  - a. Fly Ash or Pozzolan: 25 percent.
  - b. Ground Granulated Blast-Furnace Slag: 50 percent.
  - c. Combined Fly Ash or Pozzolan, and Ground Granulated Blast-Furnace Slag: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
7. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
8. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

## L. Concrete Mixing

1. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, **as directed**. Furnish batch certificates for each batch discharged and used in the Work.
  - a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
2. 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.
  - a. For concrete batches of 1 cu. yd. (0.76 cu. m) 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.



- b. For concrete batches larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
- c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

### 1.3 EXECUTION

#### A. Examination

1. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
2. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
  - a. Completely proof-roll subbase in one direction and repeat in perpendicular direction, **as directed**. Limit vehicle speed to 3 mph (5 km/h).
  - b. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
  - c. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Division 02 Section "Earthwork".
3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Remove loose material from compacted subbase surface immediately before placing concrete.

#### C. Edge Forms And Screed Construction

1. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
2. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

#### D. Steel Reinforcement

1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
2. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
3. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
5. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.
6. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M.
7. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

#### E. Joints

1. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
  - a. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.



2. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
  - a. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  - b. Provide tie bars at sides of paving strips where indicated.
  - c. Butt Joints: Use bonding agent **OR** epoxy bonding adhesive, **as directed**, at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - d. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
  - e. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
3. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
  - a. Locate expansion joints at intervals of 50 feet (15.25 m) unless otherwise indicated.
  - b. Extend joint fillers full width and depth of joint.
  - c. Terminate joint filler not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished surface if joint sealant is indicated.
  - d. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
  - e. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  - f. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
4. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
  - a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces, **as directed**.
    - 1) Tolerance: Ensure that grooved joints are within 3 inches (75 mm) either way from centers of dowels.
  - b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
    - 1) Tolerance: Ensure that sawed joints are within 3 inches (75 mm) either way from centers of dowels.
  - c. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
  - d. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) **OR** 3/8-inch (10-mm), **as directed**, radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces, **as directed**.

#### F. Concrete Placement

1. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.
2. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.



3. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
4. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
5. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
6. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
7. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  - a. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
8. Screed paving surface with a straightedge and strike off.
9. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
10. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
11. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
  - a. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
12. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - a. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
  - b. Do not use frozen materials or materials containing ice or snow.
  - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
13. Hot-Weather Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
  - a. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - b. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  - c. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

G. Float Finishing

1. General: Do not add water to concrete surfaces during finishing operations.
2. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
  - a. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.



- b. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
- c. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

#### H. Special Finishes

1. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
  - a. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
  - b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
  - c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
  - d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
2. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch (1.6 mm).
  - a. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
  - b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
  - c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
  - d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
3. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
  - a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) **OR** 40 lb/100 sq. ft. (19.5 kg/10 sq. m) **OR** 60 lb/100 sq. ft. (29 kg/10 sq. m), **as directed**, of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
  - b. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
  - c. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
  - d. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.
4. Rock-Salt Finish: After initial floating **OR** troweling **OR** brooming, **as directed**, uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft. (0.2 kg/10 sq. m).
  - a. Embed rock salt into plastic concrete with roller or magnesium float.
  - b. Cover paving surface with 1-mil- (0.025-mm-) thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
  - c. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.
5. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:





- a. Uniformly spread dry-shake hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), unless greater amount is recommended by manufacturer to match paving color required.
- b. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
- c. After final power floating, apply a hand-trowel finish followed by a broom finish.
- d. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

I. Detectable Warnings

1. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Division 02 Section "Unit Pavers".
  - a. Tolerance for Opening Size: Plus 1/4 inch (6 mm), no minus.
2. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
  - a. Before using stamp mats, verify that the vent holes are unobstructed.
  - b. Apply liquid release agent to the concrete surface and the stamp mat.
  - c. Stamping: While initially finished concrete is plastic **OR** After application and final floating of pigmented mineral dry-shake hardener, **as directed**, accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
  - d. Trimming: After 24 hours, cut off the tips of mortar formed by the vent holes.
  - e. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

J. Concrete Protection And Curing

1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
2. Comply with ACI 306.1 for cold-weather protection.
3. 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 (1 kg/sq. m 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.
4. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
5. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
  - a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - 1) Water.
    - 2) Continuous water-fog spray.
    - 3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
  - b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm) and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.
  - c. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas that have been subjected to



heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

K. Paving Tolerances

1. Comply with tolerances in ACI 117 and as follows:
  - a. Elevation: 3/4 inch (19 mm).
  - b. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
  - c. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
  - d. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
  - e. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
  - f. Vertical Alignment of Dowels: 1/4 inch (6 mm).
  - g. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
  - h. Joint Spacing: 3 inches (75 mm).
  - i. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
  - j. Joint Width: Plus 1/8 inch (3 mm), no minus.

L. Pavement Marking

1. Do not apply pavement-marking paint until layout, colors, and placement have been verified with the Owner.
2. Allow concrete paving to cure for a minimum of 28 days and be dry before starting pavement marking.
3. Sweep and clean surface to eliminate loose material and dust.
4. Apply paint with mechanical equipment to produce markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
  - a. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to concrete surface. Mask an extended area beyond edges of each stencil to prevent paint application beyond stencil. Apply paint so that it cannot run beneath stencil.
  - b. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal. (0.72 kg/L).

M. Wheel Stops

1. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
2. Securely attach wheel stops to paving with not less than two steel **OR** galvanized-steel, **as directed**, dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

N. Preformed Traffic-Calming Devices

1. Install preformed speed bumps **OR** humps **OR** cushions, **as directed**, in bed of adhesive applied as recommended by manufacturer for heavy traffic.
2. Securely attach preformed speed bumps **OR** humps **OR** cushions, **as directed**, to paving with hardware spaced as recommended by manufacturer for heavy traffic. Recess head of hardware beneath top surface.

O. Field Quality Control

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) **OR** 5000 sq. ft. (465 sq. m), **as directed**, or fraction thereof of each concrete mixture placed each day.



- 1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
    - b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
    - c. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    - d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
    - e. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
    - f. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.
      - 1) A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
  3. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
  4. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
  5. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
  6. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner.
  7. Concrete paving will be considered defective if it does not pass tests and inspections.
  8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  9. Prepare test and inspection reports.
- P. Repairs And Protection
1. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by the Owner.
  2. Drill test cores, where directed by the Owner, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
  3. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
  4. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 02614



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**SECTION 02614a - ROLLER COMPACTED CONCRETE PAVEMENT****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of roller compacted concrete pavement. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Submittals**

1. Product Data: For each type of product indicated.

**1.2 PRODUCTS****A. Cementitious Materials:**

1. Portland cement shall conform to ASTM C 150, Type I. Low alkali is to be used with aggregates when directed. In lieu of low-alkali cement, the Contractor may use a combination of Portland cement that does not meet the low-alkali requirement with a suitable pozzolan or ground granulated blast-furnace slag (GGBFS) provided the following requirement is met. The expansion of the proposed combination shall be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C 150 when tested in conformance with ASTM C 441. These two tests shall be performed concurrently at an independent certified laboratory at the Contractor's expense. the Owner reserves the right to confirm the test results and to adjust the percentage of pozzolan or GGBFS in the combination to suit other requirements at no additional cost to the Owner. Portland cement shall be furnished in bulk.
2. Pozzolan shall conform to ASTM C 618, and, in addition, limits in Table 2A, Uniformity Requirements (for air content) shall apply to all fly ash. Table 1A, Supplementary Optional Chemical Requirement for Maximum Alkalies, shall apply when it is to be used with aggregates listed to require low-alkali cement. Pozzolan shall be furnished in bulk.
3. The temperature of the cementitious materials as delivered to the site shall not exceed 150 degrees F.

**B. Admixtures:** All chemical admixtures furnished as liquids shall be in a solution of suitable viscosity and dilution for field use as determined by the Owner.

1. Water-Reducing Admixture (WRA) shall meet the requirements of ASTM C 494, Type D.
2. Air-entraining admixture shall conform to ASTM C 260.

**C. Water for washing aggregates and for mixing and curing concrete shall be free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and shall comply with COE CRD-C 400.****D. Aggregates**

1. Composition: Fine aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands. Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, air-cooled blast-furnace slag, or a combination thereof.

**OR**

All concrete mixtures will be proportioned by the Owner except that proportions for the slipformed facing concrete mixture will be selected by the Contractor. RCC shall be composed of cementitious materials, water, fine and coarse aggregates, and possibly admixtures. The cementitious material shall be portland cement, or portland cement in combination with pozzolan. An admixture when approved or directed will be a water-reducing/retarding admixture. Air-entraining admixture will be used in the bedding concrete and other conventional concrete.



### 1.3 EXECUTION

- A. **Concrete Mixing Plant:** A continuous mixing plant(s) shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional redi-mix batch plant and shall be capable of producing a uniform continuous product (at both maximum and minimum production rates) that is mixed so that complete intermingling of all ingredients occurs without balling, segregation, and wet or dry portions.
- B. **Trucks:** Truck mixers or agitators used for transporting central-mixed conventional concrete shall conform to the applicable requirements of ASTM C 94. Truck mixers shall not be used to transport concrete with larger than 37.5 mm (1-1/2-inch) nominal maximum size aggregate (NMSA) or 2 inch slump, or less. Nonagitators may be used for transporting conventional central-mixed concrete over a smooth road when the hauling time is less than 15 minutes and the slump is less than 3 inches. Bodies of nonagitators shall be smooth, water-tight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation.
- C. **Belt Conveyors:** Belt conveyors shall be designed and operated to assure a uniform flow of concrete from mixer or delivery truck to final place of deposit without segregation of ingredients or loss of mortar and shall be provided with positive means for preventing segregation of the concrete or loss of mortar at transfer points and the point of placing. The NMSA required in mixture proportions furnished by the Owner will not be changed to accommodate the belt width.
- D. **Spreading and Remixing Equipment:** The primary spreading procedure shall be accomplished by dozer. Graders or other equipment not specified may be used to facilitate the RCC spreading process only when approved. For open, unrestricted areas, the dozer shall be a minimum size and weight equivalent to a Caterpillar D-6. For restricted placement areas, such as placement of RCC near the dam crest or next to abutments, the dozer shall have as a minimum a size and weight equivalent to a Caterpillar D-4. There shall be a minimum of one operating dozer for each 200 cubic yards of RCC placed each hour. The dozers shall be equipped with well-maintained grousers. A front-end loader with operator shall be available to assist with deposition and spreading of RCC as needed in confined areas. The equipment shall be maintained in good operating condition. The equipment shall not leak or drip oil, grease, or other visible contaminants onto the RCC surface. All equipment used for spreading and remixing that leaves the surface of the structure for maintenance or repairs or, for any other reason, must be cleaned of all contaminants by an approved method before returning to the structure surface. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.
- E. **Compaction Equipment:**
  - 1. Self-propelled vibratory rollers shall be used for primary rolling and shall be double-drum. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a minimum gross mass of 20,000 pounds and shall produce a minimum dynamic force of 350 pounds per linear inch of drum width. The operating frequency shall be variable in the approximate range of 1,700 to 3,000 cycles per minute. The amplitude shall be adjustable between 0.015 and 0.04 inches. The roller shall be capable of full compaction in both forward and reverse directions. The roller shall be operated at speeds not exceeding 2.2 ft/s. Within the range of the operating capability of the equipment, the Owner may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate.
  - 2. Small vibratory rollers shall be used to compact the RCC where the larger vibratory rollers specified above cannot maneuver. The rollers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers. When small rollers are used, total lift thickness of the RCC layer or lift shall be reduced to not over 6 inches



- uncompacted thickness to permit adequate compaction. Rollers shall have independent speed and vibration controls and shall be capable of a wide range of speed adjustments.
3. The tampers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Tampers cannot compact the RCC to the same density and thickness as the primary rollers. When tampers are used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 6 inches uncompacted thickness to assure adequate compaction.
- F. Placing During Rain: RCC shall not be placed during rainfall of 0.1 inch/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the opinion of the Owner, no damage to the RCC is occurring. Work shall commence only after excess free surface water and contaminated paste or RCC have been removed. The surface shall have gained sufficient strength (no less than 4 hours after the RCC placement was suspended) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, the RCC surface shall be washed to break up and remove laitance and/or mud-like coatings from the surface. Any undercut coarse aggregate shall be removed. All waste shall be removed and disposed of in an approved manner.
- G. Hot-Weather Placement: In hot-weather placement the temperature of the RCC shall be controlled so that it does not exceed 75.0 degrees F when placed. Placement shall be suspended as soon as the RCC temperature exceeds 75 degrees F. Measures that can be taken to prevent temperatures exceeding 75 degrees F include, but are not limited to; 1.) chilling mixing water, 2.) sprinkling aggregate stockpiles, 3.) use of a canopy to shade the RCC placement areas, 4.) placing during nighttime and early morning hours, or 5.) restricting placements to cloudy days. Use of any of these systems shall not be reason for extension of completion dates specified in these specifications. In addition, to prevent potential damage to the RCC due to hot-weather related placement conditions, all RCC operation shall be suspended between June 15 and October 31, unless directed otherwise.

END OF SECTION 02614a



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## SECTION 02614b - STEEL REINFORCED PORTLAND CEMENT CONCRETE OVERLAYS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of steel reinforced Portland cement concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Coarse Aggregate:

1. Composition: Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, a combination thereof, or crushed blast-furnace slag.
2. Particle Shape: Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by ASTM D 3398.
3. Gradation: The maximum size of coarse aggregate shall be the lesser of 1/4 of the pavement thickness or 2 inches nominal size. Gradation limits are specified in ASTM C 136.
4. Deleterious Substances: The amount of deleterious substances in the coarse aggregate shall not exceed the limits, defined in ASTM C 117 and C 123.

- B. Fine Aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand and shall be composed of clean, hard, durable particles. Particles of the fine aggregate shall be generally spherical or cubical in shape. Gradation limits are specified in ASTM C 136.

- C. Portland Cement shall be Type I in compliance with ASTM C 150.

- D. Air-Entraining Admixture shall be in compliance with ASTM C 260. Concrete mixtures shall have air content by volume of concrete of 4 to 7 percent based on measurements made immediately after discharge from the mixer.

- E. Concrete Mixture shall have a nominal slump of 2 inches with a maximum of 3 inches and a 28-day flexural strength of not less than 650 psi.

- F. Joint and Crack Sealing Materials: Joint filler, joint sealant, and crack sealant shall comply with the following:

1. Expansion Joint Fillers shall comply with ASTM D 1751 or D 1752 or shall be resin impregnated fiberboard in compliance with the physical requirements of ASTM D 1752.
2. Type I Sealant shall comply with Fed. Spec. SS-S-200, except that sealant may be furnished as a ready-mixed liquid.
3. Type II Sealant shall comply with Fed. Spec. SS-S-1401.
4. Type V Sealant shall comply with COE CRD-C-527 and may be either a single- or multiple-component material.

- G. Epoxy-Resin Materials: Materials used in epoxy-resin grout, mortar, and concrete shall comply with the following:



1. Epoxy-Resin Grout shall be a two-compound material formulated to comply with ASTM C 881.
2. Epoxy-Resin Concrete shall be composed of epoxy-resin binder and uniformly graded aggregate in compliance with ASTM C 144. The maximum size of aggregate shall be 3/8 or 1/2 inch.

H. Steel Reinforcement: All reinforcement shall be free from loose flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce bond. Bar mats shall comply with ASTM A 184. Welded steel wire fabric shall comply with ASTM A 185. Tie bars shall be deformed bars in compliance with ASTM A 615, A 616, or A 617. Dowels shall be plain steel bars complying with ASTM A 499.

### 1.3 EXECUTION

- A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc. to meet the required grade. Bonding course shall be applied to the area prepared to receive overlay and shall be of epoxy-resin grout and Portland cement mortar.
- B. Reinforcement Steel shall be installed by the strike-off method wherein the concrete is deposited on the subgrade and struck to the indicated elevation of the steel. The reinforcement shall be laid upon the prestruck surface.
- C. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.
- D. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.
- E. Joints shall be saw cut and in alignment with underlying existing joints.
- F. Finishing:
1. Transverse Finishing: Immediately after placement, concrete shall be accurately struck off and screeded to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. The finishing machine shall make at least two trips over each area of pavement to compact the concrete and produce a surface of uniform texture, true to grade.
  2. Longitudinal Floating: After completion of the transverse finishing, the longitudinal mechanical float shall be operated to smooth and finish the pavement to grade.
  3. Hand Finishing shall be with an approved strike and tamping template and a longitudinal float.
  4. Straightedge Finishing: After the longitudinal floating is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. The final finish shall be made with the straightedges, which shall be used to float the entire pavement surface.
  5. Burlap Drag Finishing: When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, drag the surface of the pavement in the direction of the concrete placement with a multiple-ply burlap drag.
  6. Edging: After other finishing has been completed, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius.
- G. Concrete Curing and Protection:
1. Concrete Curing Methods shall consist of mat method, impervious sheeting method, or liquid membrane curing method.
  2. Concrete Protection: Protect repaired areas against damage prior to final acceptance. Traffic shall be excluded from repaired areas.



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END OF SECTION 02614b



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## SECTION 02614c - FIBER REINFORCED PORTLAND CEMENT CONCRETE OVERLAYS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of fiber reinforced Portland cement concrete overlays. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Coarse Aggregate:

1. Composition: Coarse aggregate shall consist of gravel, crushed gravel, crushed stone, a combination thereof, or crushed blast-furnace slag.
2. Particle Shape: Particles of the coarse aggregate shall be generally spherical or cubical in shape. The quantity of flat and elongated particles in any size group shall not exceed 20 percent by weight as determined by ASTM D 3398.
3. Gradation: The maximum size of coarse aggregate shall be the lesser of 1/4 of the pavement thickness or 2 inches nominal size. Gradation limits are specified in ASTM C 136.
4. Deleterious Substances: The amount of deleterious substances in the coarse aggregate shall not exceed the limits, defined in ASTM C 117 and C 123.

- B. Fine Aggregate shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sand and shall be composed of clean, hard, durable particles. Particles of the fine aggregate shall be generally spherical or cubical in shape. Gradation limits are specified in ASTM C 136.

- C. Portland Cement shall be Type I in compliance with ASTM C 150.

- D. Air-Entraining Admixture shall be in compliance with ASTM C 260. Concrete mixtures shall have air content by volume of concrete of 4 to 7 percent based on measurements made immediately after discharge from the mixer.

- E. Concrete Mixture shall have a nominal slump of 2 inches with a maximum of 3 inches and a 28-day flexural strength of not less than 650 psi.

- F. Joint and Crack Sealing Materials: Joint filler, joint sealant, and crack sealant shall comply with the following:

1. Expansion Joint Fillers shall comply with ASTM D 1751 or D 1752 or shall be resin impregnated fiberboard in compliance with the physical requirements of ASTM D 1752.
2. Type I Sealant shall comply with Fed. Spec. SS-S-200, except that sealant may be furnished as a ready-mixed liquid.
3. Type II Sealant shall comply with Fed. Spec. SS-S-1401.
4. Type V Sealant shall comply with COE CRD-C-527 and may be either a single- or multiple-component material.

- G. Epoxy-Resin Materials: Materials used in epoxy-resin grout, mortar, and concrete shall comply with the following:



1. Epoxy-Resin Grout shall be a two-compound material formulated to comply with ASTM C 881.
2. Epoxy-Resin Concrete shall be composed of epoxy-resin binder and uniformly graded aggregate in compliance with ASTM C 144. The maximum size of aggregate shall be 3/8 or 1/2 inch.

H. Steel Fibers: The fibers shall be made from low carbon steel. The following sizes of steel are acceptable:

1. 0.010-inch x 0.022-inch flat steel fiber,
2. 0.010-inch x 0.50-inch round steel fiber,
3. 0.016-inch x 1.0-inch round steel fiber,
4. 0.016-inch x 0.75-inch round steel fiber with 0.010-inch x 0.020-inch flat section along the length of the fiber
5. 2.5-inch x 0.025-inch round steel fibers.

### 1.3 EXECUTION

A. Preparation of Existing Surface: The Contractor shall raise and reset all structures such as manhole frames, valve boxes, drainage structures, etc. to meet the required grade. Bonding course shall be applied to the area prepared to receive overlay and shall be of epoxy-resin grout and Portland cement mortar.

B. Reinforcement Steel shall be installed by the strike-off method wherein the concrete is deposited on the subgrade and struck to the indicated elevation of the steel. The reinforcement shall be laid upon the prestruck surface.

C. Concrete Placement: Concrete shall be placed within 45 minutes from the time all ingredients are charged into the mixing drum.

D. Vibration: In the final phases of placing, surface vibrating equipment shall be used, and the duration of vibration shall not exceed 20 seconds.

E. Joints shall be saw cut and in alignment with underlying existing joints.

F. Finishing:

1. Transverse Finishing: Immediately after placement, concrete shall be accurately struck off and screeded to such elevation that when consolidated and finished, the surface of the pavement will be free from porous places and will be at the required grade. The finishing machine shall make at least two trips over each area of pavement to compact the concrete and produce a surface of uniform texture, true to grade.
2. Longitudinal Floating: After completion of the transverse finishing, the longitudinal mechanical float shall be operated to smooth and finish the pavement to grade.
3. Hand Finishing shall be with an approved strike and tamping template and a longitudinal float.
4. Straightedge Finishing: After the longitudinal floating is completed but while the concrete is still plastic, minor irregularities and score marks in the pavement surface shall be eliminated by means of long-handled wood floats and straightedges. The final finish shall be made with the straightedges, which shall be used to float the entire pavement surface.
5. Broom Finishing: Burlap drag finishing will not be allowed as this brings the steel fibers to the surface. Finishing shall be accomplished using a stiff broom.
6. Edging: After other finishing has been completed, the edges of slabs along the forms and at the joints shall be carefully finished with an edging tool to form a smooth rounded surface of the required radius.

G. Concrete Curing and Protection:

1. Concrete Curing Methods shall consist of mat method, impervious sheeting method, or liquid membrane curing method.



2. Concrete Protection: Protect repaired areas against damage prior to final acceptance. Traffic shall be excluded from repaired areas.

END OF SECTION 02614c



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## SECTION 02617 - CRACK SEALING OF BITUMINOUS PAVEMENTS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for crack sealing of bituminous pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Manufacturer's Recommendations: Where installation procedures, or any part thereof, are required to be in accordance with the manufacturer's recommendations, printed copies of these recommendations shall be submitted to the Owner. Installation of the material will not be allowed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.
2. Schedules/Construction Equipment List: List of proposed equipment to be used in performance of construction work including descriptive data shall be submitted to the Owner.
3. Samples: Samples of the materials (sealant, primer if required, and backup material), in sufficient quantity for testing and approval shall be submitted to the Owner. No material will be allowed to be used until it has been approved.

- C. Safety: Joint sealant shall not be placed within 25 feet of any liquid oxygen (LOX) equipment, LOX storage, or LOX piping. Joints in this area shall be thoroughly cleaned and left unsealed.

- D. Test Requirements: The joint sealant and backup or separating material shall be tested for conformance with the referenced applicable material specification. Testing of the materials shall be performed in an approved independent laboratory and certified copies of the test reports shall be submitted and approved prior to the use of the materials at the job site. Samples will be retained by the Owner for possible future testing should the materials appear defective during or after application. Conformance with the requirements of the laboratory tests specified will not constitute final acceptance of the materials. Final acceptance will be based on the performance of the in-place materials.

- E. Equipment: Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and shall be maintained in satisfactory condition at all times.

### 1.2 PRODUCTS

#### A. Materials

1. Liquid Asphalt: ASTM D 2027, Grade MC-250.
2. Emulsified Asphalt: ASTM D 977, Grade AS-2.
3. Sealing Compound: ASTM D 3405.
4. Backer Rod: ASTM D 5249.
5. Fine Aggregate: Natural sand or crusher dust having a maximum size of not more than 1/8 inch and be free of clay or organic-matter.

### 1.3 EXECUTION

#### A. Preparation:

1. All cracks to be sealed shall be cleaned of dirt and debris, and moisture shall be removed.



2. Crack Cleaning Equipment shall consist of a portable air compressor with hose and nozzles for directing air directly into cracks and stiff bristle brooms.
3. Heating Equipment for Liquid Asphalt shall be mobile and shall be equipped with an agitating device for stirring material during heating, a thermometer, regulating equipment for heat control, and a gravity-type draw-off valve.
4. Heating Equipment for Sealing Compound: Unless otherwise required by the manufacturer's recommendations, the equipment shall be mobile and shall consist of double-boiler, agitator-type kettles with oil medium in the outer space for heat transfer. The applicator unit shall be so designed that the sealant will circulate through the delivery hose and return to the inner kettle when not sealing cracks.
5. Application Equipment shall have a spout or nozzle of such size that the sealing material will be placed in the cracks without entrapping air in cracks or spreading material on adjacent pavement surface.

B. Installation:

1. Backer Rod: Install backer in accordance with manufacturer's instructions where required under sealing compound.
2. Sealing Compound: All cracks 1/8 inch wide and wider shall be sealed. The application temperature for sealing compound shall comply with ASTM C 1193. Cracks 1/2 inch wide and wider shall be filled with a slurry of fine sand and an emulsified asphalt or liquid asphalt. After the slurry has cured, cracks shall be sealed with liquid asphalt or emulsified asphalt and lightly sanded.
3. Liquid and Emulsified Asphalt Sealer: The temperature shall be varied so that it flows freely into cracks and completely fills cracks without entrapping air. Cracks shall be free of moisture before filling and shall be filled slightly above the pavement surface. When excess sealer has been removed, the sealer shall be covered with fine sand.
4. Traffic Control: Traffic will not be permitted over sealed cracks until the sealer has cooled so that it is not picked up by vehicle tires. The Contractor will be responsible for all barricades and flagmen necessary to control traffic.

END OF SECTION 02617



## SECTION 02617a - SPRAY APPLICATIONS, SEAL COATS, AND SURFACE TREATMENTS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for the spray applications, seal coats, and surface treatments of asphalt concrete pavements. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

- A. Bituminous Material: Bituminous material shall be liquid asphalt complying with ASTM D 2028, Grade RC-25O, or tar complying with ASTM D 490, Grade RT-6.

- B. Aggregate: Aggregates shall consist of crushed stone, crushed gravel, or crushed slag. The moisture content of the aggregate shall be such that the aggregate will be readily coated with the bituminous material. Aggregate gradations shall be in compliance with ASTM C 136.

#### C. Construction Equipment

1. Bituminous Distributor shall be designed and equipped to distribute the bituminous material uniformly at even heat on variable widths of surface at readily determined and controlled rates and pressures recommended by the manufacturer and with an allowable variation from any specified rate not exceeding 5 percent.
2. Single-Pass Surface Treatment Machine shall be capable of distributing the bituminous material and aggregates uniformly in controlled amounts in a single-pass operation over the surface to be sealed.
3. Heating Equipment for Storage Tanks shall consist of steam coils, hot oil coils, or electrical coils. If steam or hot oil coils are used, the coils must be so designed and maintained that the bituminous material cannot become contaminated.
4. Power Rollers shall be the self-propelled tandem and three-wheel type rollers, weighing not less than 5 tons and shall be suitable for rolling bituminous pavements.
5. Self-Propelled Pneumatic-Tired rollers shall have a total compacting width of not less than 60 inches. The gross weight shall be adjustable within the ranges of 200 to 350 lb/in. of compacting width.
6. Spreading Equipment: Aggregate spreading equipment shall be adjustable and capable of spreading aggregate at controlled amounts per square yard.
7. Drags: Broom drags shall consist of brooms mounted on a frame, designed to spread fine aggregate uniformly over the surface of a bituminous pavement. Towing equipment shall have pneumatic tires.
8. Brooms and Blowers shall be of the power type and shall be suitable for cleaning surfaces of bituminous pavements.

### 1.3 EXECUTION

#### A. Installation

1. Spreading Aggregate: Application of seal aggregate shall immediately follow the application of bituminous material, and in no case shall the time to application exceed 15 minutes.



2. Brooming and Rolling: Begin the rolling operations immediately following the application of cover aggregate. Rolling shall be accomplished with pneumatic-tired rollers; steel-wheeled rollers shall be used in a supplementary capacity only. All surplus aggregate shall be swept off the surface and removed not less than 26 hours or more than four days after rolling is completed.

END OF SECTION 02617a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02617	02612a	Asphalt Paving

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## SECTION 02618 - TRAFFIC COATINGS

### 1.1 GENERAL

#### A. Description Of Work:

1. This specification covers the furnishing and installation of materials for traffic coating. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes traffic coatings for the following applications:
  - a. Interior and exterior pedestrian traffic.
  - b. Vehicular traffic.
  - c. Pavement markings.

#### C. Submittals

1. Product Data: For each product indicated.
2. Shop Drawings: Show extent of each traffic coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions.
3. Samples: For each type of finish indicated.
4. Material test reports.
5. Material certificates.
6. Qualification data.
7. Maintenance data.
8. Warranty.
9. LEED Submittal:
  - a. Product Data for Credit EQ 4.2: For interior field-applied traffic coatings and pavement marking paints, including printed statement of VOC content.

#### D. Quality Assurance

1. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of traffic coatings required for this Project.
2. Fire-Test-Response Characteristics: Provide traffic coating materials with the fire-test-response characteristics as determined by testing identical products per test method below for deck type and slopes indicated by an independent testing and inspecting agency that is acceptable to authorities having jurisdiction.
  - a. Class A **OR B OR C, as directed**, roof covering per ASTM E 108 or UL 790.
3. Preinstallation Conference: Conduct conference at Project site.

#### E. Delivery, Storage, And Handling

1. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing the following information:
  - a. Manufacturer's brand name.
  - b. Type of material.
  - c. Directions for storage.
  - d. Date of manufacture and shelf life.
  - e. Lot or batch number.
  - f. Mixing and application instructions.
  - g. Color.
2. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

#### F. Project Conditions



1. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F (5 deg C), when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F (3 deg C) above dew point.
  - a. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of substrate.
2. Do not install traffic coating until items that will penetrate membrane have been installed.

G. Warranty

1. Special Warranty: Manufacturer's standard form in which traffic coating manufacturer agrees to repair or replace traffic coatings that deteriorate during the specified warranty period. Warranty does not include deterioration or failure of traffic coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new substrate cracks exceeding 1/16 inch (1.6 mm) in width, fire, vandalism, or abuse by snowplow, maintenance equipment, and truck traffic.
  - a. Deterioration of traffic coatings includes the following:
    - 1) Adhesive or cohesive failures.
    - 2) Abrasion or tearing failures.
    - 3) Surface crazing or spalling.
    - 4) Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.
  - b. Warranty Period: Five years from date of Substantial Completion.

## 1.2 PRODUCTS

A. Materials

1. Traffic Coatings: Complying with ASTM C 957.
2. Material Compatibility: Provide primers; base, intermediate, and topcoats; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
3. VOC Content: Provide traffic coatings and pavement marking paints, for use inside the weatherproofing system, with VOC content of 150 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Traffic Coating

1. Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.
  - a. Material: Epoxy **OR** Urethane, **as directed**.
2. Preparatory and Base Coats: Single- or multicomponent, aromatic liquid urethane elastomer.
3. Intermediate Coat: Single- or multicomponent, aromatic liquid urethane elastomer **OR** Single- or multicomponent, aliphatic liquid urethane elastomer **OR** Liquid epoxy, **as directed**.
4. Topcoat: Single- or multicomponent, aromatic liquid urethane elastomer **OR** Single- or multicomponent, aliphatic liquid urethane elastomer **OR** Single- or multicomponent, aromatic liquid urethane elastomer with UV inhibitors **OR** Liquid epoxy, **as directed**.
  - a. Color: As selected by the Owner from manufacturer's full range.
5. Aggregate: Uniformly graded, washed silicon carbide sand **OR** Uniformly graded, washed silica sand **OR** Uniformly graded, washed flint shot silica **OR** Walnut shell granules **OR** Aluminum-oxide grit, **as directed**, of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.
  - a. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated, but not less than the following:
    - 1) Intermediate Coat: 8 to 10 lb/100 sq. ft. (3.6 to 4.5 kg/10 sq. m) **OR** To refusal, **as directed**.





- 2) Topcoat: 8 to 10 lb/100 sq. ft. (3.6 to 4.5 kg/10 sq. m) **OR** As required to achieve slip-resistant finish, **as directed**.

C. Miscellaneous Materials

1. Joint Sealants: As specified in Division 07 Section "Joint Sealants".
2. Sheet Flashing: Nonstaining.
  - a. Minimum Thickness: 60 mils (1.5 mm) **OR** 50 mils (1.3 mm), **as directed**.
  - b. Material: Sheet material recommended in writing by traffic coating manufacturer **OR** Uncured neoprene sheet **OR** Cured neoprene sheet, **as directed**.
3. Adhesive: Contact adhesive recommended in writing by traffic coating manufacturer.
4. Reinforcing Strip: Fiberglass mesh recommended in writing by traffic coating manufacturer.

D. Pavement Markings

1. Pavement-Marking Paint: Alkyd-resin ready mixed, complying with AASHTO M 248, Type S **OR** N **OR** F, **as directed**.
  - a. Color: White **OR** Yellow **OR** As indicated, **as directed**.
    - 1) Use blue for spaces accessible to people with disabilities.
2. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, with drying time of less than three **OR** 45, **as directed**, minutes.
  - a. Color: White **OR** Yellow **OR** As indicated, **as directed**.
    - 1) Use blue for spaces accessible to people with disabilities.
3. Glass Beads: AASHTO M 247, Type 1.

### 1.3 EXECUTION

A. Examination

1. Examine substrates, with Installer present, for compliance with requirements and for other conditions affecting performance of traffic coatings.
  - a. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
  - b. Verify compatibility with and suitability of substrates.
  - c. Begin coating application only after minimum concrete curing and drying period recommended by traffic coating manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.
  - d. Verify that substrates are visibly dry and free of moisture.
    - 1) Test for moisture vapor transmission by plastic sheet method according to ASTM D 4263.
    - 2) Test for moisture content by measuring with an electronic moisture meter **OR** method recommended in writing by manufacturer, **as directed**.
  - e. Application of coating indicates acceptance of surfaces and conditions.

B. Preparation

1. Clean and prepare substrates according to ASTM C 1127 and manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.
2. Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.
3. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.
  - a. Remove grease, oil, paints, and other penetrating contaminants from concrete.
  - b. Remove concrete fins, ridges, and other projections.
  - c. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
  - d. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.



C. Terminations And Penetrations

1. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.
2. Provide sealant cants at penetrations and at reinforced and nonreinforced, deck-to-wall butt joints.
3. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.
4. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

D. Joint And Crack Treatment

1. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.
  - a. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

E. Traffic Coating Application

1. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.
  - a. Start traffic coating application in presence of manufacturer's technical representative.
  - b. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft. (9 sq. m).
2. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated, and omit aggregate on vertical surfaces.
3. Cure traffic coatings according to manufacturer's written recommendations. Prevent contamination and damage during application and curing stages.

F. Pavement Markings

1. Do not apply traffic paint for striping and other markings until traffic coating has cured according to manufacturer's written recommendations.
2. Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates for a 15-mil- (0.38-mm-) minimum wet film thickness.
3. Spread glass beads uniformly into wet traffic paint at a rate of 6 lb/gal. (0.72 kg/L).

G. Field Quality Control

1. Testing: Engage a qualified testing agency to perform the following field tests and inspections and prepare test reports:
  - a. Samples of material delivered to Project site shall be taken, identified, sealed, and certified in presence of Owner and Contractor.
  - b. Testing agency shall perform tests for characteristics specified, using applicable referenced testing procedures.
  - c. Testing agency shall verify thickness of coatings during traffic coating application.
  - d. If test results show traffic coating materials do not comply with requirements, remove noncomplying materials, prepare surfaces, and reapply traffic coatings.
2. Flood Testing: Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after traffic coating has completely cured. Install temporary containment assemblies, plug or dam drains, and flood with potable water.
  - a. Flood to an average depth of 2-1/2 inches (65 mm) with a minimum depth of 1 inch (25 mm) and not exceeding a depth of 4 inches (100 mm).
  - b. Flood each area for 24 **OR** 48 **OR** 72, **as directed**, hours.
  - c. After flood testing, repair leaks, repeat flood tests, and make further repairs until traffic coating installation is watertight.
  - d. Engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.



3. Final Traffic Coating Inspection: Arrange for traffic coating manufacturer's technical personnel to inspect membrane installation on completion.
    - a. Notify the Owner or Owner 48 hours in advance of date and time of inspection.
  4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- H. Protecting And Cleaning
1. Protect traffic coatings from damage and wear during remainder of construction period.
  2. Clean spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 02618



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02618	02612a	Asphalt Paving
02618	02614	Cement Concrete Pavement

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## SECTION 02620 - STEEL CURBS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of steel curbs. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

- A. Standard Steel Curb Sections: Noncorrosive steel sections as required to match existing.

- B. Coating: Steel curb sections shall be zinc coated.

#### C. Joint Materials

1. Expansion Joint Fillers: ASTM D 1751 or ASTM D 1752.
2. Joint Sealers: ASTM D 1850.

- D. Concrete: Concrete shall have a minimum compressive strength of 3,000 psi. The maximum size of aggregate shall be 1-1/2 inches. Concrete shall have a slump of not more than 3 inches and an air content by volume of concrete of 3 to 6 percent.

### 1.3 EXECUTION

- A. Preparation: The subgrade shall be constructed to grade and cross section. The subgrade shall be of materials equal in bearing quality to the subgrade under the adjacent pavement and shall be compacted. The subgrade shall be maintained in a smooth, compacted condition, in conformity with the required section and established grade until the concrete is placed. The subgrade shall be in a moist condition when concrete is placed.

#### B. Installation

1. Steel Curb Setting: Steel curbs shall be carefully set to alignment and grade and to conform to the dimensions of the curb.
2. Concrete Placement And Finishing: Concrete shall be placed in layers not to exceed 6 inches. Concrete shall be thoroughly consolidated. Floated surfaces shall then be brushed with longitudinal strokes. The top surface of the entrance shall be finished to grade with a wood float. Expansion joints and contraction joints shall be constructed at right angles to the line of curb. Contraction joints shall be constructed by means of 1/8-inch thick separators, of a section conforming to the cross section of the curb and gutter. Contraction joints shall match joints in abutting Portland cement concrete pavement. At other pavements, construction joints shall be placed at not less than 5 feet nor greater than 15 feet apart. Expansion joints shall be formed by means of preformed expansion joint filler material cut and shaped to the cross section of curb. Expansion joints shall be provided in curb at the end of all returns. Expansion joints shall match expansion joints of abutting Portland cement concrete pavement. At other pavements, expansion joints at least 1/2 inch in width shall be provided at intervals not exceeding 45 feet. Exposed concrete surfaces shall be cured for not less than 7 days.



3. Backfilling: After curing, debris shall be removed and the area adjoining the concrete shall be backfilled, graded, and compacted.
4. Sealing Joints: Expansion joints and the top 1-inch depth of contraction joints shall be sealed with joint sealer. The joint opening shall be thoroughly cleaned before the sealing material is placed. Excess material on exposed surfaces of the concrete shall be removed immediately and exposed concrete surfaces cleaned.

END OF SECTION 02620





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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02620	02614	Cement Concrete Pavement

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## SECTION 02630 - ASPHALT CONCRETE SIDEWALKS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of asphalt concrete sidewalks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Asphaltic Concrete:

1. Hot-Mixed, Hot-Laid Bituminous Paving Mixtures: ASTM D 3515.
2. Plant-Mixed, Stockpiled Asphalt Cold Mixes: Asphalt Institute Manual MS-14.

#### B. Bituminous Prime: ASTM D 2027, Grades MC-30 or MC-70; ASTM D 2028, Grade RC-70; or ASTM D 2026, Grade SC-70.

#### C. Base Course: ASTM D 2940.

#### D. Bituminous Tack Coat: ASTM D 977, Grades RS-1, MS-1 or SS-1h; ASTM D 2027, Grade MC-30; ASTM D 2028, Grade RC-70; ASTM D 2026, Grade SC-70; or ASTM D 2397, Grades CRS-1 or CSS-1.

#### E. Seal Coat: ASTM D 2027, Grade HC-250 or MC-800; or D 2028, Grade RC-250 or RC-800.

#### F. Slurry Coat Mixture shall be comprised of 70 percent sand or fine aggregate, 10 percent water, and 20 percent liquid or emulsified asphalt.

1. Fine Aggregate: ASTM D 1073, Grade 2.
2. Emulsified Asphalt: ASTM D 977, Grades SS-1 or SS-1h.

### 1.3 EXECUTION

#### A. Application Temperatures: Application temperatures for all asphalt materials shall comply with provisions of the Asphalt Institute publications and the applicable ASTM standards.

#### B. Subgrade: Construct the subgrade for walkway replacement true to grade and compact as required.

#### C. Base Course

1. Placing: Spread the base course material evenly upon the prepared subgrade, in a layer of such depth that when compacted the layer will be uniform and of the thickness required.
2. Compaction: Immediately following the spreading of the material, compact the base course with equipment to a density as required.

#### D. Surface Course

1. Placing: Apply prime coat, and allow it to cure. The placing of the mixture shall be continuous. Paint all contact surfaces of previously constructed sidewalk with a tack coat of rapid-setting liquid asphalt just before the fresh mixture is placed.



2. Forms: Set forms with the upper edge true to line and hold grade rigidly in place by stakes placed on the outside of the forms and set flush with the top edge of the forms.
3. Compaction: Immediately following the placement of the asphalt concrete mixture, compact the surface course with equipment to a density as required.
4. Backfilling: After removing the forms and debris, backfill the exposed or excavated area adjoining the sidewalk with granular material, grade, and compact to conform to the surrounding area.

E. Patching

1. For Repair Operations Involving Raveling, Heaving, Spalling, and Alligating: Cut asphalt concrete paving back to solid material, making cut area rectangular with vertical sides. Remove deteriorated pavement including base material if required. Replace base course, compact, and tack coat the base material and the vertical surfaces of cut area. Fill area with new asphalt concrete and compact level with existing walkway. Dust patched area with sand or mineral dust.
2. Pothole Repair: Cut rectangular hole around pothole back to solid pavement leaving straight, vertical edges. Remove loose material and water to firm base. Fill holes and compact to within 3 inches of the surface in layers not exceeding 6 inches with either base material or asphalt mixture. Apply tack coat to base material and vertical edges. On the surface layer, fill with asphalt mixture and mound to such height that when compacted the mix will be level with surrounding walkway surface. Dust patched area with sand or mineral dust.
3. Low Spot or Depression Repair: Determine limits of depression with straightedge, and mark outline with crayon. Apply tack coat, 0.05 to 0.15 gallon per square yard, to the cleaned area, and allow to cure. Spread area with asphalt concrete mix and feather edge by raking and manipulation of the material. Roll and compact area to surrounding walkway level. Recheck with straightedge. Apply a sand seal to the patched area to prevent entrance of water.
4. Polished Aggregate Repair: Clean and dry area thoroughly. Apply tack coat at a rate of 0.05 to 0.15 gallon per square yard; overlay area with new asphalt concrete mix to a minimum 1-1/2 inch thickness and feather to adjoining walkway surfaces. Roll with pneumatic or steel rollers.
5. Damaged Edging Repair: Remove damaged or deteriorated edging materials and replace.
6. Prime Coat: Prime new base course with MC-70 liquid asphalt at a rate of 0.20 to 0.30 gallon per square yard. Take care to apply to more asphalt than will penetrate into the base course during curing. Blot excess prime with sand before the surfacing material is applied.
7. Tack Coat: Surfaces and cut edges of existing asphalt concrete shall be given a tack coat of MC-70 liquid asphalt at a rate of 0.05 to 0.15 gallon per square yard. After application of the tack coat, allow time for the material to cure before surfacing and patching material is placed.
8. Seal Coat Spray Application: Walkway surfaces that are to be sealed shall receive a liquid asphalt coat applied at a rate of 0.15 to 0.20 gallon per square yard, along with a fine aggregate at a rate of 15 to 20 pounds per square yard.

- F. Crack Repair: Fill cracks after drying with liquid asphalt, sand asphalt emulsion water mixture, or slurry seal. After thorough cleaning, work the mixture into cracks by broom or squeegee. Cracks 1/8 to 1/2 inch width shall be slurry sealed and filled with liquid asphalt. Dust repaired cracks with fine aggregate or mineral dust to prevent cracking. Final thickness of the slurry seal shall be 1/8 inch minimum.

END OF SECTION 02630



## SECTION 02630a - MISCELLANEOUS SIDEWALKS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of miscellaneous sidewalks. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Aggregate shall comply with the following:

1. Surface Course Aggregates shall be well-graded, crushed stone, 3/4- to 1-1/4 inch size, consisting of clean, sound, durable particles.
2. Masonry Grout Aggregate: ASTM C 404, Size 2.

#### B. Base Course: Base course material shall be a granular dense-graded, high-quality compactable material.

#### C. Ready-Mixed Concrete: Ready-mixed concrete shall comply with ASTM C 94. The concrete shall attain a minimum compressive strength of 3,000 psi at 28 days.

#### D. Portland Cement Concrete: Cement shall comply with ASTM C 150.

#### E. Joint Filler: Masonry joint filler shall be Portland cement concrete mix with cement complying with ASTM C 150.

#### F. Masonry Units: Color and texture shall match the existing as nearly as is practicable.

#### G. Wood and Preservatives: Footboards and supports shall be 1-1/2 inch thick Number 1 dense Douglas fir or yellow pine lumber, pressure-treated with chromated copper arsenate (CCA) preservative complying with applicable ASTM Standards. Retention shall be a minimum of 0.25 pounds per cubic foot.

### 1.3 EXECUTION

#### A. Base Course Repair: Remove material in soft spots to such depth required to provide a firm foundation for surface materials and fill with granular material of a quality that will compact when moistened. Roll or tamp this material to obtain the proper density.

#### B. Surface Repair

1. Aggregate Walkways: Spread the surface material evenly on the base course in a layer of such depth that when compacted, the layer will be uniform with a minimum thickness of 4 inches.
2. Joint Filling: Completely remove and clean the joint of all loose joint material, dirt, clay, or other foreign matter. Fill the joint flush with concrete to provide a uniform surface.
3. Wood Walkways: Secure wood members with galvanized nails, screws, bolts, or other approved fasteners to ensure tight joints.



4. Masonry Walkways: New or salvaged masonry units will be placed on a 3/4-inch mortar setting bed with mortar joints matching the existing walkway. Place the setting bed on a fresh 3-inch thick Portland cement concrete slab.

END OF SECTION 02630a



## SECTION 02630b - PRECAST SIDEWALKS AND PAVERS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of precast sidewalks and pavers. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.
  - a. For stone varieties proposed for use on Project, include data on physical properties specified or required by referenced ASTM standards.
2. Stone Samples: For each color, grade, finish, and variety of stone required.

### 1.2 PRODUCTS

#### A. Precast Concrete Patio Blocks: ASTM C 936. Natural or colored, minimum 2 inches thick.

#### B. Exposed Aggregate or Granite: ASTM C 615 and National Building Granite Quarries Association, Inc.

1. Exposed Limestone: Limestone (Oolitic), ASTM C 568, Category II.
2. Exposed White Tumblestone Aggregate: As required to meet project requirements.

#### C. Stone Pavers

1. Bluestone Flagging Paver: Irregular cut, 1 inch thick.
2. White Marble, Crushed Stone: ASTM C 503 and Marble Institute of America (MIA), 3 inches thick.
3. Bluestone, Crushed Stone: 3 inches thick.
4. Natural Cleft Slate: ASTM C 629, 3/4-inch irregular cut, 1/2-inch random rectangular cut, or 1/4-inch random rectangular butted joints.

#### D. Granite Blocks: Blocks shall be 3 to 5 inches thick and comply with requirements of ASTM C 615 and National Building Granite Quarries Association, Inc. Sizes shall be 3-1/2 inches square; 4 to 12 inches by 3 to 5 inches; and 6 to 15 inches by 3 to 6 inches.

#### E. Mortar and Grout

1. Portland Cement: ASTM C 150 and the staining requirements of ASTM C 91.
2. Masonry Cement: ASTM C 91, non-staining.
3. Hydrated Lime: ASTM C 207, Type S.
4. Sand: ASTM C 144.
  - a. White Pointing Mortar: Natural white sand or ground white stone.
  - b. Colored Pointing Mortar: Marble, granite, or sound stone.

### 1.3 EXECUTION

#### A. Preparation

1. Clean stone or concrete block with clear water.
2. Ferrous Metal: Apply a heavy coat of bituminous paint on metal surfaces in contact with block.

#### B. Installation



1. Expansion Joints: Install continuous strips of preformed joint filler.
2. Clean sub-base and saturate with clean water.
3. Slush Coat: Apply 1/16-in. thick slush coat of cement grout over concrete sub-base about 15 minutes prior to placing setting bed.
4. Setting Bed: Mix one 94-lb. bag of cement to 3 cu. ft. of sand. Use only enough water to produce a moist surface when setting bed is ready for setting of stone. Spread and screed to a uniform thickness.
5. Set stone or concrete block before initial set of cement bed occurs. Wet stone or block thoroughly before setting. Apply a thin layer of neat cement paste 1/32-in. to 1/16-in. thick to setting bed, or bottom of stone or block.
6. Grout joints as soon as possible after initial set of setting bed and tool slightly concave. Use grout mix of one bag Portland cement to 2 cu. ft. sand. Cure grout by maintaining in a moist condition for 7 days. Do not permit traffic on surface during setting of units or for at least 24 hours after final grouting of joints.

END OF SECTION 02630b





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Task	Specification	Specification Description
02630	02264c	Unit Pavers

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## SECTION 02695 - POROUS UNIT PAVING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for porous unit paving. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes the following:
  - a. Porous paving consisting of concrete pavers set in aggregate setting beds.
  - b. Edge restraints.
  - c. Cast-in-place concrete edge restraints.
  - d. Precast concrete curbs.
  - e. Granite curbs.

#### C. Submittals

1. Product Data: For materials other than aggregates.
2. Sieve Analyses: For aggregate materials, according to ASTM C 136.
3. Samples:
  - a. Full-size units of each type of unit paver indicated.
  - b. Exposed edge restraints.
  - c. Precast concrete curbs.
  - d. Granite curbs.
  - e. Aggregate fill.
4. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

#### D. Quality Assurance

1. Preinstallation Conference: Conduct conference at Project site.

#### E. Delivery, Storage, And Handling

1. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
2. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

### 1.2 PRODUCTS

#### A. Concrete Unit Pavers

1. Concrete Grid Pavers: Grid paving units complying with ASTM C 1319, made from normal-weight aggregates.
2. Solid Concrete Pavers for Porous Paving: Solid interlocking paving units of shapes that provide openings between units, complying with ASTM C 936, resistant to freezing and thawing when tested according to ASTM C 67, **as directed**, and made from normal-weight aggregates.
  - a. Thickness: 2-3/8 inches (60 mm) **OR** 3-1/8 inches (80 mm) **OR** 3-1/2 inches (90 mm) **OR** 4 inches (100 mm), **as directed**.
  - b. Face Size and Shape: As indicated.
  - c. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.



## B. Accessories

1. Plastic Edge Restraints: Triangular PVC extrusions, 1-3/4 inches (45 mm) high by 3-1/2 inches (90mm) wide **OR** 3-1/8 inches (80 mm) high by 9-1/2 inches (240 mm) wide, **as directed**, designed to serve as edge restraints for unit pavers; rigid type for straight edges and flexible type for curved edges, with pipe connectors and 3/8-inch- (9.5-mm-) diameter by 12-inch- (300-mm-) long steel spikes.
2. Steel Edge Restraints: Painted steel edging, 3/16 inch (4.8 mm) thick by 4 inches (100 mm) high **OR** 1/4 inch (6.4 mm) thick by 5 inches (125 mm) high, **as directed**, with loops pressed from or welded to face to receive stakes at 36 inches (900 mm) o.c., and with steel stakes 15 inches (380 mm) long for each loop.
  - a. Color: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
3. Aluminum Edge Restraints: Straight, 1/8-inch- (3.2-mm-) thick by 4-inch- (100-mm-) high **OR** Straight, 3/16-inch- (4.8-mm-) thick by 4-inch- (100-mm-) high **OR** L-shaped, 1/8-inch- (3.2-mm-) thick by 1-3/8-inch- (35-mm-) high **OR** L-shaped, 3/16-inch- (4.8-mm-) thick by 2-1/4-inch- (57-mm-) high, **as directed**, extruded-aluminum edging, with loops pressed from face to receive stakes at 12 inches (300 mm) o.c., and with aluminum stakes 12 inches (300 mm) long for each loop.
4. Precast Concrete Curbs: Made from normal-weight concrete with a compressive strength not less than 5000 psi (35 MPa) **OR** 6000 psi (41 MPa), **as directed**, and water absorption not more than 5 percent, in shapes and sizes indicated.
  - a. Color and Texture: As indicated by manufacturer's designations **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
5. Granite Curbs: Granite curbing, with face battered 1 inch per foot (1:12), produced in random lengths not less than 36 inches (900 mm) from granite complying with ASTM C 615.
  - a. Granite Color and Grain: Light gray **OR** Dark gray **OR** Buff **OR** White **OR** Black **OR** Pink, **as directed**, with fine **OR** medium **OR** coarse, **as directed**, grain.
  - b. Top Width: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 6 inches (150 mm), **as directed**.
  - c. Face Height: 4 inches (100 mm) **OR** 6 inches (150 mm) **OR** 8 inches (200 mm), **as directed**.
  - d. Total Height: 12 inches (300 mm) **OR** 16 inches (400 mm) **OR** 18 inches (450 mm), **as directed**.
  - e. Top Finish: Sawed **OR** Thermal **OR** Bushhammered, **as directed**.
  - f. Face Finish: Split **OR** Sawed **OR** Thermal **OR** Bushhammered, **as directed**.

## C. Aggregate Setting-Bed Materials

1. Graded Aggregate for Subbase: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 57 **OR** ASTM D 448 for Size No. 5 **OR** ASTM D 2940, subbase material **OR** requirements in Division 02 Section "Earthwork" for subbase material, **as directed**.
2. Graded Aggregate for Base Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** ASTM D 448 for Size No. 57 **OR** ASTM D 2940, base-course material **OR** requirements in Division 02 Section "Earthwork" for base-course material, **as directed**.
3. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
4. Soil Mix for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate blended with planting soil mix complying with requirements in Division 02 Section(s) "Lawns And Grasses" **OR** "Exterior Plants", **as directed**. Use blend consisting of 1/2 sand and 1/2 soil mix **OR** 2/3 sand and 1/3 soil mix, **as directed**.
5. Graded Aggregate for Leveling Course: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** 9, **as directed**.
6. Soil for Porous Paver Fill: Planting soil mix complying with requirements in Division 02 Section(s) "Lawns And Grasses" **OR** "Exterior Plants", **as directed**.



7. Graded Aggregate for Porous Paver Fill: Sound crushed stone or gravel complying with ASTM D 448 for Size No. 8 **OR** 9, **as directed**.
  - a. Provide stone of color indicated **OR** to match the Owner's sample, **as directed**.
8. Grass Seed: Comply with requirements in Division 02 Section "Lawns And Grasses".
9. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications; made from polyolefins or polyesters, with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - a. Survivability: Class 2; AASHTO M 288.
  - b. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D 4751.
  - c. Permittivity: 0.02 per second, minimum; ASTM D 4491.
  - d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.
10. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - a. Survivability: Class 2; AASHTO M 288.
  - b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D 4751.
  - c. Permittivity: 0.5 per second, minimum; ASTM D 4491.
  - d. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

### 1.3 EXECUTION

#### A. Preparation

1. Proof-roll prepared subgrade according to requirements in Division 02 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with porous paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base **OR** base, **as directed**, course for porous paving.

#### B. Installation, General

1. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be structurally unsound or visible in finished work.
2. Cut unit pavers with motor-driven masonry saw equipment or a block splitter, **as directed**, to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
3. Tolerances:
  - a. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/16-inch (1.5-mm) unit-to-unit offset from flush.
  - b. Variation from Level or Indicated Slope: Do not exceed 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) or a maximum of 1/2 inch (13 mm).
4. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
  - a. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after porous paver installation.
  - b. For metal edge restraints with top edge exposed, drive stakes at least 1 inch (25 mm) below top edge.
  - c. Install job-built concrete edge restraints to comply with requirements in Division 02 Section "Cement Concrete Pavement".
5. Provide curbs as indicated. Install curbs before placing unit pavers.
  - a. Install precast concrete **OR** granite, **as directed**, curbs on a bedding of compacted base-course material over compacted subgrade. Install curbs before placing base course for pavers. Set curbs at elevations indicated, accurately aligned, and place and compact base-course material behind curbs as indicated.
  - b. Install precast concrete curbs on aggregate base course after placing and compacting base course for pavers. Set curbs with top edge 1 inch (25 mm) below top of pavers. Anchor curbs with metal stakes driven through holes in curbs into base-course material.



- c. Install precast concrete curbs on aggregate-base course after placing and compacting base course for pavers. Set curbs with top surface 1/2 inch (13 mm) **OR** 2 inches (50 mm) **OR** 4 inches (100 mm), **as directed**, above top of pavers. Anchor curbs with metal stakes driven behind curbs into base-course material.

C. Setting-Bed Installation

1. Compact soil subgrade uniformly to at least 95 percent of ASTM D 698 **OR** ASTM D 1557, **as directed**, laboratory density.
2. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Owner, and replace with compacted backfill or fill as directed.
3. Place separation **OR** drainage, **as directed**, geotextile over prepared subgrade, overlapping ends and edges at least 12 inches (300 mm).
4. For light-traffic uses, place aggregate subbase **OR** subbase and base, **as directed**, compact by tamping with plate vibrator, and screed to depth indicated.
5. For heavy-duty applications, place aggregate subbase **OR** subbase and base, **as directed**, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.
6. Place drainage geotextile over compacted subbase, overlapping ends and edges at least 12 inches (300 mm).
7. Place drainage geotextile over compacted base course, overlapping ends and edges at least 12 inches (300 mm).
8. Place leveling course and screed to a thickness of 1 to 1-1/2 inches (25 to 38 mm) **OR** 2 to 2-1/2 inches (50 to 64 mm) **OR** 3 inches (76 mm), **as directed**, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

D. Paver Installation

1. Set unit pavers on leveling course, being careful not to disturb leveling base. If pavers have lugs or spacer bars to control spacing, place pavers hand tight against lugs or spacer bars. If pavers do not have lugs or spacer bars, place pavers with a 1/16-inch- (1.6-mm-) minimum and 1/8-inch- (3.2-mm-) maximum joint width. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8 inch (10 mm) with pieces cut to fit from full-size pavers.
  - a. When installation is performed with mechanical equipment, use only unit pavers with lugs or spacer bars on sides of each unit.
2. Compact pavers into leveling course with a low-amplitude plate vibrator capable of a 3500- to 5000-lbf (16- to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
  - a. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
  - b. Before ending each day's work, compact installed concrete pavers except for 36-inch (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).
  - c. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.
  - d. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
3. Place soil fill as follows, immediately after vibrating pavers into leveling course. Spread and screed soil fill level with tops of pavers. Vibrate pavers and add soil fill until porous paving is filled to about 3/4 inch (19 mm) from top surface; remove excess soil fill if any.
  - a. Before ending each day's work, place soil fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
  - b. As work progresses to perimeter of installation, place soil fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.



- c. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
  4. After filling pavers with soil, sow seed to comply with requirements in Division 02 Section "Lawns And Grasses". except sow seed at half the rate specified for seeding lawns. Sweep seed from surfaces of pavers into voids and water with fine spray.
    - a. Within 24 hours after sowing seed, spread an additional 3/16 inch (4.8 mm) of soil fill over seed and soak with water.
  5. Place graded aggregate fill immediately after vibrating pavers into leveling course. Spread and screed aggregate fill level with tops of pavers.
    - a. Before ending each day's work, place aggregate fill in installed porous paving except for 42-inch (1067-mm) width of unfilled paving adjacent to temporary edges (laying faces).
    - b. As work progresses to perimeter of installation, place aggregate fill in installed paving that is adjacent to permanent edges unless it is within 42 inches (1067 mm) of laying face.
    - c. Before ending each day's work and when rain interrupts work, cover paving that has not been filled with nonstaining plastic sheets to protect it from rain.
  6. Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- E. Maintenance And Protection
  1. Water newly planted grass and keep moist until grass is established. Maintain grass that is planted in paving to comply with requirements in Division 02 Section "Lawns And Grasses".
  2. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades for 60 days after planting.

END OF SECTION 02695



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## SECTION 02695a - VITRIFIED BRICK PAVEMENT REPLACEMENT

### 1.1 GENERAL

#### A. General

1. Limits of Brick Pavement Replacement shall be as per the detail entitled "Payment Limits for Surface Restoration" shown in the plans, plus one foot on each side. Alternate individual bricks may have to be removed in order to maintain staggered joint pattern along the edge of the undisturbed brick pavement.

### 1.2 PRODUCT

#### A. Preparation

1. Base shall be provided and shaped to match level, kind and thickness (4" min.) of adjoining base. The base material shall be compacted to meet the density standards. 4" 2500 PSI concrete base may be used for irregular patches and where compaction is otherwise impractical. Concrete shall be properly placed, consolidated and cured. One inch of sand, or good grade dirt, free from clay, loam or other foreign matter shall be used for cushion to hold the bricks in place. The sand shall be shaped to a true surface parallel to required finished pavement surface.

#### B. Materials

1. Existing bricks shall be cleaned, stored, and secured by the Contractor.

### 1.3 EXECUTION

#### A. Reinstallation of Bricks

1. The bricks shall be installed in rows, better face upward, sorted by size with joints staggered, then rolled daily with a static tandem wheel roller. Additional bricks, if required, will be supplied by the Owner. City Personnel shall inspect work daily. After inspection, the bricks shall be sprayed with a solution of lime and water, using 26 lbs. of lime to 55 gallons of water. Asphalt steep 7330 or equal shall be used for joint filler. The steep shall be heated until fluid and poured over bricks and removed when cool with square pointed shovels dipped in lime water. Removed asphalt may be reused. If adjoining bricks are grouted, new filler shall be grout (8:1, builders sand: cement).

#### B. Acceptance

1. Upon completion of the work, and before acceptance and final payment, the Contractor shall remove all false work, equipment, rubbish, surplus, and discarded materials. The Contractor shall restore in an acceptable manner all property, both public and private, damaged during the prosecution of the work. The Contractor shall leave the roadway in a neat and presentable condition each day.

END OF SECTION 02695a



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Task	Specification	Specification Description
02695	02614	Cement Concrete Pavement

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**SECTION 02711 - CHAIN-LINK FENCES AND GATES****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for chain-link fences and gates. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. Section Includes:
  - a. Chain-link fences.
  - b. Gates: Manually and Motor operated, horizontal slide and swing.

**C. Performance Requirements**

1. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
  - a. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified and on the following:
    - 1) Wind Loads: **<Insert loads required for Project location>**.
    - 2) Exposure Category: **B OR C OR D, as directed**.
    - 3) Fence Height: 10 feet (3 m).
    - 4) Material Group: **IA, ASTM F 1043, Schedule 40 steel pipe OR IC, electric-resistance-welded round steel pipe, as directed**.
3. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

**D. Submittals**

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
  - a. Fence and gate posts, rails, and fittings.
  - b. Chain-link fabric, reinforcements, and attachments.
  - c. Accessories: Privacy slats **OR** Barbed wire **OR** Barbed tape, **as directed**.
  - d. Gates and hardware.
  - e. Gate operators, including operating instructions.
  - f. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.
2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
  - a. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
  - b. Wiring Diagrams: For power, signal, and control wiring.
3. Samples: Prepared on Samples of size indicated below:
  - a. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
4. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.



5. Qualification Data: For qualified professional engineer **OR** testing agency **OR** factory-authorized service representative, **as directed**.
6. Product Certificates: For each type of chain-link fence, operator, and gate, from manufacturer.
7. Product Test Reports: For framing strength according to ASTM F 1043.
8. Field quality-control reports.
9. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
  - a. Polymer finishes.
  - b. Gate hardware.
  - c. Gate operator.
10. Warranty: Sample of special warranty.

#### E. Quality Assurance

1. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
  - a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for gates with automatic gate operators serving as a required means of access.
4. Preinstallation Conference: Conduct conference at Project site.

#### F. Project Conditions

1. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

#### G. Warranty

1. Special Warranty: Manufacturer's standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - a. Failures include, but are not limited to, the following:
    - 1) Faulty operation of gate operators and controls.
    - 2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - b. Warranty Period: Five **OR** 15, **as directed**, years from date of Substantial Completion.

## 1.2 PRODUCTS

#### A. Chain-Link Fence Fabric

1. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
  - a. Fabric Height: As indicated on Drawings **OR** As directed.
  - b. Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
    - 1) Mesh Size: 2-1/8 inches (54 mm) **OR** 2 inches (50 mm) **OR** 1-3/4 inches (44 mm) **OR** 1 inch (25 mm), **as directed**.
    - 2) Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft. (122 g/sq. m) **OR** 0.35 oz./sq. ft. (107 g/sq. m) **OR** 0.30 oz./sq. ft. (92 g/sq. m), **as directed**.
    - 3) Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) **OR** Class 2, 2.0 oz./sq. ft. (610 g/sq. m), **as directed**, with zinc coating applied before **OR** after, **as directed**, weaving.



- 4) Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 1, 0.60 oz./sq. ft. (183 g/sq. m) **OR** Class 2, 1.0 oz./sq. ft. (305 g/sq. m), **as directed**.
- 5) Polymer-Coated Fabric: ASTM F 668, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**, -coated steel wire.
  - a) Color: Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.
- 6) Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
- c. Aluminum Wire Fabric: ASTM F 1183, with mill **OR** caustic-cleaned or etched, **as directed**, finish, and wire diameter of 0.148 inch (3.76 mm) **OR** 0.192 inch (4.88 mm), **as directed**.
  - 1) Mesh Size: 2 inches (50 mm) **OR** 1 inch (25 mm), **as directed**.
- d. Selvage: Knuckled at both selvages **OR** Twisted top and knuckled bottom, **as directed**.

B. Fence Framing

1. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 or ASTM F 1083, **as directed**, based on the following:
  - a. Fence Height: 72 inches (1830 mm) **OR** 96 inches (2440 mm) **OR** As indicated on Drawings, **as directed**.
  - b. Light Industrial Strength: Material Group IC-L, round steel pipe, electric-resistance-welded pipe **OR** Group II-L, roll-formed steel C-section shapes **OR** Group III-L, hot-rolled H-beam shapes **OR** Group IV, Alternative Design, **as directed**.
    - 1) Line Post: 1.9 inches (48 mm) in diameter **OR** 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 2.25 by 1.7 inches (57 by 43 mm), **as directed**.
    - 2) End, Corner and Pull Post: 2.375 inches (60 mm) **OR** 2.875 inches (73 mm) **OR** 4.0 inches (102 mm) **OR** 2.25 by 1.7 inches (57 by 43 mm), **as directed**.
  - c. Heavy Industrial Strength: Material Group IA, round steel pipe, Schedule 40 **OR** Group IC, round steel pipe, electric-resistance-welded pipe **OR** Group II, roll-formed steel C-section shapes **OR** Group III, hot-rolled H-beam shapes **OR** Group IV, Alternative Design, **as directed**.
    - 1) Line Post: 1.9 inches (48 mm) in diameter **OR** 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 1.875 by 1.63 inches (48 by 41 mm) **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm), **as directed**.
    - 2) End, Corner and Pull Post: 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm) **OR** 3.5 by 1.5 inches (89 by 38 mm), **as directed**.
  - d. Horizontal Framework Members: Intermediate, top and bottom rails, **as directed**, complying with ASTM F 1043.
    - 1) Top Rail: 1.66 inches (42 mm) in diameter **OR** 1.25 by 1.63 inches (32 by 41 mm), **as directed**.
  - e. Brace Rails: Comply with ASTM F 1043.
  - f. Metallic Coating for Steel Framing:
    - 1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
    - 2) Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
    - 3) External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear,



verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.

- 4) Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
- 5) Coatings: Any coating above.
- g. Polymer coating over metallic coating.
  - 1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

#### C. Tension Wire

1. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
  - a. Type I, aluminum coated (aluminized).
  - b. Type II, zinc coated (galvanized) by hot-dip **OR** electrolytic, **as directed**, process, with the following minimum coating weight:
    - 1) Class 3: Not less than 0.8 oz./sq. ft. (244 g/sq. m) of uncoated wire surface.
    - 2) Class 4: Not less than 1.2 oz./sq. ft. (366 g/sq. m) of uncoated wire surface.
    - 3) Class 5: Not less than 2 oz./sq. ft. (610 g/sq. m) of uncoated wire surface.
    - 4) Matching chain-link fabric coating weight.
  - c. Type III, Zn-5-Al-MM alloy with the following minimum coating weight:
    - 1) Class 60: Not less than 0.6 oz./sq. ft. (183 g/sq. m) of uncoated wire surface.
    - 2) Class 100: Not less than 1 oz./sq. ft. (305 g/sq. m) of uncoated wire surface.
    - 3) Matching chain-link fabric coating weight.
2. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) **OR** 0.148-inch- (3.8-mm-), **as directed**, diameter, tension wire complying with ASTM F 1664, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**, -coated steel wire.
  - a. Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.
3. Aluminum Wire: 0.192-inch- (4.88-mm-) diameter tension wire, mill finished, complying with ASTM B 211 (ASTM B211M), Alloy 6061-T94 with 50,000-psi (344-MPa) minimum tensile strength.

#### D. Swing Gates

1. General: Comply with ASTM F 900 for gate posts and single **OR** double, **as directed**, swing gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
  - a. Gate Leaf Width: 36 inches (914 mm) **OR** As indicated, **as directed**.
  - b. Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
2. Pipe and Tubing:
  - a. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing **OR** manufacturer's standard protective coating and finish, **as directed**.
  - b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
  - c. Gate Posts: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
  - d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**.
4. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Hardware:





- a. Hinges: 180-degree inward **OR** 180-degree outward **OR** 360-degree inward and outward, **as directed**, swing.
- b. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate, **as directed**.
- c. Padlock and Chain: Owner furnished.
- d. Lock: Manufacturer's standard internal device furnished in lieu of gate latch, **as directed**.
- e. Closer: Manufacturer's standard, **as directed**.

E. Horizontal-Slide Gates

1. General: Comply with ASTM F 1184 for gate posts and single **OR** double, **as directed**, sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
  - a. Classification: Type I Overhead Slide (opening widths to 40 feet (12.2 m) with an overhead clearance of up to 22 feet (6.7 m)).
    - 1) Gate Leaf Width: As indicated **OR** As directed.
    - 2) Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
  - b. Classification: Type II Cantilever Slide (opening widths to 30 feet (9.1 m) and heights to 8 feet (2.44 m))
    - 1) Class 1 with external **OR** Class 2 with internal, **as directed**, roller assemblies.
    - 2) Gate Frame Width and Height: 48 inches (1200 mm) wide or less by 72 inches (1830 mm) high or less **OR** More than 48 inches (1200 mm) wide by any height **OR** As indicated, **as directed**.
2. Pipe and Tubing:
  - a. Zinc-Coated Steel: Protective coating and finish to match fence framing **OR** Manufacturer's standard protective coating and finish, **as directed**.
  - b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
  - c. Gate Posts: Comply with ASTM F 1184. Provide round tubular steel **OR** rectangular tubular steel **OR** round tubular aluminum **OR** rectangular tubular aluminum, **as directed**, posts.
  - d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**.
4. Extended Gate Posts and Frame Members: Extend gate posts and frame end members above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
6. Hardware:
  - a. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate, **as directed**.
  - b. Padlock and Chain: Owner furnished.
  - c. Lock: Manufacturer's standard internal device furnished in lieu of gate latch, **as directed**.
  - d. Hangers, roller assemblies, and stops fabricated from galvanized steel **OR** galvanized malleable iron **OR** mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners, **as directed**.

F. Fittings

1. General: Comply with ASTM F 626.
2. Post Caps: Provide for each post.
  - a. Provide line post caps with loop to receive tension wire or top rail.
3. Rail and Brace Ends: For each gate, corner, pull, and end post.
4. Rail Fittings: Provide the following:
  - a. Top Rail Sleeves: Pressed-steel or round-steel tubing **OR** Aluminum Alloy 6063, **as directed**, not less than 6 inches (152 mm) long.



- b. Rail Clamps: Line and corner boulevard clamps for connecting intermediate, and bottom, **as directed**, rails in the fence line-to-line posts.
    5. Tension and Brace Bands: Pressed steel **OR** Aluminum Alloy 6063, **as directed**.
    6. Tension Bars: Steel **OR** Aluminum **OR** Fiberglass, **as directed**, length not less than 2 inches (50 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
    7. Truss Rod Assemblies: Steel, hot-dip galvanized after threading **OR** Mill-finished aluminum, **as directed**, rod and turnbuckle or other means of adjustment.
    8. Barbed Wire Arms: Pressed steel or cast iron **OR** Aluminum, **as directed**, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts **OR** integral with post cap, **as directed**; for each post unless otherwise indicated, and as follows:
      - a. Provide line posts with arms that accommodate top rail or tension wire.
      - b. Provide corner arms at fence corner posts, unless extended posts are indicated.
      - c. Type I, single slanted arm.
      - d. Type II, single vertical arm.
      - e. Type III, V-shaped arm.
      - f. Type IV, A-shaped arm.
    9. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
      - a. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
        - 1) Hot-Dip Galvanized Steel: 0.106-inch- (2.69-mm-) **OR** 0.148-inch- (3.76-mm-), **as directed**, diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric, **as directed**.
        - 2) Aluminum: ASTM B 211 (ASTM B 211M); Alloy 1350-H19; 0.148-inch- (3.76-mm-) **OR** 0.192-inch- (4.88-mm-), **as directed**, diameter, mill-finished wire.
    10. Finish:
      - a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g /sq. m) zinc.
        - 1) Polymer coating over metallic coating.
      - b. Aluminum: Mill finish.
- G. Privacy Slats
1. Material: PVC, UV-light stabilized, flame resistant, four ply, **as directed**, not less than 0.006 inch (0.15 mm) **OR** 0.023 inch (0.58 mm), **as directed**, thick; attached to not less than 0.0475-inch- (1.21-mm-) diameter, twisted galvanized wire; hedge-type lattice, **as directed**; sized to fit mesh specified for direction indicated.  
**OR**  
 Material: Polyethylene tubular slats, not less than 0.023 inch (0.58 mm) thick, manufactured for chain-link fences from virgin polyethylene containing UV inhibitor, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips **OR** fins for increased privacy factor, **as directed**.  
**OR**  
 Material: Fiber-glass-reinforced plastic, UV-light stabilized, not less than 0.06 inch (1.5 mm) thick, sized to fit mesh specified for direction indicated; with vandal-resistant fasteners and lock strips, **as directed**.  
**OR**  
 Material: Aluminum, not less than 0.01 inch (0.25 mm) thick, sized to fit mesh specified for direction indicated.  
**OR**  
 Material: Redwood, 5/16 inch (7.9 mm) thick, sized to fit mesh specified for direction indicated.
  2. Color: As indicated by manufacturer's designations **OR** As selected from manufacturer's full range **OR** As indicated on Drawings, **as directed**.
- H. Barbed Wire



1. Steel Barbed Wire: Comply with ASTM A 121, for two-strand barbed wire, 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 5 inches (127 mm) o.c.
    - a. Aluminum Coating: Type A.
    - b. Zinc Coating: Type Z, Class 3.
  2. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665 two-strand barbed wire, 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round aluminum alloy **OR** galvanized-steel, **as directed**, barbs spaced not more than 5 inches (127 mm) o.c.:
    - a. Polymer Coating: Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**, -coated steel wire.
      - 1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.
- I. Barbed Tape
1. Wire-Reinforced Tape: ASTM F 1910; with four-point, needle-sharp barbs permanently cold clenched around a core wire.
    - a. Core Wire: High-tensile-strength, zinc-coated steel **OR** stainless steel, **as directed**.
  2. Clips: Stainless steel, 0.065 inch (1.7 mm) thick by 0.375 inch (9.5 mm) wide, capable of withstanding a minimum 150-lbf (667-N) pull load to limit extension of coil, resulting in a concertina pattern when deployed.
  3. Tie Wires: Stainless steel, 0.065 inch (1.7 mm) in diameter.
  4. Fabrication: Continuous coils of barbed tape as defined in ASTM F 1379 for the following characteristics:
    - a. Configuration: Single **OR** Double, **as directed**, coil.
    - b. Style: Helical **OR** Concertina, **as directed**, pattern.
    - c. Coil Diameter(s): 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil **OR** As indicated on Drawings, **as directed**.
    - d. Coil Loop Spacing(s): 12 inches (300 mm) **OR** Manufacturer's standard **OR** As indicated on Drawings, **as directed**.
    - e. Barb Length Classification: Long, 1.2-inch (30.5-mm) **OR** Medium, 0.4-inch (10.2-mm) **OR** Short, 0.1875-inch (4.76-mm), **as directed**, barb.
    - f. Barb Spacing: 4 inches (102 mm) o.c.
    - g. Barb Set: Straight **OR** Offset **OR** Manufacturer's standard, **as directed**.
- J. Gate Operators
1. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
    - a. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
    - b. Provide operator with UL approval **OR** -approved components, **as directed**.
    - c. Provide electronic components with built-in troubleshooting diagnostic feature.
    - d. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
  2. Comply with NFPA 70.
  3. UL Standard: Fabricate and label gate operators to comply with UL 325.
  4. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
    - a. Voltage: 12-V dc **OR** 120 V **OR** 208-220 V **OR** NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected, **as directed**.
    - b. Horsepower: 1/4 **OR** 1/3 **OR** 3/4, **as directed**.
    - c. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.



- d. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
- e. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
- f. Phase: One **OR** Polyphase, **as directed**.
- 5. Gate Operators: Gate **OR** Equipment base/pad **OR** Pedestal post **OR** In ground, **as directed**, mounted and as follows:
  - a. Hydraulic Swing **OR** Slide, **as directed**, Gate Operators:
    - 1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **as directed**.
    - 2) Gate Speed: Minimum 45 feet (13.7 m) **OR** 60 feet (18.2 m), **as directed**, per minute.
    - 3) Maximum Gate Weight: 300 lb (137 kg).
    - 4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.
    - 5) Locking: Hydraulic in both directions.
    - 6) Heater: Manufacturer's standard track and roller heater with thermostatic control.
    - 7) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
  - b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
    - 1) Duty: Light **OR** Medium **OR** Heavy, **as directed**, duty, residential **OR** commercial/industrial, **as directed**.
    - 2) Gate Speed: Minimum 45 feet (13.7 m) per minute **OR** 60 feet (18.2 m) per minute **OR** variable speed, **as directed**.
    - 3) Maximum Gate Weight: 600 lb (272 kg) **OR** 800 lb (363 kg), **as directed**.
    - 4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** 60 cycles per hour **OR** Continuous duty, **as directed**.
    - 5) Operating Type: Crank arm **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
    - 6) Drive Type: Enclosed worm gear **OR** worm gear and chain-and-sprocket, **as directed**, reducers, roller-chain drive. **OR**  
Drive Type: V-belt and worm gear **OR** chain-and-sprocket, **as directed**, reducers, roller-chain drive.
- 6. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 **OR** NEMA ICS 6, Type 4, **as directed**, enclosure for surface **OR** recessed or flush **OR** equipment base/pad **OR** pedestal, **as directed**, mounting and with space for additional optional equipment. Provide the following remote-control device(s):
  - a. Control Station: Keyed, two **OR** three, **as directed**, -position switch, located remotely from gate. Provide two keys per station. **OR**  
Control Station: Momentary-contact, single **OR** three, **as directed**, -button-operated; located remotely from gate. Key switch to lock out open and close buttons, **as directed**.
    - 1) Function: Open, stop, **as directed**, and close.
  - b. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple **OR** single, **as directed**, -code system, permitting four different access time periods, **as directed**; face-lighted unit fully visible at night, **as directed**.
    - 1) Reader Type: Touch plate **OR** Swipe **OR** Insertion **OR** Proximity, **as directed**.
    - 2) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
  - c. Digital Keypad Entry Unit: Multiple-code capability **OR** Multiple-programmable, code capability, **as directed**, of not less than five **OR** 500 **OR** 2500, **as directed**, possible individual codes, consisting of one- to seven **OR** four **OR** five, **as directed**, -digit codes, and permitting four different access time periods, **as directed**.
    - 1) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.



- 2) Face-lighted unit with metal-keyed **OR** keyless-membrane, **as directed**, keypad fully visible at night.
- d. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide one **OR** two, **as directed**, programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
  - 1) Transmitters: Single **OR** Three, **as directed**, button operated, with open **OR** open and close, **as directed**, function.
  - 2) Channel Settings: Two **OR** Three **OR** Four, **as directed**, independent channel settings controlling separate receivers for operating more than one gate from each transmitter.
- e. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry, **as directed**.
  - 1) Residential System: Designed to be wired to same line with telephone.  
**OR**  
Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access 20 **OR** 100, **as directed**, telephones and with electronic directory, **as directed**.
- f. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and loop detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.
  - 1) Loop: Wire, in size indicated for field assembly, for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.  
**OR**  
Loop: Factory preformed in size indicated; style for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.
- g. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and presence detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide retroreflective **OR** emitter/receiver, **as directed**, detector with adjustable detection zone pattern and sensitivity, designed to detect the presence or transit of a vehicle in gate pathway when infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.
7. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
  - a. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction **OR** Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction, **as directed**.
  - b. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
  - c. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel **OR** self-coiling cable **OR** gate edge transmitter and operator receiver system, **as directed**.
    - 1) Along entire gate leaf leading edge (for swing gates and slide gates).
    - 2) Along entire gate leaf trailing edge (for slide gates).
    - 3) Across entire gate leaf bottom edge (for vehicular swing and slide gates complying with UL 325 or to suit Project; consider retaining for pedestrian gates).



- 4) Along entire length of gate posts (for slide gates; revise for sensor edge at pinch point post of swing gates).
  - 5) Along entire length of gate guide posts (for Type II Cantilever Slide, Class 1 gates).
  - 6) Where indicated on Drawings.
- d. Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.
8. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
  - a. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge **OR** Mechanical device, key, or crank-activated release, **as directed**.
9. Operating Features:
  - a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability for monitoring and auditing gate activity, **as directed**. Provide unit that is isolated from voltage spikes and surges.
  - b. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
  - c. Master/Slave Capability: Control stations designed and wired for gate pair operation.
  - d. Automatic Closing Timer: With adjustable time delay before closing and timer cut-off switch, **as directed**.
  - e. Open Override Circuit: Designed to override closing commands.
  - f. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
  - g. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
  - h. Clock Timer: 24-hour **OR** Seven-day, **as directed**, programmable for regular events.
10. Accessories:
  - a. Warning Module: Audio **OR** Visual, **as directed**, constant **OR** strobe, **as directed**, light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
  - b. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.
    - 1) Fail Safe: Gate opens and remains open until power is restored.
    - 2) Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
  - c. External electric-powered solenoid **OR** magnetic, **as directed**, lock with delay timer allowing time for lock to release before gate operates.
  - d. Fire **OR** Postal, **as directed**, box.
  - e. Fire strobe **OR** siren, **as directed**, alarm.
  - f. Intercom System: **<Insert requirements>**.
  - g. Instructional, Safety, and Warning Labels and Signs: According to UL 325 **OR** Manufacturer's standard for components and features specified **OR** As indicated on Drawings, **as directed**.
  - h. Equipment Bases/Pads: Cast-in-place or precast concrete, depth not less than 12 inches (300 mm), dimensioned and reinforced according to gate-operator component manufacturer's written instructions and as indicated on Drawings.

#### K. Grout And Anchoring Cement

1. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
2. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to



erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer, for exterior applications.

L. Fence Grounding

1. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - a. Material above Finished Grade: Copper **OR** Aluminum, **as directed**.
  - b. Material on or below Finished Grade: Copper.
  - c. Bonding Jumpers: Braided copper tape, 1 inch (25 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
2. Connectors and Grounding Rods: Comply with UL 467.
  - a. Connectors for Below-Grade Use: Exothermic welded type.
  - b. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

1.3 EXECUTION

A. Examination

1. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, **as directed**, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - a. Do not begin installation before final grading is completed unless otherwise permitted by the Owner.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Preparation

1. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152.5 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Installation, General

1. Install chain-link fencing to comply with ASTM F 567 and more stringent requirements indicated.
  - a. Install fencing on established boundary lines inside property line.

D. Chain-Link Fence Installation

1. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
2. Post Setting: Set posts in concrete **OR** with mechanical anchors **OR** by mechanically driving into soil, **as directed**, at indicated spacing into firm, undisturbed soil.
  - a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - b. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - 1) Exposed Concrete: Extend 2 inches (50 mm) above grade; shape and smooth to shed water.
    - 2) Concealed Concrete: Top 2 inches (50 mm) below grade as indicated on Drawings to allow covering with surface material.
    - 3) Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
    - 4) Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches (125 mm) deep and 3/4 inch (20 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with



- nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
- c. Mechanically Driven Posts: Drive into soil to depth of 30 inches (762 mm) **OR** 36 inches (914 mm), **as directed**. Protect post top to prevent distortion.
  3. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more **OR** 30 degrees or more **OR** as indicated on Drawings, **as directed**.
  4. Line Posts: Space line posts uniformly at 96 inches (2440 mm) **OR** 10 feet (3 m), **as directed**, o.c.
  5. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
    - a. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
  6. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
    - a. Extended along top **OR** bottom **OR** top and bottom, **as directed**, of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
    - b. Extended along top of barbed wire arms **OR** extended posts, **as directed**, and top of fence fabric for supporting barbed tape.
    - c. As indicated.
  7. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
  8. Intermediate and Bottom Rails: Install and secure to posts with fittings.
  9. Chain-Link Fabric: Apply fabric to outside **OR** inside, **as directed**, of enclosing framework. Leave 1 inch (25.4 mm) **OR** 2 inches (50 mm), **as directed**, between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
  10. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (380 mm) o.c.
  11. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
    - a. Maximum Spacing: Tie fabric to line posts at 12 inches (300 mm) o.c. and to braces at 24 inches (610 mm) o.c.
  12. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts, **as directed**.
  13. Privacy Slats: Install slats in direction indicated, securely locked in place.
    - a. Vertically **OR** Horizontally, **as directed**, for privacy factor of 70 to 75.  
**OR**  
Diagonally, for privacy factor of 80 to 85.  
**OR**  
Direction and privacy factor, **as directed**, as indicated.





14. Barbed Wire: Install barbed wire uniformly spaced, angled toward security side of fence **OR** as indicated on Drawings, **as directed**. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
  15. Barbed Tape: Comply with ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.
- E. Gate Installation
1. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.
- F. Gate Operator Installation
1. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
  2. Excavation for Support Posts **OR** Pedestals **OR** Equipment Bases/Pads, **as directed**: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate-operator component manufacturer's written instructions and as indicated.
  3. Vehicle Loop Detector System: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
  4. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.
- G. Grounding And Bonding
1. Fence Grounding: Install at maximum intervals of 1500 feet (450 m), **as directed**, except as follows:
    - a. Fences within 100 Feet (30 m) of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet (225 m), **as directed**.
      - 1) Gates and Other Fence Openings: Ground fence on each side of opening.
        - a) Bond metal gates to gate posts.
        - b) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (460 mm) below finished grade.
  2. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
  3. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
  4. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (150 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
    - a. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
    - b. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
  5. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
  6. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
    - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
    - b. Make connections with clean, bare metal at points of contact.
    - c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.



- d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
- e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
7. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

#### H. Field Quality Control

1. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
  - a. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
  - b. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify the Owner promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
  - c. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

#### I. Adjusting

1. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, **as directed**, and limit switches.
  - a. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
  - b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - c. Test and adjust controls, alarms, **as directed**, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lubricate hardware, gate operator, **as directed**, and other moving parts.

#### J. Demonstration

1. Train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 02711

**SECTION 02711a - HIGH-SECURITY CHAIN-LINK FENCES AND GATES****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for high-security chain-link fences and gates. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. Section Includes:
  - a. High-security chain-link fences.
  - b. Gates: Motor operated, horizontal slide and swing.

**C. Performance Requirements**

1. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Structural Performance: Chain-link fences and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
  - a. Minimum Post Size: Determine according to ASTM F 1043 for framework up to 12 feet (3.66 m) high, and post spacing not to exceed 10 feet (3 m) for Material Group IA, ASTM F 1043, Schedule 40 steel pipe **OR** Group IC, electric-resistance-welded round steel pipe, **as directed**.  
**OR**  
Minimum Post Size and Maximum Spacing: Provide line posts of size and in spacing indicated, but not less than sizes and spacings determined according to ASTM F 1916, including Appendix **OR** CLFMI WLG 2445, **as directed**, based on mesh size and pattern specified and the following:
    - 1) Wind Loads: Determine design wind loads applicable to Project from basic wind speed and exposure category according to CLFMI WLG 2445.
    - 2) Exposure Category: B **OR** C **OR** D, **as directed**.
    - 3) Fence Height: 10 feet (3 m).
    - 4) Material Group: IA, ASTM F 1043, Schedule 40 steel pipe **OR** IC, electric-resistance-welded round steel pipe, **as directed**.
  - b. Fabric Tension: Provide fences in which fabric deflections do not exceed those indicated in Table X1.1 of ASTM F 1916 when tested by applying a 30-lbf (133-N) force at midpoint between rails and horizontally between posts for every eighth lower panel along the fence line.
  - c. Fence Post Rigidity: Provide fences in which post deflections do not exceed 3/4 inch (19 mm) when tested according to ASTM F 1916 by applying a 50-lbf (222-N) force at midheight of every eighth post along the fence line.
3. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

**D. Submittals**

1. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates, **as directed**.
  - a. Fence and gate posts, rails, and fittings.
  - b. Chain-link fabric, reinforcements, and attachments.
  - c. Accessories: Barbed wire **OR** Barbed tape, **as directed**.



- d. Gates and hardware.
  - e. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
  - f. Wiring Diagrams: For power, signal, and control wiring.
  2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
    - a. Gate Operator: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.
    - b. Wiring Diagrams: For power, signal, and control wiring.
  3. Samples: Prepared on Samples of size indicated below:
    - a. Polymer-Coated Components: In 6-inch (150-mm) lengths for components and on full-sized units for accessories.
  4. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  5. Qualification Data: For qualified professional engineer **OR** testing agency **OR** factory-authorized service representative, **as directed**.
  6. Product Certificates: For each type of chain-link fence, operator, **as directed**, and gate, from manufacturer.
  7. Product Test Reports: For framing strength according to ASTM F 1043.
  8. Field quality-control reports.
  9. Soil sterilization certificate of treatment stating materials and quantities used, and date of application.
  10. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
    - a. Polymer finishes.
    - b. Gate hardware.
    - c. Gate operator.
  11. Warranty: Sample of special warranty.
- E. Quality Assurance
1. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
    - a. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
  2. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  3. Emergency Access Requirements: Comply with requirements of authorities having jurisdiction for automatic gate operators serving as a required means of access.
  4. Preinstallation Conference: Conduct conference at Project site.
- F. Project Conditions
1. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.
- G. Warranty
1. Special Warranty: Manufacturer's standard form in which manufacturer **OR** Installer, **as directed**, agrees to repair or replace components of high-security chain-link fences and gates that fail in materials or workmanship within specified warranty period.
    - a. Failures include, but are not limited to, the following:
      - 1) Deflection of fence fabric beyond design limits.



- 2) Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- 3) Faulty operation of gate operators and controls.
- b. Warranty Period: Five **OR** 15, **as directed**, years from date of Substantial Completion.

## 1.2 PRODUCTS

### A. Chain-Link Fence Fabric

1. Chain-Link Fence Fabric: Provide fabric in one **OR** two, **as directed**, -piece heights measured between top and bottom of outer edge of selvage. Comply with CLFMI Product Manual and with requirements indicated below:
  - a. Fabric Height: As indicated on Drawings **OR** As directed.
    - 1) Steel Wire Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
      - a) Mesh Size: 2 inches (51 mm) **OR** 1 inch (25.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
  - b. Fabric Heights and Overlap: As indicated on Drawings **OR** As directed.
    - 1) Steel Wire Lower Fabric: Wire with a diameter of 0.192 inch (4.88 mm) **OR** 0.148 inch (3.76 mm) **OR** 0.120 inch (3.05 mm) **OR** 0.113 inch (2.87 mm), **as directed**.
      - a) Mesh Size: 2 inches (51 mm) **OR** 1 inch (25.4 mm) **OR** 3/8 inch (9.5 mm), **as directed**.
    - 2) Steel Wire Upper Fabric: Wire with a diameter of 0.120 inch (3.05 mm).
      - a) Mesh Size: 3/8 inch (9.5 mm).
  - c. Aluminum-Coated Fabric: ASTM A 491, Type I, 0.40 oz./sq. ft. (122 g/sq. m) **OR** 0.35 oz./sq. ft. (107 g/sq. m) **OR** 0.30 oz./sq. ft. (92 g/sq. m), **as directed**.
  - d. Zinc-Coated Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. (366 g/sq. m) **OR** Class 2, 2.0 oz./sq. ft. (610 g/sq. m), **as directed**, with zinc coating applied before **OR** after, **as directed**, weaving.
  - e. Zn-5-Al-MM Aluminum-Mischmetal-Coated Fabric: ASTM F 1345, Type III, Class 2, 1.0 oz./sq. ft. (305 g/sq. m).
  - f. Polymer-Coated Fabric: ASTM F 668, Class 2b over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**, -coated steel wire.
    - 1) Color: Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected by the Owner from manufacturer's full range, **as directed**, complying with ASTM F 934.
  - g. Coat selvage ends of fabric that is metallic coated before the weaving process with manufacturer's standard clear protective coating.
  - h. Selvage: Twisted and barbed top and bottom.

### B. Security Fence Framing

1. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts.
  - a. Fence Height: 96 inches (2440 mm) **OR** 12 feet (3.66 m) **OR** As indicated on Drawings, **as directed**.
  - b. Heavy **OR** Light, **as directed**, Industrial Strength: Material Group IA, round steel pipe, Schedule 40 **OR** Group IC, round steel pipe, electric resistance-welded pipe, **as directed**.
    - 1) Line Post: 2.375 inches (60 mm) in diameter **OR** 2.875 inches (73 mm) in diameter **OR** 4 inches (100-mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 8.625 inches (168 mm) in diameter **OR** 2.25 by 1.70 inches (67 by 43 mm) **OR** 3.25 by 2.50 inches (83 by 64 mm), **as directed**.
    - 2) End, Corner, and Pull Post: 2.875 inches (73 mm) in diameter **OR** 4.0 inches (102 mm) in diameter **OR** 6.625 inches (168 mm) in diameter **OR** 8.625 inches (168 mm) in diameter, **as directed**.
  - c. Rail Members: Intermediate, top, and brace, **as directed**, rails complying with ASTM F 1043 for Heavy Industrial.
  - d. Metallic Coating for Steel Framing:



- 1) Type A, consisting of not less than minimum 2.0-oz./sq. ft. (0.61-kg/sq. m) average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. (1.22-kg/sq. m) zinc coating per ASTM A 653/A 653M.
- 2) Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
- 3) External, Type B, zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. (0.27 kg/sq. m) of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil- (0.0076-mm-) thick, zinc-pigmented coating.
- 4) Type C, Zn-5-Al-MM alloy, consisting of not less than 1.8-oz./sq. ft. (0.55-kg/sq. m) coating.
- 5) Coatings: Any coating above.
- e. Polymer coating over metallic coating.
  - 1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

#### C. Tension Wire

1. Metallic-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, marcelled tension wire complying with ASTM A 817 and ASTM A 824, with the following metallic coating:
  - a. Type I, aluminum coated (aluminized).
  - b. Type II, zinc coated (galvanized) by hot-dip **OR** electrolytic, **as directed**, process, with Class 5 minimum coating weight of not less than 2.0 oz./sq. ft. (610 g/sq. m) of uncoated wire surface.
2. Polymer-Coated Steel Wire: 0.177-inch- (4.5-mm-) diameter, tension wire complying with ASTM F 1664, Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**, -coated steel wire.
  - a. Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

#### D. Swing Gates

1. General: Comply with ASTM F 900 for gate posts and single **OR** double, **as directed**, swing gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
  - a. Gate Leaf Width: 36 inches (914 mm) **OR** As indicated, **as directed**.
  - b. Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
2. Pipe and Tubing:
  - a. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing **OR** manufacturer's standard protective coating and finish, **as directed**.
  - b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
  - c. Gate Post Size and Weight: Not less than required by ASTM F 900 **OR** ASTM F 1916, **as directed**.
  - d. Gate Posts: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
  - e. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**, and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) or wider.
4. Extended Gate Posts and Frame Members: Extend above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
5. Provide separate isolated gate frame according to ASTM F 1916 and as indicated.



- a. Separation between Hinge and Latch Post and Fence Termination Post: 2 inches (51 mm) minimum, 2-1/2 inches (63.5 mm) maximum.
  6. Hardware: Comply with ASTM F 1916.
    - a. Hinges: 180-degree inward **OR** 180-degree outward **OR** 360-degree inward and outward, **as directed**, swing.
    - b. Latches permitting operation from one side **OR** both sides, **as directed**, of gate with provision for padlocking accessible from both sides of gate, **as directed**.
    - c. Padlock and Chain: Owner furnished.
    - d. Lock: Manufacturer's standard, **as directed**, internal device furnished in lieu of gate latch, **as directed**.
    - e. Closer: Manufacturer's standard, **as directed**.
    - f. For gates 14 feet (4.27 m) and higher, add locking device to transom.
- E. Horizontal-Slide Gates
  1. General: Comply with ASTM F 1184 for gate posts and single **OR** double, **as directed**, sliding gate types. Provide automated vehicular gates that comply with ASTM F 2200, **as directed**.
    - a. Classification: Type I Overhead Slide.
      - 1) Gate Leaf Width: As indicated.
      - 2) Gate Fabric Height: 72 inches (1830 mm) or less **OR** More than 72 inches (1830 mm) **OR** As indicated, **as directed**.
    - b. Classification: Type II Cantilever Slide, Class 1 with external **OR** Class 2 with internal, **as directed**, roller assemblies.
      - 1) Gate Frame Width and Height: 48 inches (1200 mm) wide or less by 72 inches (1830 mm) high or less **OR** More than 48 inches (1200 mm) wide by any height **OR** As indicated, **as directed**.
  2. Pipe and Tubing:
    - a. Zinc-Coated Steel: Protective coating and finish to match fence framing **OR** Manufacturer's standard protective coating and finish, **as directed**.
    - b. Aluminum: Comply with ASTM B 429/B 429M; mill **OR** manufacturer's standard, **as directed**, finish.
    - c. Gate Post Size and Weight: Not less than required by ASTM F 1184 **OR** ASTM F 1916, **as directed**.
    - d. Gate Frames and Bracing: Round tubular steel **OR** Rectangular tubular steel **OR** Round tubular aluminum **OR** Rectangular tubular aluminum, **as directed**.
  3. Frame Corner Construction: Welded **OR** Assembled with corner fittings, **as directed**, and 3/8-inch- (9.5-mm-) diameter, adjustable truss rods for panels 5 feet (1.52 m) or wider.
  4. Extended Gate Posts and Frame Members: Extend above top of chain-link fabric at both ends of gate frame 12 inches (300 mm) **OR** as indicated, **as directed**, as required to attach barbed wire **OR** tape, **as directed**, assemblies.
  5. Overhead Track Assembly: Manufacturer's standard track, with overhead framing supports, bracing, and accessories, engineered to support size, weight, width, operation, and design of gate and roller assemblies.
  6. Hardware:
    - a. Latches permitting operation from one side **OR** both sides, **as directed**, of gate with provision for padlocking accessible from both sides of gate, **as directed**.
    - b. Padlock and Chain: Owner furnished.
    - c. Lock: Manufacturer's standard, **as directed**, internal device furnished in lieu of gate latch, **as directed**.
    - d. Hangers, roller assemblies, and stops fabricated from galvanized steel **OR** galvanized malleable iron **OR** mill-finished Grade 319 aluminum-alloy casting with stainless-steel fasteners, **as directed**.
- F. Fittings
  1. General: Comply with ASTM F 626.
  2. Post Caps: Provide for each post.
    - a. Provide line post caps with loop to receive tension wire or top rail.



3. Rail and Brace Ends: For each gate, corner, pull, and end post.
4. Rail Fittings: Provide the following:
  - a. Top-Rail Sleeves: Pressed steel or round steel tubing not less than 6 inches (152 mm) long.
  - b. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom, **as directed**, rails in the fence line to line posts.
5. Tension and Brace Bands, Tension Bars, and Truss Rod Assemblies: Comply with ASTM F 2611.
6. Barbed Wire Arms: Pressed steel or cast iron **OR** Aluminum, **as directed**, with clips, slots, or other means for attaching strands of barbed wire, and means for attaching to posts **OR** integral with post cap, **as directed**; for each post unless otherwise indicated, and as follows:
  - a. Provide line posts with arms that accommodate top rail or tension wire.
  - b. Provide corner arms at fence corner posts, unless extended posts are indicated.
  - c. Type I, single slanted arm.
  - d. Type II, single vertical arm.
  - e. Type III, V-shaped arm.
  - f. Type IV, A-shaped arm.
  - g. Bolts or rivets for connection to post.
7. Tie Wires, Clips, and Fasteners: Comply with ASTM F 626 and ASTM F 1916.
  - a. High-Security Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
    - 1) Metallic-Coated Steel: 0.148-inch- (3.76-mm-) **OR** 0.192-inch- (4.88-mm-), **as directed**, diameter wire; zinc **OR** aluminum, **as directed**, coating.
    - 2) Stainless steel.
8. Power-Driven Fabric Fasteners: Comply with ASTM F 1916.
9. Finish:
  - a. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. (366 g/sq. m) of zinc.
    - 1) Polymer coating over metallic coating.
  - b. Aluminum: Mill finish.

#### G. Barbed Wire

1. Steel Barbed Wire: Comply with ASTM A 121, High Security Grade, for two-strand barbed wire; 0.099-inch- (2.51-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round barbs spaced not more than 3 inches (76 mm) o.c.
  - a. Aluminum Coating: Type A.
2. Polymer-Coated, Galvanized-Steel Barbed Wire: Comply with ASTM F 1665, Type II, for two-strand barbed wire; 0.080-inch- (2.03-mm-) diameter line wire with 0.080-inch- (2.03-mm-) diameter, four-point round aluminum-alloy **OR** galvanized-steel, **as directed**, barbs spaced not more than 3 inches (76 mm) o.c.
  - a. Polymer Coating: Class 1 **OR** Class 2a **OR** Class 2b, **as directed**, over aluminum **OR** zinc **OR** Zn-5-Al-MM-alloy, **as directed**, -coated steel wire.
    - 1) Color: Match chain-link fabric **OR** Dark green **OR** Olive green **OR** Brown **OR** Black **OR** As selected from manufacturer's full range, **as directed**, complying with ASTM F 934.

#### H. Barbed Tape

1. Wire-Reinforced Tape: ASTM F 1910; with four-point, needle-sharp barbs permanently cold clenched around a core wire.
  - a. Core Wire: High-tensile-strength, zinc-coated steel or stainless steel.
2. Clips: Stainless steel, 0.065 inch (1.65 mm) thick by 0.375 inch (9.5 mm) wide; capable of withstanding a minimum 150-lbf (667-N) pull load to limit extension of coil, resulting in a concertina pattern when deployed.
3. Tie Wires: Stainless steel, 0.065 inch (1.65 mm) in diameter.





4. Fabrication: Continuous coils of barbed tape as defined in ASTM F 1379 for the following characteristics:
    - a. Configuration: Single **OR** Double, **as directed**, coil.
    - b. Style: Helical **OR** Concertina, **as directed**, pattern.
    - c. Coil Diameter(s): 18 inches (457 mm) **OR** 24 inches (610 mm) **OR** 24-inch (610-mm) inner coil and 30-inch (762-mm) outer coil **OR** As indicated on Drawings, **as directed**.
    - d. Coil Loop Spacing(s): 12 inches (305 mm) **OR** Manufacturer's standard **OR** As indicated on Drawings, **as directed**.
    - e. Barb Length Classification: Long, 1.2-inch (30.5-mm) **OR** Medium, 0.4-inch (10.2-mm) **OR** Short, 0.1875-inch (4.76-mm), **as directed**, barb.
    - f. Barb Spacing: 4 inches (102 mm) o.c.
    - g. Barb Set: Straight **OR** Offset **OR** Manufacturer's standard, **as directed**.
  5. Ground Barrier Stakes: 3/8-inch- (9.5-mm-) diameter galvanized reinforcing bar, 18 inches (457 mm) long with 180-degree end hook 3-1/2 inches (89 mm) long.
- I. Gate Operators
1. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, with remote-control stations, safety devices, and weatherproof enclosures; coordinate electrical requirements with building electrical system.
    - a. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.
    - b. Provide operator with UL approval **OR** UL-approved components, **as directed**.
    - c. Provide electronic components with built-in troubleshooting diagnostic feature.
    - d. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.
  2. Comply with NFPA 70.
  3. UL Standard: Manufacturer and label gate operators to comply with UL 325.
  4. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1 and the following:
    - a. Voltage: 12-V dc **OR** 120 V **OR** 208-220 V **OR** NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected, **as directed**.
    - b. Horsepower: 1/4 **OR** 1/3 **OR** 3/4, **as directed**.
    - c. Enclosure: Open dripproof **OR** Totally enclosed **OR** Manufacturer's standard, **as directed**.
    - d. Duty: Continuous duty at ambient temperature of 105 deg F (40 deg C) and at altitude of 3300 feet (1005 m) above sea level.
    - e. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.
    - f. Phase: One **OR** Polyphase, **as directed**.
  5. Gate Operators: Gate **OR** Equipment base/pad **OR** Pedestal post **OR** In ground, **as directed**, mounted and as follows:
    - a. Hydraulic Swing **OR** Slide, **as directed**, Gate Operators:
      - 1) Duty: Medium **OR** Heavy, **as directed**.
      - 2) Gate Speed: Minimum 45 feet (13.7 m) **OR** 60 feet (18.2 m), **as directed**, per minute.
      - 3) Maximum Gate Weight: 800 lb (363 kg).
      - 4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** Continuous duty, **as directed**.
      - 5) Operating Type: Wheel and rail drive with manual release, **as directed**.
      - 6) Hydraulic Fluid: Of viscosity required for gate operation at ambient temperature range for Project.
      - 7) Locking: Hydraulic in both directions.
      - 8) Heater: Manufacturer's standard track and roller heater with thermostatic control.
    - b. Mechanical Swing **OR** Slide, **as directed**, Gate Operators:
      - 1) Duty: Medium **OR** Heavy **OR** Maximum security, **as directed**.



- 2) Gate Speed: Minimum 45 feet (13.7 m) per minute **OR** 60 feet (18.2 m) per minute **OR** variable speed, **as directed**.
  - 3) Maximum Gate Weight: 800 lb (363 kg) **OR** 3000 lb (1360 kg), **as directed**.
  - 4) Frequency of Use: 10 cycles per hour **OR** 25 cycles per hour **OR** 60 cycles per hour **OR** Continuous duty, **as directed**.
  - 5) Operating Type: Crank arm **OR** Enclosed **OR** Wheel and rail drive **OR** Roller chain, **as directed**, with manual release, **as directed**.
  - 6) Drive Type: Enclosed worm gear and chain-and-sprocket, **as directed**, reducers, roller-chain drive.  
**OR**  
Drive Type: V-belt and worm gear **OR** chain-and-sprocket, **as directed**, reducers, roller-chain drive.
6. Remote Controls: Electric controls separated from gate and motor and drive mechanism, with NEMA ICS 6, Type 1 **OR** NEMA ICS 6, Type 4, **as directed**, enclosure for surface **OR** recessed or flush **OR** equipment base/pad **OR** pedestal, **as directed**, mounting and with space for additional optional equipment. Provide the following remote-control device(s):
- a. Control Station: Keyed, two **OR** three, **as directed**, -position switch, located remotely from gate. Provide two keys per station.  
**OR**  
Control Station: Momentary contact, single **OR** three, **as directed**, -button operated, located remotely from gate. Key switch to lock out open and close buttons, **as directed**.
    - 1) Function: Open, stop, **as directed**, and close.
  - b. Card Reader: Functions only when authorized card is presented. Programmable, magnetic multiple **OR** single, **as directed**, -code system, permitting four different access time periods, **as directed**; face-lighted unit fully visible at night, **as directed**.
    - 1) Reader Type: Touch plate **OR** Swipe **OR** Insertion **OR** Proximity, **as directed**.
    - 2) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
  - c. Digital Keypad Entry Unit: Multiple-code capability **OR** Multiple-programmable code capability, **as directed**, of not less than five **OR** 500 **OR** 2500, **as directed**, possible individual codes, consisting of one- to seven **OR** four **OR** five, **as directed**, -digit codes and permitting four different access time periods, **as directed**.
    - 1) Features: Timed anti-passback **OR** Limited-time usage **OR** Capable of monitoring and auditing gate activity, **as directed**.
    - 2) Face-lighted unit with metal-keyed **OR** keyless-membrane, **as directed**, keypad fully visible at night.
  - d. Radio Control: Digital system consisting of code-compatible universal receiver for each gate, located where indicated, with remote antenna with coaxial cable and mounting brackets designed to operate gates. Provide one **OR** two, **as directed**, programmable transmitter(s) with multiple-code capability permitting validating or voiding of not less than 1000 **OR** 10,000, **as directed**, codes per channel configured for the following functions:
    - 1) Transmitters: Single **OR** Three, **as directed**, -button operated, with open **OR** open and close, **as directed**, function.
    - 2) Channel Settings: Two **OR** Three **OR** Four, **as directed**, independent channel settings controlling separate receivers for operating more than one gate from each transmitter.
  - e. Telephone Entry System: Hands-free voice-communication system for connection to building telephone system with digital-entry code activation of gate operator and auxiliary keypad entry, **as directed**.
    - 1) System: Designed to be wired to same line with telephone.  
**OR**  
Multiunit System: Designed to be wired to a dedicated telephone line, with capacity to access 20 **OR** 100, **as directed**, telephones and with electronic directory, **as directed**.



- f. Vehicle Loop Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and loop detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide electronic detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light designed to detect presence or transit of a vehicle over an embedded loop of wire and to emit a signal activating the gate operator. Provide number of loops consisting of multiple strands of wire, number of turns, loop size, and method of placement at location shown on Drawings, as recommended in writing by detection system manufacturer for function indicated.
  - 1) Loop: Wire, in size indicated for field assembly, for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.  
**OR**  
Loop: Factory preformed in size indicated; style for pave-over **OR** saw-cut with epoxy-grouted, **as directed**, installation.
- g. Vehicle Presence Detector: System including automatic closing timer with adjustable time delay before closing, timer cut-off switch, **as directed**, and presence detector designed to open and close gate **OR** hold gate open until traffic clears **OR** reverse gate, **as directed**. Provide retroreflective **OR** emitter/receiver, **as directed**, detector with adjustable detection zone pattern and sensitivity, designed to detect presence or transit of a vehicle in gate pathway when an infrared beam in zone pattern is interrupted, and to emit a signal activating the gate operator.
- 7. Obstruction Detection Devices: Provide each motorized gate with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:
  - a. Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction **OR** Stop gate in opening cycle and reverse gate in closing cycle and hold until clear of obstruction, **as directed**.
  - b. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
  - c. Sensor Edge: Contact-pressure-sensitive safety edge, profile, and sensitivity designed for type of gate and component indicated, in locations as follows. Connect to control circuit using take-up cable reel **OR** self-coiling cable **OR** gate edge transmitter and operator receiver system, **as directed**.
    - 1) Along entire gate leaf leading edge (for swing gates and slide gates).
    - 2) Along entire gate leaf trailing edge (for slide gates).
    - 3) Across entire gate leaf bottom edge (for vehicular swing and slide gates complying with UL 325 or to suit Project; consider retaining for pedestrian gates).
    - 4) Along entire length of gate posts (for slide gates; revise for sensor edge at pinch point post of swing gates).
    - 5) Along entire length of gate guide posts (for Type II Cantilever Slide, Class 1 gates).
    - 6) Where indicated on Drawings.
  - d. Photoelectric/Infrared Sensor: System designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted.
- 8. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop gate at fully retracted and fully extended positions.
- 9. Emergency Release Mechanism: Quick-disconnect release of operator drive system of the following type of mechanism, permitting manual operation if operator fails. Design system so control circuit power is disconnected during manual operation.
  - a. Type: Integral fail-safe release, allowing gate to be pushed open without mechanical devices, keys, cranks, or special knowledge **OR** Mechanical device, key, or crank-activated release, **as directed**.
- 10. Operating Features:
  - a. Digital Microprocessor Control: Electronic programmable means for setting, changing, and adjusting control features with capability of monitoring and auditing gate activity, **as directed**. Provide unit that is isolated from voltage spikes and surges.
  - b. System Integration: With controlling circuit board capable of accepting any type of input from external devices.
  - c. Master/Slave Capability: Control stations designed and wired for gate pair operation.



- d. Automatic Closing Timer: With adjustable time delay before closing and timer cut-off switch, **as directed**.
- e. Open Override Circuit: Designed to override closing commands.
- f. Reversal Time Delay: Designed to protect gate system from shock load on reversal in both directions.
- g. Maximum Run Timer: Designed to prevent damage to gate system by shutting down system if normal time to open gate is exceeded.
- h. Clock Timer: 24-hour **OR** Seven-day, **as directed**, programmable for regular events.
- 11. Accessories:
  - a. Warning Module: Audio **OR** Visual, **as directed**, constant **OR** strobe, **as directed**, light alarm sounding three to five seconds in advance of gate operation and continuing until gate stops moving; compliant with the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines.
  - b. Battery Backup System: Battery-powered drive and access-control system, independent of primary drive system.
    - 1) Fail Safe: Gate opens and remains open until power is restored.
    - 2) Fail Secure: Gate cycles on battery power, then fail safe when battery is discharged.
  - c. External electric-powered solenoid **OR** magnetic, **as directed**, lock with delay timer allowing time for lock to release before gate operates.
  - d. Fire **OR** Postal, **as directed**, box.
  - e. Fire strobe **OR** siren, **as directed**, sensor.
  - f. Intercom System: As required to meet Project requirements.
  - g. Instructional, Safety, and Warning Labels and Signs: According to UL 325 **OR** Manufacturer's standard for components and features specified **OR** As indicated on Drawings, **as directed**.
  - h. Equipment Bases/Pads: Precast concrete, depth not less than 12 inches (305 mm), dimensioned and reinforced according to gate operator component manufacturer's written instructions and as indicated on Drawings.

J. Grout And Anchoring Cement

- 1. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.
- 2. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with potable water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended in writing by manufacturer for exterior applications.

K. Fence Grounding

- 1. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - a. Material above Finished Grade: Copper **OR** Aluminum, **as directed**.
  - b. Material on or below Finished Grade: Copper.
  - c. Bonding Jumpers: Braided copper tape, 1 inch (25.4 mm) wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- 2. Connectors and Grounding Rods: Listed in UL 467.
  - a. Connectors for Below-Grade Use: Exothermic welded type.
  - b. Grounding Rods: Copper-clad steel, 5/8 by 96 inches (16 by 2440 mm).

L. Soil Sterilization

- 1. Soil Sterilant: Type approved by authorities having jurisdiction.
- 2. Polyethylene Sheeting: 6 mils (0.15 mm) thick, black, and serving as soil separation fabric.
- 3. Stone Ground Cover: 3/4- to 2-inch (19- to 51-mm) crushed stone or washed gravel.



### 1.3 EXECUTION

#### A. Examination

1. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, **as directed**, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - a. Do not begin installation before final grading is completed unless otherwise permitted by the Owner.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

#### B. Preparation

1. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (152 m) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

#### C. Installation, General

1. Install chain-link fencing to comply with ASTM F 567 **OR** ASTM F 1916, **as directed**, and more stringent requirements specified.
  - a. Install fencing on established boundary lines inside property line.

#### D. Chain-Link Fence Installation

1. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
2. Post Setting: Set posts in concrete **OR** with mechanical anchors **OR** by mechanically driving into soil, **as directed**, at indicated spacing into firm, undisturbed soil.
  - a. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - b. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - 1) Exposed Concrete: Extend 2 inches (51 mm) above grade or to same elevation as concrete grade beam, **as directed**; shape and smooth to shed water.
    - 2) Concealed Concrete: Top 2 inches (51 mm) below grade as indicated on Drawings to allow covering with surface material.
    - 3) Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
    - 4) Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches (127 mm) deep and 3/4 inch (19 mm) larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout **OR** anchoring cement, **as directed**, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
3. Terminal Posts: Locate and install terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more, at any abrupt change in grade, and at intervals not greater than 500 feet (152 m). For runs exceeding 500 feet (152 m), space pull posts an equal distance between corner or end posts.
4. Line Posts: Space line posts uniformly at 96 inches (2440 mm) **OR** 10 feet (3 m), **as directed**, o.c.
5. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.



- a. Locate horizontal braces at midheight of fabric 72 inches (1830 mm) or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
6. Barbed Wire Arms: Bolt or rivet to top of post. Angle single arms away from approach side of fence.
7. Tension Wire: Install according to ASTM F 567 and ASTM F 1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- (3.05-mm-) diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (610 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
  - a. Extended along top and bottom, **as directed**, of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152 mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.
  - b. Extended along top of barbed wire arms **OR** extended posts, **as directed**, and top of fence fabric for supporting barbed tape.
  - c. As indicated.
8. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended by fencing manufacturer.
9. Bottom Rails: Install and secure to posts with fittings; anchor rail at midspan to concrete footing **OR** continuous grade beam, **as directed**.
10. Chain-Link Fabric: Apply fabric on the approach side of fence, inside of enclosing framework. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
  - a. Leave 1-1/2 inches (38 mm) **OR** 2 inches (51 mm), **as directed**, between finish grade or surface and bottom selvage unless otherwise indicated.
  - b. Where indicated, bury an 18-inch- (457-mm-) wide, polymer-coated fabric 12 inches (305 mm) into trench; overlap above-grade fabric 6 inches (152 mm) and secure to bottom rail with tie wires. Backfill and compact trench.
  - c. Overlapping Fabric: At or between post or rail according to ASTM F 1916, with wire ties or steel strap method.
11. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches (381 mm) o.c.
12. Tie Wires: Power-fastened or manually fastened ties configured to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends one and one-half machine twists or three full manual twists, and cut off protruding ends to preclude untwisting by hand.
  - a. Maximum Spacing: Tie fabric to line posts at 12 inches (305 mm) o.c. and to braces at 24 inches (610 mm) o.c.
13. Power-Driven Fasteners: Fasten 0.192- or 0.148-inch (4.87- or 3.76-mm) wire fabric with 2- or 1-inch (51- or 25.4-mm) mesh size.
  - a. Fasten fabric to line posts 12 inches (305 mm) o.c. and to braces 24 inches (610 mm) o.c.
14. Fasteners: Install nuts for tension bands and carriage bolts on the side of fence opposite the fabric side. Peen ends of bolts or score threads to prevent removal of nuts, **as directed**.
15. Barbed Wire: Install barbed wire uniformly spaced as indicated on Drawings **OR** as directed. Pull wire taut, install securely to extension arms, and secure to end post or terminal arms.
16. Barbed Tape: Comply with ASTM F 1911. Install barbed tape uniformly in configurations indicated and fasten securely to prevent movement or displacement.
17. Ground Barrier Stakes: Stake coils at 10 feet (3 m) o.c., driven to full depth.

#### E. Gate Installation

1. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-



resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

F. Gate Operator Installation

1. General: Install gate operators according to manufacturer's written instructions, aligned and true to fence line and grade.
2. Excavation for Support Posts **OR** Pedestals **OR** Equipment Bases/Pads, **as directed**: Hand-excavate holes for bases/pads, in firm, undisturbed soil to dimensions and depths and at locations as required by gate operator component manufacturer's written instructions and as indicated.
3. Vehicle Loop Detector System: Cut grooves in pavement and bury **OR** Bury, **as directed**, and seal wire loop according to manufacturer's written instructions. Connect to equipment operated by detector.
4. Comply with NFPA 70 and manufacturer's written instructions for grounding of electric-powered motors, controls, and other devices.

G. Grounding And Bonding

1. Fence Grounding: Install at maximum intervals of 100 feet (30 m) except as follows:
  - a. Gates and Other Fence Openings: Ground fence on each side of opening.
    - 1) Bond metal gates to gate posts.
    - 2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches (457 mm) below finished grade.
2. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet (45 m) on each side of crossing.
3. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
4. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches (152 mm) below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location, including the following:
  - a. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
  - b. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
5. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.
6. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
  - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  - b. Make connections with clean, bare metal at points of contact.
  - c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
7. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

H. Soil Sterilization

1. General: Comply with ASTM F 1916.
2. Apply sterilant after completing grounding and other below-grade electrical work along fence line and within zone between double-row chain-link fence installation.



3. Install soil separation fabric continuously between double-row chain-link fence installation, overlapping punctures and joints 6 inches (152 mm).
4. Lay continuous 3-inch- (75-mm-) deep bed of crushed stone or washed gravel over soil separation fabric.
5. Extend soil sterilization 4 feet (1.2 m) **OR** 6 feet (1.8 m), **as directed**, beyond outside and inside of fence.

I. Field Quality Control

1. Fabric Testing: Test fabric tension according to ASTM F 1916.
2. Fence Post Rigidity Testing: Test line posts for rigidity according to ASTM F 1916.
3. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
  - a. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
  - b. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify the Owner promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
  - c. Report: Prepare test reports, certified by testing agency, of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

J. Adjusting

1. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
2. Automatic Gate Operator: Energize circuits to electrical equipment and devices. Adjust operators, controls, safety devices, alarms, **as directed**, and limit switches.
  - a. Hydraulic Operator: Purge operating system, adjust pressure and fluid levels, and check for leaks.
  - b. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - c. Test and adjust controls, alarms, **as directed**, and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lubricate hardware, gate operator, **as directed**, and other moving parts.

K. Demonstration

1. Train Owner's personnel to adjust, operate, and maintain high-security chain-link fences and gates.

END OF SECTION 02711a





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Task	Specification	Specification Description
02711	01204	No Specification Required
02711	02244	Tree Protection And Trimming



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## SECTION 02712 - FARM-TYPE WIRE FENCING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of farm-type wire fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.

### 1.2 PRODUCTS

#### A. Fabric shall be galvanized steel wire complying with ASTM A 116.

#### B. Framework

1. Steel
  - a. Posts shall comply with ASTM A 702, T-section, zinc-coated.
  - b. Stays shall be 9-1/2 gauge twisted wire, galvanized in compliance with ASTM A 641, Class 3.
2. Wood: Posts shall be cut from cedar, Douglas fir, pine, or other approved species of timber. Posts shall be peeled, treated, dressed, and cured and shall contain no unsound knots. All posts shall match existing post dimensions. All wood posts and braces shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with AWPAC2.
  - a. Preservative. Wood cut or sawed after treatment shall have the cut surfaces well-coated with the preservative used in the treatment. All wood shall be pressure treated in accordance with AWPAC1 or AWPAC2, as applicable.

#### C. Braces: Steel braces shall have the same configuration as line posts and uprights without the anchor plate. Braces shall meet all of the requirements for wood posts.

#### D. Connectors

1. Wire for Attaching Fabric to Posts shall be 12-1/2 gauge or coarser, galvanized in compliance with ASTM A 641, Class 3.
2. Staples and Nails shall comply with Fed. Spec. FF-N-105. Staples and nails shall be zinc-coated and of sufficient length for purpose required.

#### E. Gates

1. Tubular Steel:
  - a. Frame shall be a minimum of 1-3/8 inch outside diameter tubular steel, braced with a sturdy center bar and diagonal adjustable brace wire to prevent sagging. Gates shall be fitted with hinges. All material shall be hot-dipped zinc-coated.
  - b. Fabric for Gates shall be as specified for the fence and shall be securely tied to the framework at top, bottom, and sides with 9-gauge wire.
2. Angle Iron
  - a. Frame shall be fabricated of angle iron with cross ties and stays of light angle iron. Frame shall be zinc-coated in compliance with ASTM A 120 or A 153.
  - b. Fabric for Gates shall be as specified for the fence and shall be securely tied to the framework at top, bottom, and sides with 9-gauge wire.
3. Wood: Provide a 3/8-inch minimum diameter galvanized steel truss rod and turnbuckle.



- F. Barbed Wire shall comply with ASTM A 121 and shall be made from 2 strands of 12-1/2 gauge galvanized steel wire, twisted, with four-point barbs spaced five inches apart. Wire shall have Class 2 zinc coating.
- G. Hardware:
1. Gate Hardware shall include the following:
    - a. Bottom Hinge shall be designed to carry the weight of the gate.
    - b. The Upper Hinge shall be adjustable.
    - c. Lock with Chain shall be 1-3/4 inch size complying with ASTM F 883.
    - d. Keeper shall automatically engage and hold the gate leaf open until manually released.
    - e. Center Plunger Rod.
    - f. Center Stop.
    - g. Vertical Lift.
    - h. Sliding Track.
  2. Lightning Arresters, Insulators and Insulator Clamps, Fasteners, Signs, and Other Accessories shall be provided and installed as required.

### 1.3 EXECUTION

- A. Installation
1. Wood Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground. Refasten all braces, gates, hardware, fabric, and other accessories.
  2. Steel Posts: Steel posts shall be held in a vertical position and driven to the required depths by an approved post driver. Tops of posts shall not be damaged by driving operation.
  3. Corner, Brace, or End Panels: Corner, brace, or end panels shall be constructed at the beginning and terminal ends, at gate openings, at all intersections, at all corners or changes in horizontal alignment of fences, in existing fence on both sides of junction with new fence, (except when junction is at a corner already braced), and on both sides of cattle guards.
  4. Pull Posts shall be constructed when the distance of unbraced fencing exceeds 640 feet. Pull posts shall be spaced equidistant in the fence at intervals of 640 feet or less.
  5. Wire Installation: Barbed and/or woven wire fabric shall be stretched to proper tension and securely fastened to posts. Top and bottom wires of fabric shall be tied or stapled to each post. Tie or staple every other wire to alternating posts. Every wire shall be tied to corner, pull, end, and gate posts. Wire for tying woven wire fabric and barbed wire shall be 9-gauge.
  6. Restretching Existing Fabric: Fabric indicated to be restretched shall be restretched to proper tension and refastened to posts. Excess fabric extending beyond the post shall be removed.
  7. Alignment: Finished fencing shall be plumb and in proper alignment with posts, and all wire work shall be taut.

END OF SECTION 02712



## SECTION 02712a - SNOW AND OTHER TEMPORARY FENCING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of snow and other temporary fencing. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

### 1.2 PRODUCTS

#### A. Pickets:

1. Size: Wood pickets shall be 3/8 inch thick, 1-1/2 inches wide, and 48 inches high.
2. Coating: Red oil paint or stain.
3. Spacing: Approximately 2 inches apart.
4. Attachment: Bind together with 3 double strands of wire.

#### B. Framework:

1. Materials: Wire shall be 13 ga. galvanized steel, complying with ASTM A 641.
2. Types: The framework shall consist of 3 parallel double strands of wire twisted between pickets to hold them securely in place.
3. Wire Connectors: Wire for attaching fabric to metal posts shall be 9 ga.
4. Staples and Nails shall comply with Fed. Spec. FF-N-105. Staples and nails shall be zinc-coated and of sufficient length for purpose required.

#### C. Gates:

1. Frame: Frame shall consist of 2 parallel horizontal wooden members with pickets attached at two-inch spacing.
2. Bracing: 2 wooden members laced diagonally on the gate between the frame boards.
3. Hardware shall include 2 strap hinges, latching device, and stop bar, all of zinc-coated steel, in compliance with ASTM A 153.

#### D. Supports:

1. Steel: Line posts and uprights shall be drive type, T sections, and provided with suitable anchor plate. The sections shall be hot-rolled steel complying with ASTM A 702, galvanized in compliance with ASTM A 123. The T sections shall have the following minimum sizes:



Post Length (Feet) Post Weight (Pounds)

5	7.32
5 1/2	7.99
6	8.65
6 1/2	9.32
7	9.98
7 1/2	10.64
8	11.31
9	12.64
10	13.97

2. Wood: Posts shall be cut from cedar, Douglas fir, pine, or other approved species of timber. Posts shall be peeled, treated, dressed, and cured. All wood posts and braces shall be given a pressure preservative treatment in a closed retort. The treatment shall comply with Fed. Spec. TT-W-571. Wood cut or sawed after treatment shall have the cut surfaces well brush-coated with the preservative used in the treatment.
3. Braces: Steel braces shall have same configuration as line posts and uprights without the anchor plate. Wood braces shall be treated No. 2 or better grade, Douglas fir or southern yellow pine. Braces shall meet all of the requirements for wood posts.
4. Location: Posts shall be evenly spaced to adequately support the fence framework.

### 1.3 EXECUTION

#### A. Installation

1. Wood Posts: Hold in line in a true vertical position by temporary bracing until backfilling is completed. Compact by hand tamping or other suitable methods to a density comparable to that of adjacent ground.
2. Steel Posts: Hold in a vertical position and drive to the required depths by an approved post driver. Post tops shall not be damaged during driving.
3. Corner, Brace, Or End Panels: Construct corner, brace, or end panels at the beginning and terminal ends, at gate openings, at all intersections, and at all corners or changes in horizontal alignment of fences, in existing fence on both sides of junction with new fence (except when junction is at a corner already braced).
4. Pull Posts shall be constructed when the distance of unbraced fencing exceeds 640 feet. Pull posts shall be spaced equidistant in the fence at intervals of 640 feet or less.
5. Framework Installation: Stretch to proper tension and securely fasten to posts. Top and bottom wires of fabric shall be tied or stapled to each post. Tie or staple every other wire to alternating posts. Every wire shall be tied or stapled to corner, pull, end, and gate posts. Wire for tied fabrics shall be 9 ga.
6. Picket Replacement: Where required, new pickets shall be securely fastened into the existing wire framework using 13 ga. galvanized wire.
7. Restretching Existing Fabric: Fabric designated to be restretched shall be restretched to proper tension and refastened to posts. Excess fabric extending beyond the post shall be removed.

END OF SECTION 02712a

**SECTION 02719 - SEGMENTAL RETAINING WALLS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for segmental retaining walls. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. This Section includes single- and multiple- depth segmental retaining walls with and without soil reinforcement.

**C. Performance Requirements**

1. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
3. Structural Performance: Engineering design shall be based on the following loads and be according to NCMA's "Design Manual for Segmental Retaining Walls."
4. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
  - a. Superimposed loads (surcharge) indicated on Drawings.
5. Seismic Performance: Engineering design shall be based on the following loads and factors and be according to NCMA's "Segmental Retaining Walls - Seismic Design Manual."
  - a. Gravity loads due to soil pressures resulting from grades and sloped backfill indicated.
  - b. Superimposed loads (surcharge) indicated on Drawings.
  - c. Horizontal Peak Ground Acceleration (A) for Project: **As directed.**

**D. Preconstruction Testing**

1. Preconstruction Testing Service: Engage a qualified testing agency to perform the following preconstruction testing:
  - a. Test soil reinforcement and backfill materials for pullout resistance according to ASTM D 6706.
  - b. Test soil reinforcement and backfill materials for coefficient of friction according to ASTM D 5321.

**E. Submittals**

1. Product Data: For each type of product indicated.
2. Samples: For each color and texture of concrete unit required. Submit full-size units **OR** sections of units not less than 3 inches (75 mm) square, **as directed.**
  - a. Include one full-size unit for each type of concrete unit required.
3. Delegated-Design Submittal: For segmental retaining walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - a. Compliance Review: Qualified professional engineer responsible for segmental retaining wall design shall review and approve submittals and source and field quality-control reports for compliance of materials and construction with design.
4. Product Certificates: For segmental retaining wall units and soil reinforcement, from manufacturer.



- a. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
  - b. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.
- 5. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for segmental retaining wall units and soil reinforcement.
  - a. Include test data for freeze-thaw durability of segmental retaining wall units.
  - b. Include test data for shear strength between segmental retaining wall units according to ASTM D 6916.
  - c. Include test data for connection strength between segmental retaining wall units and soil reinforcement according to ASTM D 6638.

F. Quality Assurance

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

G. Delivery, Storage, And Handling

- 1. Store and handle concrete units and accessories to prevent deterioration or damage due to contaminants, breaking, chipping, or other causes.
- 2. 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 (71 deg C) or below 32 deg F (0 deg C), and other conditions that might damage them. Verify identification of geosynthetics before using and examine them for defects as material is placed.

## 1.2 PRODUCTS

A. Segmental Retaining Wall Units

- 1. Concrete Units: ASTM C 1372, 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 (1.6 mm) from specified dimension.
  - a. Provide units that comply with requirements for freeze-thaw durability.
  - b. Provide units that interlock with courses above and below by means of integral lugs or lips, pins, clips, or hollow cores filled with drainage fill.
- 2. Color: As selected from manufacturer's full range.
- 3. Shape and Texture: Provide units of basic shape and dimensions indicated with machine-split textured **OR** smooth, **as directed**, exposed faces.
- 4. Shape and Texture: Provide units matching basic shape, dimensions, and face texture indicated by referencing manufacturer's pattern designation.
- 5. Shape and Texture: Provide units of any basic shape and dimensions that will produce segmental retaining walls of dimensions and profiles indicated without interfering with other elements of the Work and with machine-split textured, flat exposed face **OR** shaped exposed face with deeply beveled vertical edges, **as directed**.
- 6. Batter: Provide units that offset from course below to provide at least 1:24 **OR** 1:16 **OR** 1:14 **OR** 1:8 **OR** 1:5, **as directed**, batter.
- 7. Cap Units: Provide cap units of shape indicated **OR** same shape as other units, **as directed**, with smooth, as-cast top surfaces without holes or lugs.
- 8. 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 **OR** as indicated, **as directed**.

B. Installation Materials

- 1. Pins: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.





2. Clips: Product supplied by segmental retaining wall unit manufacturer for use with units provided, made from nondegrading polymer reinforced with glass fibers.
3. Cap Adhesive: Product supplied or recommended by segmental retaining wall unit manufacturer for adhering cap units to units below.
4. Leveling Base: Comply with requirements in Division 02 Section "Earthwork" for base material **OR** Division 02 Section "Subdrainage" for drainage fill, **as directed**.
  - a. Leveling Course: Lean concrete with a compressive strength of not more than 500 psi (3.4 MPa).
5. Drainage Fill: Comply with requirements in Division 02 Section "Subdrainage".
6. Reinforced-Soil Fill: ASTM D 2487; GW, GP, SW, SP, and SM soil classification groups or a combination of these groups; free of debris, waste, frozen materials, vegetation, and other deleterious matter; meeting the following gradation according to ASTM C 136: 20 to 100 percent passing No. 4 (4.75-mm) sieve, 0 to 60 percent passing No. 40 (0.425-mm) sieve, 0 to 35 percent passing No. 200 (0.075-mm) sieve, and with fine fraction having a plasticity index of less than 20.
7. Nonreinforced-Soil Fill: Comply with requirements in Division 02 Section "Earthwork" for satisfactory soils.
8. Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent.
  - a. Apparent Opening Size: No. 70 to 100 (0.212- to 0.150-mm) sieve, maximum; ASTM D 4751.
  - b. Minimum Grab Tensile Strength: 110 lb (49.9 kg); ASTM D 4632.
  - c. Minimum Weight: 4 oz./sq. yd. (132 g/sq. m).
9. Subdrainage Pipe and Filter Fabric: Comply with requirements in Division 02 Section "Subdrainage".
  - a. Product Type: Knitted or woven geogrid made from polyester yarns with a protective coating **OR** Molded geogrid made from high-density polyethylene **OR** Woven geotextile made from polyamides, polyesters, or polyolefins, **as directed**.

C. Source Quality Control

1. Direct manufacturer to test and inspect each roll of soil reinforcement at the factory for minimum average roll values for geosynthetic index property tests, including the following:
  - a. Weight.
  - b. Roll size.
  - c. Grab or single-rib strength.
  - d. Aperture opening.
  - e. Rib or yarn size.

### 1.3 EXECUTION

A. Examination

1. Examine areas and conditions, with Installer present, for compliance with requirements for excavation tolerances, condition of subgrades, and other conditions affecting performance of segmental retaining walls.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Retaining Wall Installation

1. General: Place units according to NCMA's "Segmental Retaining Wall Installation Guide" and segmental retaining wall unit manufacturer's written instructions.
  - a. Lay units in running bond **OR** bond pattern indicated, **as directed**.
  - b. Form corners and ends by using special units **OR** cutting units with motor-driven saw **OR** splitting units with mason's hammer and chisel, **as directed**.
2. Leveling Base: Place and compact base material to thickness indicated and with not less than 95 percent maximum dry unit weight according to ASTM D 698.



- a. Leveling Course: At Contractor's option, unreinforced lean concrete may be substituted for upper 1 to 2 inches (25 to 50 mm) of base **OR** Place unreinforced lean concrete over leveling base 1 to 2 inches (25 to 50 mm) thick, **as directed**. Compact and screed concrete to a smooth, level surface.
3. 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.
  - a. Tamp units into leveling base as necessary to bring tops of units into a level plane.
4. 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.
  - a. 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.
  - b. For units with lips at front of units, slide units as far forward as possible for firm contact with lips of units below.
  - c. For units with lips at bottom rear of units, slide units as far forward as possible for firm contact of lips with units below.
  - d. For units with pins, install pins and align units.
  - e. For units with clips, install clips and align units.
5. Cap Units: Place cap units and secure with cap adhesive.

C. Fill Placement

1. General: Comply with requirements in Division 02 Section "Earthwork", NCMA's "Segmental Retaining Wall Installation Guide," and segmental retaining wall unit manufacturer's written instructions.
2. Fill voids between and within units with drainage fill. Place fill as each course of units is laid.
3. 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.
  - a. Use only hand-operated compaction equipment within 48 inches (1200 mm) of wall, or one-half of height above bottom of wall, whichever is greater.
  - b. Compact reinforced-soil fill to not less than 95 percent maximum dry unit weight according to ASTM D 698.
    - 1) In areas where only hand-operated compaction equipment is allowed, compact fills to not less than 90 percent maximum dry unit weight according to ASTM D 698.
    - 2) In areas where fill height exceeds 15 feet (4.5 m), compact reinforced-soil fill that will be more than 15 feet (4.5 m) below finished grade to not less than 98 percent maximum dry unit weight according to ASTM D 698.
    - 3) In areas where fill height exceeds 30 feet (9 m), compact reinforced-soil fill that will be more than 30 feet (9 m) below finished grade to not less than 100 percent maximum dry unit weight according to ASTM D 698.
  - c. Compact nonreinforced-soil fill to comply with Division 02 Section "Earthwork".
4. Place drainage geotextile against back of wall and place layer of drainage fill at least 12 inches (300 mm) **OR** 6 inches (150 mm), **as directed**, wide behind drainage geotextile to within 12 inches (300 mm) of finished grade. Place another layer of drainage geotextile between drainage fill and soil fill.
5. Place a layer of drainage fill at least 12 inches (300 mm) **OR** 6 inches (150 mm), **as directed**, wide behind wall to within 12 inches (300 mm) of finished grade. Place a layer of drainage geotextile between drainage fill and soil fill.
6. Wrap subdrainage pipe with filter fabric and place in drainage fill as indicated, sloped not less than 0.5 percent to drain.
7. Place impervious fill over top edge of drainage fill layer.
8. Slope grade at top of wall away from wall unless otherwise indicated. Slope grade at base of wall away from wall. Provide uniform slopes that will prevent ponding.



9. Place soil reinforcement in horizontal joints of retaining wall where indicated and according to soil-reinforcement manufacturer's written instructions. Embed reinforcement a minimum of 8 inches (200 mm) into retaining wall and stretch tight over compacted backfill. Anchor soil reinforcement before placing fill.
  - a. Place additional soil reinforcement at corners and curved walls to provide continuous reinforcement.
  - b. Place geosynthetics with seams, if any, oriented perpendicular to segmental retaining walls.
  - c. Do not dump fill material directly from trucks onto geosynthetics.
  - d. Place at least 6 inches (150 mm) of fill over reinforcement before compacting with tracked vehicles or 4 inches (100 mm) before compacting with rubber-tired vehicles.
  - e. Do not turn vehicles on fill until first layer of fill is compacted and second layer is placed over each soil-reinforcement layer.
- D. Construction Tolerances
  1. Variation from Level: For bed-joint lines along walls, do not exceed 1-1/4 inches in 10 feet (32 mm in 3 m), 3 inches (75 mm) maximum.
  2. 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 (32 mm in 3 m).
  3. 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 (32 mm in 3 m).
- E. Field Quality Control
  1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  2. Comply with requirements in Division 02 Section "Earthwork" for field quality control.
    - a. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 150 feet (45 m) or less of segmental retaining wall length.
    - b. In each compacted backfill layer, perform at least 1 field in-place compaction test for each 24 inches (600 mm) of fill depth and each 50 feet (15 m) or less of segmental retaining wall length.
- F. Adjusting
  1. Remove and replace segmental retaining wall construction of the following descriptions:
    - a. Broken, chipped, stained, or otherwise damaged units. Units may be repaired if the Owner approves methods and results.
    - b. Segmental retaining walls that do not match approved Samples.
    - c. Segmental retaining walls that do not comply with other requirements indicated.
  2. Replace units so segmental retaining wall matches approved Samples and mockups, complies with other requirements, and shows no evidence of replacement.

END OF SECTION 02719



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## SECTION 02719a - MODULAR RETAINING WALL

### 1.1 GENERAL

#### A. Description

1. This specification covers the furnishing and installation of materials for modular retaining wall, and furnishing and installing accessories, all as indicated. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Definitions

1. Block Facing Units - Hollow concrete structural retaining wall units, plant cast from Portland cement, water, and mineral aggregates with or without the inclusion of other materials. The units are intended for use in the construction of mortarless, segmental retaining walls.
2. Geogrid - A geosynthetic formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.
3. Unit Fill - Compacted fill for the voids in the precast concrete wall units.
4. Wall Fill - Compacted soil which is within the geogrid reinforced soil mass.
5. Retained backfill - Any compacted soil which is behind the reinforced wall fill.
6. Foundation Soil - Compacted or in-situ soil beneath the entire wall.

#### C. Submittals

1. Product Data: For each type of product indicated.
2. Submittals: Shop drawings shall be submitted for approval.

#### D. Quality Control

1. Test units for 28-day strength in accordance with ASTM C 140. Average compressive strength shall be not less than 3000 psi (210 kg/sq cm).
2. Test units for freeze/thaw protection in accordance with ASTM C 90, and for water retention in accordance with ASTM C 941.
3. After unit samples have been accepted, erect and clean sample wall, of minimum of 15 sq ft (1.4 sq m), of each type of retaining wall. Sample wall shall be representative of retaining wall exposed in finished areas. Each sample wall will be checked for shade range, texture, soundness of construction, surface cleanliness, and conformity with other requirements of this Section. Secure acceptance of each cleaned sample wall from the Owner before starting work. Protect wall from damage. Remove sample wall after retaining walls have been accepted.

#### E. Job Conditions

1. Protect surfaces of weather-exposed units at end of each day and at start of each shut-down period with nonstaining waterproof cover extending at least two feet down on all sides of structure.
2. Protect surfaces and products adjacent to work that could possibly be damaged by water and cleaner.

#### F. Delivery, Storage And Handling

1. Retaining Wall Facing Units:
  - a. Contractor shall check the units and connection accessories upon delivery to ensure that proper materials have been received.
  - b. Contractor shall prevent excessive mud, wet cement, epoxy, and like materials from coming in contact with and affixing to the units.
  - c. Contractor shall protect the units from damage (i.e. cracks, chips, spalls). Damaged units shall be evaluated for usage in the wall according to ASTM C 90 and ASTM C 145.



2. Geogrid
  - a. Contractor shall check the geogrid upon delivery to ensure that the proper material has been received.
  - b. Geogrids shall be stored above -20°F (-29°C).
  - c. Contractor shall prevent excessive mud, wet cement, epoxy, and like materials from coming in contact with and affixing to the geogrid material.
  - d. Rolled geogrid material may be laid flat or stood on end for storage.

## 1.2 PRODUCTS

### A. Concrete Retaining Wall Units

1. Modular unit face dimensions of 8 in. (200 mm) thick by 18 in. (450 mm) long. Depth dimensions shall be no less than 20 in. (500 mm). Dry unit weight of wall units shall be no less than 90 lbs (35 kg). When tested in accordance with ASTM C 426, average linear shrinkage of three specimens shall be less than 0.045 percent. Color of faces and texture exposed to view shall be determined by the Owner.
  - a. Standard modular units: ASTM C 90, lightweight, two-cell type. Aggregate: ASTM C 331 (C 33).
  - b. Solid mini or cap units: ASTM C145, lightweight type. Aggregate: ASTM C 331 (C 33).
2. Connecting Pins: Poltruded polyester resin rods with fiberglass reinforcement; minimum flexural strength 100,000 psi (7 030 kg/sq cm).
3. Geogrid: The geogrids shall be a regular grid structure of select high density polyethylene or polypropylene resin and meet or exceed the design pullout test values required to stabilize and retain the fill above retaining wall.
4. Unit Fill: Gradation Size No. 67, or crushed stone drainage material acceptable to modular unit manufacturer.
5. Base Material: Material shall consist of compacted sand, gravel, crushed rock or leveling concrete (non-reinforced) as shown on construction drawing. The compacted leveling pad shall be a minimum 6 in. (150 mm) thick.
6. Backfill, Foundation Backfill And Wall Fill: As specified in Division 02 Section "Earthwork".
7. Underdrain: As specified in Division 02 Section "Subdrainage".
8. Cleaner: ProSoCo, Inc.'s Sure Klean, or accepted equivalent. Cleaner shall be capable of removing contaminants without damaging units.

## 1.3 EXECUTION

### A. Installation

1. Place base material to a minimum of 6 in. (150 mm) of compacted thickness. Material shall be compacted so as to provide a level hard surface on which to place the first course of units. Compaction shall be to 95% of standard proctor for sand or gravel type materials. For crushed rock, material shall be densely compacted. Grade top of base to plus/minus 1/4 in. (6 mm) of indicated level. Install underdrain UNDERDRAIN SYSTEMS.
2. Install first course of units in full contact with base, with vertical joints butted and top dead level; align unit faces. Install connecting pins, if required, and fill voids; tamp void fill and sweep top of units clean.
3. Lay successive units locking onto laid course at prescribed batter. Fill voids as work progresses.
4. Place geogrid on compacted, level backfill at indicated elevations and orientation. Hook leading edge over connecting pins and pull taut; anchor before placing additional backfill. Tracked mechanical equipment is not permitted on geogrid. Compaction of fill within 3 ft (1 m) of wall face shall be by hand operated equipment.
5. Tolerances
  - a. Variation from designed incline lines and controlling surface of walls: within 2 in. (50 mm) in 20 ft (6 m) vertical.



- b. Variation from conspicuous vertical lines: within 1 in. (25 mm) of 20 ft (6 m) vertical.
- c. Variation from level and other conspicuous horizontal lines: within 1 in. (25 mm) in 20 ft (6 m) horizontal, and within 2 in. (50 mm) in 40 ft (12 m), and more, horizontal.
- d. Variation of linear wall lines from established position in plan: within 1 in. (25 mm) in 20 ft (12 m), and within 2 in. (50 mm) in 40 ft (24 m), and more.

B. Cleaning

- 1. Clean installed work after completion of setting and backfill.
- 2. Before cleaning, protect adjacent surfaces and plants sensitive to masonry cleaner.
- 3. Wet wall and apply cleaner in accordance with cleaner manufacturer's printed instructions. Rinse units with clean water to remove masonry cleaner and sand. Installed work shall be clean and free from discoloration, stains, and smears.

END OF SECTION 02719a



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Task	Specification	Specification Description
02720	02612a	Asphalt Paving

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**SECTION 02721 - BEAM-TYPE GUARDRAIL****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for beam-type guardrail. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Submittals**

1. Product Data: For each type of product indicated.
2. Shop drawings shall be submitted for approval.

**1.2 PRODUCTS****A. Rail Elements, End Sections, and Fasteners**

1. ARTBA technical bulletin No. 268-B.
2. Provide galvanized steel W-beam in accordance with AASHTO M-180, class A, type 1.
3. Shop curve rail elements when required radius of installation on horizontal curve is 150 ft (46 m) or less. Provide W-beam rail (ARTBA RE-3) with a flared end section (ARTBA RE-5), rounded end section (ARTBA RE-6) at each end of installations.
4. Provide standard back-up plates behind rail elements at all intermediate, non-splice posts when steel posts and blocks are used.
5. Galvanize the rail sections, including end sections, in accordance with ASTM A 525, coating G-210.

**B. Posts**

1. Wood: Provide wood posts with blocks, size as required by State DOT. Rough sawn or S4S timber of Douglas Fir or any other locally approved species that is either No. 1 grade or Select Structural grade when graded in accordance with the requirements for Timber and Posts as set forth in WWPA-01 may be used. Give all wood posts and blocks a preservative treatment in accordance with the requirements of AASHTO M-133. Cut to length and bore posts and blocks for bolt holes before treatment.
2. Steel: Provide steel posts with blocks. Fabricate posts and blocks from W6X9 structural steel shapes complying with the requirements of ASTM A 36. Fabricate in the shop, grind smooth all corners and edges, galvanize posts and blocks after fabrication in accordance with ASTM A 123.

**C. Bolts, Nuts, and Washers**

1. Provide galvanized bolts, nuts, and washers that meet common ARTBA standards, designed to develop the required joint strength. Provide bolts with rounded heads to provide minimum obstruction.
2. Provide galvanized steel bolts conforming to the requirements of ASTM A 307, nuts conforming to the requirements of ASTM A 563, Grade A or better and galvanized steel washers, all galvanized in accordance with the requirements of ASTM A 153. Provide high strength bolts conforming to the requirements of ASTM A 325 where needed.

**D. Reflectors: Provide guardrail reflectors as indicated. Place the galvanized steel tabs with reflective sheeting at every post except no reflectors are to be placed along the guardrail end flares.****E. Breakaway Cable Terminal (BCT) Assemblies: Provide BCT assemblies in accordance with the ARTBA details and standards referenced on the details.**



- F. Concrete and Reinforcement for the Post Footings: In accordance with applicable sections of Division 03 Section "Cast-in-place Concrete".

### 1.3 EXECUTION

- A. Guardrail: Erect steel beam-type guardrail in locations and to lines and grades as directed and in accordance with details indicated.
- B. Erection
1. Firmly set posts spaced at 6 ft. 3 in. (1.9 m) centers to the required depth. Set posts by placing in hand or mechanically dug holes or by driving, with or without pilot holes. Backfill gaps around posts with approved material that is moistened and thoroughly compacted. Repair damaged roadway surfacing where pavement is disturbed.
  2. Position the top of W-beam rail at 27 in. (0.69 m) above the finished roadway surface. Align rail both vertically and horizontally within 1/4-in. (6 mm) from the theoretical alignments. Lap the rail sections at posts, in the direction of traffic in the adjacent lane, and lap end sections on the face of the rail.
  3. Exercise care to avoid damage to treated wood and galvanized steel parts. Repair or replace damaged parts at the Contractor's expense. Securely tighten all bolts in the finished guardrail. Toenail the wood blocks to wood posts with two 16 penny galvanized nails, one on each side of the top of the block.

END OF SECTION 02721

**SECTION 02722 - TRAFFIC SIGNS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of traffic signs. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**1.2 PRODUCT****A. Sign Foundations:**

1. Replacement Foundation Footing Concrete shall be a mixture of cement complying with ASTM C 150 and aggregate complying with ASTM C 33. Compressive strength shall be 2,800 psi at 28 days.
2. Sulfur Mortar shall comply with ASTM C 287.
3. Reinforcing Steel shall comply with ASTM A 615.

**B. Sign Supports shall be of the "break-away" type. Supports shall be strong enough to resist applicable wind forces without damage, but shall be designed to experience a brittle rupture type failure or a "quick separation" type joint.****1. Sign Support, Aluminum:**

- a. Replacement Castings shall be Alloy A356.0-T6 in compliance with ASTM B 108.
- b. Replacement Structural Members shall comply with ASTM B 308.
- c. Replacement Bars, Rods, Shapes, and Tubes shall comply with ASTM B 221, alloy 6061-T6.
- d. Replacement Bolts, Nuts, and Screws shall match items being replaced and shall be alloy 2024-T4 with anodic coating complying with ASTM B 580, or 6061-T6 in compliance with ASTM B 211. Bolt heads shall be hexagon. Bolt threads shall be Class 2, 2A, or 2B in compliance with ANSI B18.2.1. Nuts shall be hexagon shaped in compliance with ANSI B18.2.2.
- e. Replacement washers shall be furnished from sheet metal complying with ASTM B 209, alloy Alclad 2024-T3 or T4.

**2. Sign Support, Steel:**

- a. Replacement Structural Members shall comply with ASTM A 36.
- b. Replacement Bars shall comply with ASTM A 108.
- c. Replacement Pipe shall comply with ASTM A 53 standard weight.
- d. Replacement Fasteners shall comply with ASTM A 307 and ASTM A 325.
- e. Replacement Anchor Bolts for anchoring base plates to concrete bases and nuts and washers shall be galvanized in compliance with ASTM A 153.

**3. Sign Support, Wood:**

- a. Replacement Wood Sign Post shall be of the species listed in AASHTO M168, dressed four sides and having a pyramidal top cut before being treated.
- b. Replacement Sign Post shall be pressure treated with creosote or creosote-tar solution complying with AWPB LP-55.

**C. Sign Face:**

1. Replacement Plywood Sign Face shall be grade HDOAB G-1 EXTERIOR, in compliance with DOC PS 1. Material shall be cut to size in compliance with ANSI D6.1E.
2. Replacement Galvanizing Steel Sign Face shall comply with USDOT FHA MUTCD.

**D. Reflective Sheeting shall be enclosed lens unless otherwise directed by the Owner.**



1. Enclosed Lens Reflective Sheeting shall comply with Fed. Spec. L-S-300.
  2. Reflective Sheeting shall comply with FP-79 minimum reflective intensity. Measurements shall comply with Fed. Spec. L-S-300.
  3. Color shall be matched visually and within the limits shown on the Color Tolerance Charts issued by the Federal Highway Administration. The diffuse day color of the reflective sheeting shall be determined in compliance with ASTM E 97.
  4. Film:
    - a. General: Reflective sheeting shall be sufficiently flexible to be easily cut to shape and permit application over, and conformance to, moderate shallow embossing characteristic of certain sign borders and symbols.
    - b. Surface: Sheeting surface shall be smooth and flat, shall facilitate cleaning and wet performance, and shall exhibit 85 degrees glossmeter rating of not less than 40, as specified in ASTM D 523. The sheeting surface shall withstand cleaning with gasoline, VM&P Naphtha, mineral spirits, turpentine, methanol, and xylol.
- E. Demountable Sign Face Materials:
1. Acrylic Plastic Reflectors: Replacement demountable sign letters, digits, arrows, borders, and alphabet accessories shall be reflectorized and shall consist of acrylic plastic reflectors supported by embossed aluminum frames. They shall comply with the Standard Alphabet for Highway Signs, of the Federal Highway Administration, Series E.
  2. Design and Fabrication: The letters shall be modified as necessary to accommodate the required reflectors. All items except border strips shall be fabricated from 0.040-inch minimum sheet aluminum. Border strips shall be of 0.032-inch minimum sheet aluminum. Mounting holes shall be provided within the frames to permit the use of screws, rivets or other acceptable fasteners. The size and spacing of the reflector holes shall provide maximum night legibility and visibility of the finished cutout figure.
  3. General Requirements: The reflectors shall be of acrylic plastic meeting the requirements of Fed. Spec. L-P-380, Type I, Class 3. The reflectors shall be yellow or colorless. The lens shall consist of a smooth front surface, free from projections or indentations other than for identification, and a rear surface bearing a prismatic configuration that will effect total internal reflection of light.
  4. Reflective Sheeting:
    - a. Demountable Sign Letters, Digits, Arrows, Borders, and Alphabet Accessories, when so specified, shall be reflectorized with reflective sheeting supported by flat aluminum backing and shall comply with the Standard Alphabet Highway Signs of the Federal Highway Administration.
    - b. Design and Fabrication: Letter design shall be Series E, modified for legibility. All items except border strips shall be fabricated from 0.040-inch sheet aluminum, 6061-T6 alloy, with mounting holes to permit use of screws, rivets, or other acceptable fasteners.
- F. Highway Delineators, Enclosed Lens Type: Replacement reflectors shall be of acrylic plastic and a minimum of 3 inches in diameter. They shall be mounted in a heavy-duty housing with a back plate. The reflector shall consist of a clear and transparent plastic lens, which shall be colorless, and a plastic back of the same material, fused to the lens under heat and pressure around the entire perimeter to form a homogeneous unit, permanently sealed against dust, water, and water vapor. The acrylic plastic shall comply with Fed. Spec. L-P-380, Type I, Class 3.
- G. Highway Delineators, High Intensity Type:
1. Replacement Reflectorized Delineators shall consist of a reflective sheeting compound of glass spheres, embedded in a weatherproof, synthetic, noncellulose material. The overall size of the plastic reflectors shall be 4 inches by 5 inches, with a reflective area of at least 17.5 square inches.
  2. Delineators shall be silver-white when viewed with reflected light.
- H. Highway Delineators Including Posts and Attachments:



1. Reflective Sheeting: Replacement reflective sheeting for delineators shall match delineators being replaced.
  2. Delineator Posts and Accessories shall be of steel or aluminum. They shall have the necessary holes for attachment of the delineator housing. The assembly shall be furnished with the necessary bolts, nuts, and washers for attaching to the posts.
  3. Insulating Materials: Neoprene, for separation of aluminum and steel parts, shall contain at least 60 percent, by volume, of pure neoprene. Other material may be used, subject to the approval of the Owner as to pliability and ability to withstand wear caused by stretching or distortion.
  4. Reflector Units for guardrail installation shall match existing reflector being replaced in size and color.
  5. Highway Delineators shall be supplemented with directional guidance signs as directed by the Owner. Signs shall be the chevron alignment type and shall comply with ANSI D6.1E, Type W 1-8.
- I. Painting Panels for Nonreflectorized Background:
1. Replacement Metal Panels for sign categories not required to be reflectorized shall have a nonreflectorized background composed of one spray coat of primer and two finish coats of baked enamel.
  2. Finish Coats shall be baked alkyd resin enamels meeting Fed. Spec. TT-E-529, Class B, of a composition that affects the finished background surface. When thoroughly dry, the colors shall match those described in the current Highway Blue Color Tolerance Chart, PR Color No. 3, or in Highway Green Color Tolerance Chart, PR Color No. 4, of the Federal Highway Administration.
  3. Wood Signs shall have two coats of oil paint complying with Fed. Spec. TT-P-52. Message paint shall be a single coat of oil paint. All colors shall comply with ANSI D6.1E.
- J. Sign Wash Detergent shall comply with ASTM D 3399.
- K. Street, Wayside, Utility Location, And Parking Lot Signs; Decals
1. Blanks: aluminum of type, size, and shape indicated.
  2. Reflective sheeting: Type 1 sheeting having Level A reflective intensity.
  3. Silk screen lettering paint and transparent process colors: as directed by the Owner.
  4. Posts
    - a. Drive type: as directed by the Owner.
    - b. Pipe type: Two-inch inside diameter.
  5. Hardware: as directed by the Owner.
  6. Fabrication
    - a. Dimensions, colors, and reflectorizing: As indicated, and in accordance with MUTCD.
    - b. Size, style, and spacing of letters, numerals, symbols, and borders: As indicated, and the Owner; as supplemented by DOT/FHA's publication entitled Standard Highway Signs as specified in MUTCD 1978.
    - c. Workmanship: as directed by the Owner.
- 1.3 EXECUTION
- A. Footings for Signs, Posts, and Supports:
1. Backfill Material shall be at or near optimum moisture and neither dry nor saturated. It shall be tamped thoroughly in place.
  2. Concrete Footings may be cast in place or precast. Hand mixing of concrete will be permitted where the quantity does not exceed one-half cubic yard.
- B. Erection of Signs and Sign Supports: Sign posts shall be erected vertically. Posts erected in sleeves shall be anchored with sulphur mortar. Mortar shall comply with ASTM C 287. Sign faces shall be positioned to be generally perpendicular to the line-of-sight for the observer. Reflectorized signs shall



be inspected at night. If specular reflection is apparent on any sign, its position shall be adjusted by the Contractor to eliminate the condition.

- C. Delineators and Hazard Markers: Delineator posts shall be driven to a depth of 30 inches.
- D. Removal of Existing Signs and Posts:
  - 1. Damaged, Obsolete, or Change of Purpose Signs and Posts shall be removed and delivered to a storage area designated by the Owner. Post hole shall be backfilled, tamped, and made level with the adjacent surface. Disturbed paving, sidewalks, and grassed areas shall be replaced with matching material of same quality and quantity as existing.
  - 2. Signs and Posts to be Replaced shall be removed and replaced by new signs and posts in identical locations. Backfill around post shall be thoroughly compacted to hold posts securely in a vertical position.
- E. Installation: Install in accordance with manufacturer's recommendations and as directed by the Owner. Unless otherwise indicated, install not more than one sign on each post.

END OF SECTION 02722





## SECTION 02723 - ELECTRICAL TRAFFIC CONTROL SIGNALS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of electrical traffic control signals. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

### 1.2 PRODUCT

- A. General: Replacement equipment items shall be regularly manufactured products.
- B. Concrete Poles: Cement ASTM C 150; aggregate ASTM C 33; minimum compressive strength 6,000 psi when tested in compliance with AASHTO T22. Tensioning steel shall comply with ASTM A 603. Strands shall not be tensioned above 70 percent of the rated ultimate strength. Epoxy compound for sealing hollow cores shall comply with ASTM D 1763.
- C. Galvanized Conduit Nipples: UL 514B.
- D. Ground Wire: Cast-in-concrete pole, No. 6 stranded bare wire, ASTM A 603.
- E. Wood Poles: ANSI 05.1, waterborne preservative-treated in compliance with AWPA C3, Retention Zone 1.
- F. Structural Steel: ASTM A 36.
- G. Steel Pipe: ASTM A 53.
- H. Steel Bars: ASTM A 576.
- I. Wire Strand: ASTM A 475.
- J. Zinc Coatings: Members, ASTM A 123; fasteners, ASTM A 153.
- K. Mast Arms for Supporting Traffic Signals: ASTM A 36; aluminum alloy 3003, or alloy alcad 3004 complying with ASTM B 209.
- L. Concrete for Pull Boxes: ASTM C 94, 3,000 psi.
- M. Cast-Iron Covers: ASTM A 48.
- N. Signal Lens: Manufactured in compliance with Article 5 and 6, ITE Technical Report Number 1.
- O. Loop Wire for Vehicle Detectors: No. 14 AWG or No. 12 AWG, stranded copper wire, type TTHN, THWN, or THW, ASTM B3.
- P. Grout: One part cement complying with ASTM C 150 and two parts sand complying with ASTM C 33.
- Q. Conduit: Polyvinyl chloride, UL 651, Schedule 40 or galvanized rigid metal, ASTM B 3.



- R. Ground Wire: Soft drawn copper, bare, stranded, ANSI C7.1.
- S. Electrical Work: NFPA No. 70.

### 1.3 EXECUTION

- A. Scheduling and Coordination: The Contractor shall ensure that required notices have been given and that power interruptions have been scheduled and approved.
- B. Traffic: Provide temporary traffic signs at and around work area. Signs and locations shall be as approved by the the Owner.
- C. Vehicle Detector Assemblies, Loop Type: Saw out existing loops to be replaced to their full depth. Install and seal loop wire. Splice and solder loop wire and lead-in cable and wrap a minimum of two wraps with silicone tape and heavy-duty electrical tape. Install sealant in compliance with the manufacturer's recommendations. Excavate and remove existing lead-in cable to be replaced, and install new lead-in cable in place and connect to cabinet ground.

END OF SECTION 02723

**SECTION 02726 - ACTIVE VEHICLE BARRIERS****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for active vehicle barriers. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Submittals**

1. Shop Drawings: Installation, Equipment, and Electrical Work
  - a. Detail drawings containing complete wiring and schematic diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including foundation and clearances for maintenance and operation. For Federal work, detail drawings shall include a copy of the Department of State certificate of barrier performance.
2. Product Data:
  - a. Vehicle Barriers: A complete list of equipment, materials, including industrial standards used and how they apply to the applicable component and manufacturer's descriptive data and technical literature, catalog cuts, and installation instructions. Information necessary to document a minimum 1-year successful field operation performance history for each type of vehicle barrier installed.
  - b. Spare Parts: Spare parts data for each different item of material and equipment used, after approval of the detail drawings. The data shall include a complete list of parts and supplies, with current unit prices and source of supply.
3. Test Reports
  - a. Field Testing: Test reports in booklet form showing all field tests, including component adjustments and demonstration of compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall indicate the final position of controls.
4. Operation and Maintenance Data
  - a. Vehicle Barriers: Operating and Maintenance Instructions
    - 1) Six copies of operation and maintenance manuals, a minimum of 2 weeks prior to field training. One complete set prior to performance testing and the remainder upon acceptance. Manuals shall be approved prior to acceptance. Operation manuals shall outline the step-by-step procedures required for system startup, operation, and shutdown. The manuals shall include the manufacturer's name, model number, service manual, parts list, and brief description of all equipment and their basic operating features. Maintenance manuals shall include routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include piping layout, equipment layout, and simplified wiring and control diagrams of the system as installed. The manuals shall also include synthetic biodegradable hydraulic oil types to be used for ambient temperature ranges of minus 30 degrees F (minus 34 degrees C) to 150 degrees F (plus 66 degrees C) to cover winter operation, summer operation, and ambient temperature ranges in between.

**C. General Requirements**

1. Performance levels shall be based on the following:
  - a. The Department of State (DOS) publication SD-SDT-02.01 Specification for Vehicle Crash Testing of Perimeter Barriers and Gates (April 1985) in which:
    - 1) Impact Conditions:



Condition Designation	Vehicle Weight	Impact Speed	Kinetic Energy
K4	15,000 lb (6,800 kg)	30 mph (48 km/h)	450,000 ft-lb (610 kJ)
K8	15,000 lb (6,800 kg)	40 mph (65 km/h)	800,000 ft-lb (1084 kJ)
K12	15,000 lb (6,800 kg)	50 mph (80 km/h)	1,250,000 ft-lb (1695 kJ)

2) Performance Levels:

- a) L 3.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 3 feet (1 m) permitted.
- b) L 2.0 Vehicle and cargo are to be stopped although vehicle partial penetration and/or barrier deflection of up to 20 feet (6 m) is permitted.
- c) L 1.0 Vehicle is disabled and does not travel more than 50 feet (15 m) after impact.

2. Vehicle Barriers furnished shall in all respects be identical to the unit tested and certified except for the width of the vehicle barrier, which is as indicated and except for bollards which have a diameter based on a required crash rating. Crash test shall be performed and data compiled by an approved independent testing agency. Test vehicle shall not vault or penetrate the barrier during the test. The design and structural materials of the vehicle barrier furnished shall be the same as those used in the crash tested barrier.

D. Nameplates

1. Nameplate data shall be permanently attached to each vehicle barrier. The data shall be legibly marked on corrosion-resistant metal plates and shall consist of at least the following:
  - a. Manufacturer's name.
  - b. Model number.
  - c. Serial number.
  - d. Date of manufacture.

E. Delivery And Storage

1. Components placed in storage shall be protected from the weather, humidity, and temperature variation, dirt and dust, or other contaminants. Structural materials shall be stored on sleepers or pallets and shall be protected from rust and objectionable materials such as dirt, grease, or oil.

F. Spare Parts

1. A manufacturer's standard recommended spare parts package, with current unit prices and source of supply complete with detailed manuals on parts replacement, shall be provided with each barrier to facilitate 1 year of normal operation. Particular consideration shall be given to system components which are not readily available from local or commercial sources and which are critical to the operation of the system.

G. Manufacturer's Services

1. Services of a manufacturer's representative who is experienced in the installation, adjustment, and operation of the equipment supplied shall be available. The representative shall supervise the installation, adjustment, and testing of the equipment.

## 1.2 PRODUCT

- A. Retractable Barriers: When in the raised position, the total retractable barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be 144 inches (3.66 m) wide. When in the lowered position, the retractable barrier shall extend no more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) wheel load. Design for this load shall be in accordance with AASHTO HB-17.

1. Powered Retractable Barrier: The retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable



of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being lowered from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.

- a. Failure Modes of Operation: The system shall be designed to remain in the last commanded position in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic barriers without power.
  - b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed **OR** totally enclosed fan cooled, **as directed**, enclosures. All couplings, motor shafts, gears, and other moving parts shall be fully guarded in accordance with 29 CFR 1910 Subpart O. Guards shall be removable without disassembling the guarded unit. For multiple barriers operated from a single hydraulic unit it is highly recommended that the electric motor be 3-phase.
  - c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure. The system shall not require continuous running of the motor to stay in the raised position, excluding the use of manual pinning to do so.
  - d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
    - 1) Flexible hydraulic lines shall be in accordance with SAE J517.
    - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
  - e. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Retractable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Barrier should be capable of being locked in the down position.

- B. Retractable Bollards: The total bollard height when in the raised position shall be no less than 30 inches (750 mm) above the roadway surface and shall have an outside diameter of no less than 8 inches (200 mm). A bollard system shall consist of a minimum of 3 bollards spaced no more than 36 inches (915 mm) from centerline to centerline of bollards across a 10 foot (3.0 m) roadway. Bollards in the lowered position shall be capable of supporting a 16,000 pound (71 kN) wheel load each. Design for this load shall be in accordance with AASHTO HB-17. Retractable bollards shall withstand a K4 **OR** K8 **OR** K12, **as directed**, Impact Condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**.



1. **Powered Retractable Bollards:** The retractable bollard shall be capable of 300 complete up/down cycles per hour. Bollards shall be capable of being raised or lowered within a 3 to 15-second range during normal use and within 2.5 seconds for emergency operations.
    - a. **Failure Modes of Operation:** The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electrical, or mechanical failure. A manual pump, or other system, shall be included for operation of hydraulic and/or mechanical barriers without power.
    - b. **Electric Motors:** Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. For multiple barriers being operated from a hydraulic power unit it is highly recommended that the electric motor be 3-phase.
    - c. **System:** The system shall be designed to maintain the barriers in the raised position, without inspection, for period of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
    - d. **Hydraulic Power Unit:** The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range, if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
      - 1) Flexible hydraulic lines shall be in accordance with SAE J517.
      - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
    - e. **Hydraulic Power Unit Enclosure:** A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
  2. **Manual Retractable Bollards:** Manual bollards shall be capable of being raised and lowered utilizing a recessed handle on the top surface of the bollard or a manual hydraulic pump, either requiring a maximum 60 pounds (267 N) of force. A mechanism, that is lockable, shall be provided to secure the bollard in either the full "UP" or full "DOWN" position.
- C. **Crash Gate:** The crash gate shall consist of steel buttresses anchored into the ground and an above grade assembly consisting of a heavy steel structure or a combination of heavy steel and structural aluminum capable of being opened and closed. The height of the gate shall be a minimum of 84 inches (2.1 m) from the road surface to the top of the gate frame. The length shall close and protect a minimum 120 inch (3.0 m) clear opening. The maximum clear opening between the gate frame and end posts, between the bottom of the gate and finished grade, and between any grill work shall be 3 inches (75 mm).
1. **Powered Crash Gate:** The gate movement shall be controlled by an electro-mechanical gate operator **OR** a hydraulic gate operator, **as directed**, consisting of an operator unit with required control circuits and operator station. The control and operating voltage shall be 24 vac (nominal) or, as an option 24 vdc. A remote control master station shall be capable of driving the gate at minimum 48 fpm (14.6 m per minute) for a slide gate or 6 degrees per second for a swing gate. Unless otherwise indicated, motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures. Crash gate shall withstand a 15,000 pound (6804 kg) vehicle at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum barrier deflection or vehicle penetration of 3 feet (1 m).



- a. Failure Mode of Operation: The system shall be designed to prevent opening of the crash gate in the event of electrical or mechanical failure. A disconnect system for the gate drive shall be provided to allow manual operation of the barrier in the event of a power outage.
  - b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity within its operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe, or a combination of flexible and carbon steel. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.
    - 1) Flexible hydraulic lines shall be in accordance with SAE J517.
    - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
  - c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
2. Manual Crash Gate: The manual crash gate shall be capable of being hinged from either side. Hinge points of both buttresses shall each contain a locking pin with padlock acceptance for securing the crash gate in the closed position. The crash gate shall withstand a 10,000 pound (4535 kg) vehicle at impact speed of 50 mph (80 km/hour), with maximum gate deflection or vehicle penetration of 10 feet (3 m) 15,000 pound (6804 kg) vehicle traveling at impact speed of 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with a maximum gate deflection or vehicle penetration of up to 3 feet (1 m).
- D. Crash Beam: The crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 **OR** 40 **OR** 50, **as directed**, mph (48 **OR** 64 **OR** 80, **as directed**, km/hour), with maximum vehicle penetration of 20 feet (6 m) 10,000 pound (4535 kg) vehicle at impact speed of 15 mph (24 km/hour), with a maximum vehicle penetration of 10 feet (3 m).
1. Powered Crash Beam: The crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
    - a. Failure Mode of Operation: A disconnect system for the crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
    - b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Buried hydraulic lines for the connection of the hydraulic power unit to the barrier shall be flexible or carbon steel pipe or a combination of flexible and carbon steel pipe. Flexible and rigid hydraulic line working pressures shall exceed the maximum system relief pressure. PVC pipe and fittings for burial of hydraulic lines shall be in accordance with ASTM D 3034 Type PS 46 with minimum pipe stiffness of 46.



- 1) Flexible hydraulic lines shall be in accordance with SAE J517.
  - 2) Rigid hydraulic lines shall be seamless carbon steel pipe in accordance with ASTM A 106.
  - c. Hydraulic Power Unit Enclosure: A NEMA Type 3R enclosure as specified in NEMA 250 shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable/lockable exterior door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
  2. Manual Crash Beam: The crash beam shall be manually raised and lowered with the aid of a counterbalanced end requiring approximately 60 pounds (267 N) of force.
- E. Portable Retractable Barrier: The portable retractable barrier shall be transportable and capable of manual and/or electro-mechanical operation. When in the raised position, the total barrier heights shall be no less than 28 inches (711 mm) above the roadway surface and shall be up to 144 inches (3.66 m wide). The barrier shall be equipped with entrance/exit ramps when the barrier extends more than 5/8 inch (16 mm) above the roadway surface. Retractable barriers in the lowered position shall be capable of supporting a 32,000 pound (142 kN) axle load or a 16,000 (71 kN) pound wheel load. Design for this load shall be in accordance with AASHTO HB-17.
1. Powered Portable Retractable Barrier: The portable retractable barrier shall be capable of 300 complete up/down cycles per hour. The retractable barrier motion shall be instantly reversible and shall be capable of raising the barrier from the lowered position to the raised position within 8 seconds during normal use, and within 2 seconds during an emergency. Also, the barrier shall be capable of being closed from the raised position to the lowered position in not more than 3 seconds. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**. Portable retractable barrier, when impacted by a 15,000 pound (6,800 kg) vehicle at impact speed of 50 mph (80 km/hour) shall disable the vehicle and allow it to travel no more than 50 feet (15.2 m) after impact. Portable power assisted retractable barriers shall be equipped with on and off ramps for smooth transition between surfaces when the barrier extends more than 5/8 inch (16 mm) above the roadway surface.
    - a. Failure Modes of Operation: The system shall be designed to prevent lowering of the barrier in the event of hydraulic, electric, or mechanical failure. A manual pump shall be included for operation of hydraulic and/or mechanical barriers without power.
    - b. Electric Motors: Unless otherwise indicated, electric motors shall have drip-proof **OR** totally enclosed, **as directed**, enclosures.
    - c. System: The system shall be designed to maintain the barriers in the raised position, without inspection, for periods of time of up to 1 week. If a hydraulic system is used, it shall be equipped with pressure relief valves to prevent overpressure.
    - d. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
  2. Manual Retractable Portable Barriers: The manual barrier shall be capable of being raised and lowered by manual means such as levers or hydraulics requiring a maximum 60 pounds (267 N) of force. The manual mechanism shall contain a locking pin which accepts a padlock for securing the barrier when it is in the "UP" position and shall also be capable of being locked in the





"DOWN" position. Retractable barrier shall withstand a K4 **OR** K8 **OR** K12, **as directed**, impact condition with Performance Level of L1.0 **OR** L2.0 **OR** L3.0, **as directed**

- F. Portable Crash Beam: The portable crash beam shall be an above-grade assembly that, in the "DOWN" position, shall present a visible obstacle to approaching vehicles. The height of the barrier shall be a minimum of 30 inches (750 mm) as measured from the roadway surface to the centerline of the crash beam. The crash beam shall be capable of blocking a minimum road width of 120 inches (3.0 m). The crash beam end shall contain a locking pin with padlock acceptance for securing the crash beam when it is in the "DOWN" position. Crash beam shall withstand a 15,000 pound (6804 kg) vehicle traveling at 30 mph (48 km/hour), with maximum vehicle penetration and/or barrier deflection of 20 feet (6 m).
1. Powered Portable Crash Beam: The portable crash beam shall be operated by means of a hydraulic power system. The crash beam shall be capable of being raised or lowered within an 8 to 15 second time range.
    - a. Failure Mode of Operation: A disconnect system for the portable crash beam shall be provided to allow manual operation of the barrier in the event of an electrical or mechanical failure.
    - b. Hydraulic Power Unit: The hydraulic power unit shall contain synthetic biodegradable hydraulic fluid which maintains its viscosity operating range, even at constant heaviest use rate, for an ambient temperature range of 20 to 150 degrees F (minus 7 to plus 66 degrees C). A hydraulic fluid heater shall be provided so that the viscosity remains within its operating range if ambient temperatures below 20 degrees F (minus 7 degrees C) are expected. Flexible hydraulic lines shall be used for the connection of the hydraulic power unit to the barrier. Flexible hydraulic line working pressures shall exceed the maximum system relief pressure; flexible hydraulic lines shall be in accordance with SAE J517.
    - c. Hydraulic Power Unit Enclosure: A weather resistant enclosure shall be provided to enclose the hydraulic power unit. The enclosure shall be designed for easy removal of the hydraulic power unit components and other accessories without complete removal of the enclosure. An access door with hinges and an inside and outside operable lockable (exterior) door latch shall be provided. Equipment within the enclosure shall be placed and configured so that all periodic maintenance can be performed through the access door without removal of the equipment. The enclosure shall be equipped with weatherproof louver vents appropriately sized and located to dissipate internal heat generation.
  2. Manual Portable Crash Beam: The crash beam shall be manually operated by means of a counter balanced system requiring approximately 60 pounds (267 N) of force.
- G. Electrical Work: Motors, manual or automatic motor control equipment except where installed in motor control centers and protective or signal devices required for the operation specified herein shall be provided in accordance with Division 15. All field wiring for loop detectors, communication lines, and power circuits shall have surge protection. Any wiring required for the operation specified herein, but not shown on the electrical plans, shall be provided under this section in accordance with Division 15.
- H. Control Panel: A control panel and control circuit shall be provided to interface between all barrier control stations and the power unit. A control panel shall be provided for the inbound lanes and a separate one for the outbound lanes where the barriers are located. The control station is defined as the main control panel and the remote control panel as shown. The control circuit shall contain all relays, timers, and other devices or an industrial programmable controller programmed as necessary for the barrier operation. The control panel shall allow direct interface with auxiliary equipment such as card readers, remote switches, loop detectors, infrared sensors, and sliding **OR** swinging, **as directed**, gate limit switches. Loop controllers shall not cause an automatic barrier raise following power loss or restoration. The enclosure shall be as indicated on the drawings. All device interconnect lines shall be run to terminal strips.
1. Voltage: The control circuit shall operate from a 120 volt 60 **OR** 50, **as directed**, Hz supply. The control circuit voltage shall be 12 **OR** 24, **as directed**, ac **OR** dc, **as directed**, for all external control panels.



2. **Main Control Panel:** A main control panel shall be supplied to control barrier function. This panel shall have a key-lockable main switch with main power "ON" and panel "ON" lights. Buttons to raise and lower each barrier **OR** set of barriers, **as directed**, shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier **OR** set of barriers, **as directed**. An emergency fast operate circuit (EFO) shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. The EFO shall also be furnished with an EFO-active light and reset button. The main control panel shall have a key lockable switch to arm or disable the remote control panel. An indicator light shall show if the remote control panel is enabled.
3. **Remote Control Panel:** A remote control panel, one panel for the inbound lane(s) and a separate panel for the outbound lane(s), shall have a panel "ON" light that is lit when enabled by a key lockable switch on the main control panel. Buttons to raise and lower each barrier shall be provided. Barrier "UP" and "DOWN" indicator lights shall be included for each barrier. The EFO shall be operated from a push button larger than the normal controls and have a flip safety cover installed over the push button or toggle switch. Activation of either EFO will operate all barriers. The EFO shall be interconnected with an EFO-active light. When the remote control panel EFO is pushed, operation of the barrier will not be possible from this panel until reset at the main control panel.

I. **Miscellaneous Equipment**

1. **Safety Equipment**
  - a. **Barrier Systems Sensors:** The sensors shall be compatible with the barrier controller and shall function as part of a complete barrier control system. The barrier system sensors shall consist of the following:
    - 1) **Suppression Loops** - Two inductive loops whose outputs shall be used to prevent barriers raising when a vehicle is within a prescribed distance of the barrier. The output of the loops shall override all barrier rise signals until one second after a vehicle clears the suppression loop.
    - 2) **Speed Loops** - Two inductive loops whose output shall be used to signal the barrier controller of a vehicle approaching at a speed greater than the posted speed (25 mph (11.2 m/sec) or less (recommended)). The speed loops shall cause the barrier control panel to annunciate a warning sound alerting the guard to make a decision as to whether the barrier should be raised or not.
    - 3) **Wrong Way Loops** - Two inductive loops whose output shall be used to signal the barrier control panel to enunciate a warning sound if a vehicle is attempting to enter the facility through the exit lane. The warning sound will alert the guard to make a decision as to whether the barrier should be raised or not.
  - b. **Traffic Lights:** Red/yellow 8 inch (200 mm) traffic lights shall be supplied for each entrance and exit to alert motorists of the barrier position. Traffic lights are not required for manual barriers. The yellow flashing light shall indicate that the barrier is fully open. All other positions shall cause the light to show red. Brackets shall be supplied to allow the light to be mounted a minimum 4.5 feet (1.4 m) above the roadway pavement on a 3.5 inch (90 mm) outside diameter metal post or mounted directly on the crash gate.
2. **Warning Annunciator:** Provide a warning annunciator built into the barrier control panel that produces a pulsing audible sound when the speed loop detects a vehicle entering the facility with excess speed. Provide a warning annunciator built into the barrier control panel that produces a continuous sound whenever a wrong way loop detects a vehicle entering from the exit. The warning annunciator shall sound until a warning annunciator silence reset button is pressed.
3. **Heater:** A waterproof barrier heater with a thermostat control and NEMA 4 junction box connection point shall be provided for de-icing and snow melting. The heater shall provide barrier operation to an ambient temperature of minus 40 degrees F (minus 40 degrees C). For retractable bollards, a 250-watt heater shall be provided for each bollard.
4. **Signage:** Signage shall read "Axle Weight Limit 9 Tons" and shall conform to FHWA SA-89-006 sign (R12.2).



5. Vertical Arm Gates (Traffic Arms): Vertical arm gates shall have an opening and closing time of less than or equal to 5 seconds. The gates shall be capable of 500 duty cycles per hour as a minimum. Gate shall operate the arm through 90 degrees. Gate operators shall be supplied with single phase 120 volt motors. Each entry lane shall be provided with a vertical arm gate. Each gate shall be capable of being operated from a remote open-close push button station in each guard booth and the gatehouse for the respective entry lane. Gates shall have a hand-crank, or other means, which will allow manual operation during power failures. Gate arms shall be constructed out of wood, steel, fiberglass, or aluminum, as specified by the manufacturer for the given lengths as shown on the drawings. Gate arms shall be covered with 16 inch (406 mm) wide reflectorized red and white sheeting. Each gate shall be furnished with a spare gate arm. Gate operator cabinets shall be constructed of galvanized steel, or aluminum and shall be painted manufacturers standard color as approved. Each gate operator shall be provided with an obstruction detector that will automatically reverse the gate motor when an obstruction is detected. The obstruction detector shall be any of the following 3 types: An electronic loop vehicle detector buried in the road, a photocell electric eye mounted on the gate operator, or a safety strip mounted on the lower edge of the arm. The detector system shall be automatically deactivated when the arm reaches the fully lowered position. Slab size and anchorage for gate operator shall be per manufacturer requirements.
  6. Vehicle Barrier Vertical Arm Gate (Traffic Arm): A traffic arm, as a separate piece of equipment, will be included with each non-portable active vehicle barrier as part of the barrier safety operating system. This traffic arm shall automatically deploy (close) when the emergency up button is activated and open when the vehicle barrier is reset. This traffic arm will not be equipped with an automatic obstruction detector.
- J. Finish: Surfaces shall be painted in accordance with requirements of Division 09 Section(s) "Exterior Painting" OR "Interior Painting", as applicable. The roadway plate shall have a nonskid surface painted white with reflective red 4 **OR 6, as directed**, inch (100 **OR 150, as directed**, mm) wide red reflective stripes 4 inches (100 mm) apart. The barrier front shall be painted white and have 4 **OR 6, as directed**, inch (100 **OR 150, as directed**, mm) wide reflective red stripes 4 inches (100 mm) apart. The diagonal striping should point down and outward from the center of the device. Bollards shall be painted white with 2 **OR 3, as directed**, inch (50 **OR 75, as directed**, mm) wide reflective red diagonal stripes. The barrier crash gate shall be painted as specified by purchaser and the crash beam shall be painted white with 3 inch (75 mm) wide reflective red diagonal stripes.
- K. Concrete: The concrete shall conform to Division 03 Section "Cast-in-place Concrete".
- L. Welding: Welding shall be in accordance with AWS D1.1/D1.1M.
- M. Pavement: After placement of the vehicle barrier, the pavement sections shall be replaced to match the section and depth of the surrounding pavement. Pavement shall be warped to match the elevations of existing pavement. Positive surface drainage, away from the vehicle barrier, shall be provided by pavement slope.

### 1.3 EXECUTION

- A. Installation: Installation shall be in accordance with manufacturer's instructions and in the presence of a representative of the manufacturer. Manufacturer's representative shall be experienced in the installation, adjustment, and operation of the equipment provided. The representative shall also be present during adjustment and testing of the equipment.
- B. Hydraulic Lines: Buried hydraulic lines shall be placed in polyvinyl chloride (PVC) sleeves. Positive drainage shall be provided from the hydraulic power unit to the barrier for drainage of condensation within the PVC sleeve.



- C. Pit Drainage: A drain connection and oil/water separator, **as directed**, shall be provided in each barrier that requires pit/vault type construction. Hookups between the storm drains shall be made. The self-priming sump pump shall have the capacity to remove minimum 150 gallons per minute (34 cubic meters per hour).
- D. Electrical: All control power wiring requiring compression terminals shall use ring-style terminals. Terminals and compression tools shall conform to UL 486A. Roundhead screws and lockwashers shall be used to provide vibration-resistant connections. Connections between any printed circuit cards and the chassis shall be made with screw connections or other locking means to prevent shock or vibration separation of the card from its chassis. The electrical power supply breaker for the hydraulic power unit shall be capable of being locked in the power on and power off positions.
- E. Field Testing: Upon completion of construction, a field test shall be performed for each vehicle barrier. The test shall include raising and lowering the barrier, both electrically and manually, through its complete range of operation. Each vehicle barrier shall then be continuously cycled for not less than 30 minutes to test for heat build-up in the hydraulic system. the Owner shall be notified at least 7 days prior to the beginning of the field test. The Contractor shall furnish all equipment and make all necessary corrections and adjustments prior to tests witnessed by the Owner. Any conditions that interfere with the proper operation of the barrier disclosed by the test shall be corrected at no additional cost to the Owner. Adjustments and repairs shall be done by the Contractor under the direction of the Owner. After adjustments are made to assure correct functioning of components, applicable tests shall be completed.
- F. Field Training: A field training course shall be provided for designated operating staff members. Training shall be provided for a total period of not less than 8 hours (for electrical/hydraulic operated units) or 1 hour (for manually operated units) of normal working time and shall start after the system is functionally complete but prior to final acceptance tests. Field training shall cover all of the items contained in the operating and maintenance instructions.

END OF SECTION 02726



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02726	01204	No Specification Required
02726	02721	Beam-Type Guardrail

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## SECTION 02953 - SEWER LINE CLEANING

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers sewer line cleaning. Cleaning procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals: Submit product data and manufacturer's instruction.

### 1.2 PRODUCTS

- A. All materials shall be clean, free of defects, corrosion, and damage. All items shall be of proper type, size, design, and characteristics for the use intended. Unless otherwise specified, all items shall be factory-made.
- B. Portable Cleaning Equipment: Equipment used in the cleaning of sewer lines shall be as required to complete the work for the size, length, and conditions of the sewer. Portable and mobile equipment shall comply with Water Pollution Control Federation Manual No. 7.
- C. Chemicals shall be of the strength required to perform the work. The chemicals shall not be damaging to pipe materials, manholes, pumping equipment, nor treatment process and shall not be contaminated by foreign substances.

### 1.3 EXECUTION

#### A. Preparation

1. Protection required to prevent damage to adjacent materials, equipment, fixtures, and finishes shall be provided. Necessary protective clothing and accessories for personnel working with chemicals shall be provided.
2. Ventilation of Sewers: Contractor shall provide proper ventilation for personnel working in the sewer.
3. Alternate Sewage Discharge: Contractor shall provide an alternate routing of sewage discharge to a downstream manhole.
4. Traffic: Contractor shall provide all traffic signs required to safely direct traffic at and around work areas.

#### B. Installation

1. Direction of Work: Sewer line cleaning work, with the exception of hydraulic scouring, shall proceed in the downstream direction. Cleaning by hydraulic scouring shall proceed in the upstream direction.
2. Testing: Upon completion of cleaning operation, test sewer lines for proper operation and observe for a period of 24 hours. Clean out all stoppages and the retest the line for proper operation.

END OF SECTION 02953



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
02953	02242	Piped Utilities Basic Materials And Methods
02953	02570	Repair And Maintenance Of Imhoff Tanks

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## SECTION 03110 - CAST-IN-PLACE CONCRETE

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for cast-in-place concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
  - a. Footings.
  - b. Foundation walls.
  - c. Slabs-on-grade.
  - d. Suspended slabs.
  - e. Concrete toppings.
  - f. Building frame members.
  - g. Building walls.

#### C. Definitions

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

#### D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
  - b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each concrete mixture.
4. Shop Drawings: For steel reinforcement and formwork. Material test reports **OR** certificates, **as directed**.

#### E. Quality Assurance

1. 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.
  - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
2. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, **as directed**, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - a. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 **OR** Sections 1 through 5 and Section 7, "Lightweight Concrete", **as directed**.
  - b. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."



4. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
5. Preinstallation Conference: Conduct conference at Project site.

F. Delivery, Storage, And Handling

1. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement, **as directed**.
2. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

## 1.2 PRODUCTS

A. Form-Facing Materials

1. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
2. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
4. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
5. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
6. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.
7. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
8. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
9. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - a. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
  - b. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
  - c. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

B. Steel Reinforcement

1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class I **OR** II, **as directed**, zinc coated after fabrication and bending.
5. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M **OR** ASTM A 934/A 934M, **as directed**, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.



6. Stainless-Steel Reinforcing Bars: ASTM A 955/A 955M, Grade 60 (Grade 420), Type 304 **OR** 316L, **as directed**, deformed.
  7. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
  8. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
  9. Deformed-Steel Wire: ASTM A 496.
  10. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel-wire **OR** deformed-steel wire, **as directed**, with less than 2 percent damaged coating in each 12-inch (300-mm) wire length.
  11. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.
  12. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
  13. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from galvanized steel wire into flat sheets.
  14. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain **OR** deformed, **as directed**, steel.
- C. Reinforcement Accessories
1. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut bars true to length with ends square and free of burrs.
  2. Epoxy-Coated Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, ASTM A 775/A 775M epoxy coated.
  3. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.
  4. Zinc Repair Material: ASTM A 780, zinc-based solder, paint containing zinc dust, or sprayed zinc.
  5. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
    - a. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
    - b. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
    - c. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.
- D. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
    - a. Portland Cement: ASTM C 150, Type I **OR** II **OR** I/II **OR** III **OR** V, **as directed**, gray **OR** white, **as directed**. Supplement with the following:
      - 1) Fly Ash: ASTM C 618, Class C **OR** F, **as directed**.
      - 2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
    - b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** I (PM), pozzolan-modified portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
  2. Silica Fume: ASTM C 1240, amorphous silica.
  3. Normal-Weight Aggregates: ASTM C 33, graded, 1-1/2-inch (38-mm) **OR** 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum coarse-aggregate size.
    - a. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
  4. Lightweight Aggregate: ASTM C 330, 1-inch (25-mm) **OR** 3/4-inch (19-mm) **OR** 1/2-inch (13-mm) **OR** 3/8-inch (10-mm), **as directed**, nominal maximum aggregate size.
  5. Water: ASTM C 94/C 94M and potable, **as directed**.
- E. Admixtures



1. Air-Entraining Admixture: ASTM C 260.
2. 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.
  - a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - b. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
3. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
4. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
5. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
  - a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

#### F. Fiber Reinforcement

1. Carbon-Steel Fiber: ASTM A 820, deformed, minimum of 1.5 inches (38 mm) **OR** 2 inches (50 mm) **OR** 2.4 inches (60 mm), **as directed**, long, and aspect ratio of 35 to 40 **OR** 45 to 50 **OR** 60 to 65, **as directed**.
  - a. Fiber: Type 1, cold-drawn wire **OR** 2, cut sheet, **as directed**.
2. Synthetic Micro-Fiber: Monofilament or fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/ C 1116M , Type III, 1/2 to 1-1/2 inches (13 to 38 mm) **OR** 1 to 2-1/4 inches (25 to 57 mm) long.
3. Synthetic Macro-Fiber: Polyolefin macro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III, 1 to 2-1/4 inches (25 to 57 mm) long.

#### G. Waterstops

1. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
  - a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
  - b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
2. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
  - a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
  - b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/16 inch thick (150 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/16 inch thick (225 mm by 4.75 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.



3. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, **as directed**, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
    - a. Profile: Flat, dumbbell with center bulb **OR** Flat, dumbbell without center bulb **OR** Ribbed with center bulb **OR** Ribbed without center bulb **OR** As indicated, **as directed**.
    - b. Dimensions: 4 inches by 3/16 inch thick (100 mm by 4.75 mm thick) **OR** 6 inches by 3/8 inch thick (150 mm by 10 mm thick) **OR** 9 inches by 3/8 inch thick (225 mm by 10 mm thick), **as directed**; nontapered.
  4. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).
  5. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch (10 by 19 mm).
- H. Vapor Retarders
1. Plastic Vapor Retarder:
    - a. ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
    - b. ASTM E 1745, Class B. Include manufacturer's recommended adhesive or pressure-sensitive tape.
    - c. ASTM E 1745, Class C, or polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick, **as directed**. Include manufacturer's recommended adhesive or pressure-sensitive joint tape.
  2. Bituminous Vapor Retarder: 110-mil- (2.8-mm-) thick, semiflexible, 7-ply sheet membrane consisting of reinforced core and carrier sheet with fortified asphalt layers, protective weathercoating, and removable plastic release liner. Furnish manufacturer's accessories including bonding asphalt, pointing mastics, and self-adhering joint tape.
    - a. Water-Vapor Permeance: 0.00 grains/h x sq. ft. x inches Hg (0.00 ng/Pa x s x sq. m); ASTM E 154.
    - b. Tensile Strength: 140 lbf/in. (24.5 kN/m); ASTM E 154.
    - c. Puncture Resistance: 90 lbf (400N); ASTM E 154.
  3. Granular Fill: Clean mixture of crushed stone or crushed or uncrushed gravel; ASTM D 448, Size 57, with 100 percent passing a 1-1/2-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
  4. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.
- I. Floor And Slab Treatments
1. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing 3/8-inch (9.5-mm) **OR** No. 4 (4.75-mm) **OR** No. 8 (2.36-mm), **as directed**, sieve.
  2. Slip-Resistive Aluminum Granule Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of not less than 95 percent fused aluminum-oxide granules.
  3. Emery Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded emery aggregate, and plasticizing admixture; with emery aggregate consisting of no less than 60 percent of total aggregate content.
    - a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
  4. Metallic Dry-Shake Floor Hardener: Pigmented **OR** Unpigmented, **as directed**, factory-packaged, dry combination of portland cement, graded metallic aggregate, rust inhibitors, and



plasticizing admixture; with metallic aggregate consisting of no less than 65 percent of total aggregate content.

a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

5. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

6. Pigmented Mineral Dry-Shake Floor Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

7. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.

#### J. Liquid Floor Treatments

1. Penetrating Liquid Floor Treatment: Clear, chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and densifies concrete surfaces.

2. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.

#### K. Curing Materials

1. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

2. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.

3. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

4. Water: Potable.

5. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

6. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.

7. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, 18 to 25 percent solids, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering, **as directed**.

8. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

9. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

#### L. Related Materials

1. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber **OR** ASTM D 1752, cork or self-expanding cork, **as directed**.

2. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 **OR** aromatic polyurea with a Type A shore durometer hardness range of 90 to 95, **as directed**, per ASTM D 2240.

3. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

4. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

a. Types I and II, non-load bearing **OR** IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.





5. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
6. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

M. Repair Materials

1. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
  - a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - b. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  - c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
  - d. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.
2. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
  - a. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  - b. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  - c. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
  - d. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

N. Concrete Mixtures, General

1. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
  - a. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
2. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent **OR** Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows, **as directed**
  - a. Fly Ash: 25 percent.
  - b. Combined Fly Ash and Pozzolan: 25 percent.
  - c. Ground Granulated Blast-Furnace Slag: 50 percent.
  - d. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
  - e. Silica Fume: 10 percent.
  - f. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
  - g. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
3. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 **OR** 0.15 **OR** 0.30 **OR** 1.00, **as directed**, percent by weight of cement.
4. Admixtures: Use admixtures according to manufacturer's written instructions.
  - a. Use water-reducing **OR** high-range water-reducing **OR** plasticizing, **as directed**, admixture in concrete, as required, for placement and workability.



- b. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  - c. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
  - d. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
5. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

O. Concrete Mixtures For Building Elements

1. Footings: Proportion normal-weight concrete mixture as follows:
  - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
2. Foundation Walls: Proportion normal-weight concrete mixture as follows:
  - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
3. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
  - a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
    - 3) Do not allow air content of troweled finished floors to exceed 3 percent.
  - e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
  - f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
4. Suspended Slabs: Proportion normal-weight concrete mixture as follows:



- a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
    - 3) Do not allow air content of troweled finished floors to exceed 3 percent.
  - e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
  - f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
5. Suspended Slabs: Proportion structural lightweight concrete mixture as follows:
- a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Calculated Equilibrium Unit Weight: 115 lb/cu. ft. (1842 kg/cu. m) **OR** 110 lb/cu. ft. (1762 kg/cu. m) **OR** 105 lb/cu. ft. (1682 kg/cu. m), **as directed**, plus or minus 3 lb/cu. ft. (48.1 kg/cu. m) as determined by ASTM C 567.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 6 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size greater than 3/8 inch (10 mm).
    - 2) 7 percent, plus or minus 2 percent at point of delivery for nominal maximum aggregate size 3/8 inch (10 mm) or less.
    - 3) Do not allow air content of troweled finished floors to exceed 3 percent.
  - e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
  - f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
6. Concrete Toppings: Proportion normal-weight concrete mixture as follows:
- a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Minimum Cementitious Materials Content: 470 lb/cu. yd. (279 kg/cu. m) **OR** 520 lb/cu. yd. (309 kg/cu. m) **OR** 540 lb/cu. yd. (320 kg/cu. m), **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm), **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
    - 3) Do not allow air content of troweled finished toppings to exceed 3 percent.
  - e. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (29.7 kg/cu. m).
  - f. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m) **OR** 1.5 lb/cu. yd. (0.90 kg/cu. m), **as directed**.
7. Building Frame Members: Proportion normal-weight concrete mixture as follows:



- a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
8. Building Walls: Proportion normal-weight concrete mixture as follows:
- a. Minimum Compressive Strength: 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**, at 28 days.
  - b. Maximum Water-Cementitious Materials Ratio: 0.50 **OR** 0.45 **OR** 0.40, **as directed**.
  - c. Slump Limit: 4 inches (100 mm) **OR** 5 inches (125 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.

P. Fabricating Reinforcement

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

Q. Concrete Mixing

- 1. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
  - a. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.
- 2. 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.
  - a. For mixer capacity of 1 cu. yd. (0.76 cu. m) 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.
  - b. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
  - c. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

### 1.3 EXECUTION

A. Formwork

- 1. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- 2. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.



3. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
    - a. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
    - b. Class B, 1/4 inch (6 mm) **OR** Class C, 1/2 inch (13 mm) **OR** Class D, 1 inch (25 mm), **as directed**, for rough-formed finished surfaces.
  4. Construct forms tight enough to prevent loss of concrete mortar.
  5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
    - a. Install keyways, reglets, recesses, and the like, for easy removal.
    - b. Do not use rust-stained steel form-facing material.
  6. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
  7. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
  8. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of permanently exposed concrete.
  9. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
  10. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
  11. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
  12. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
- B. Embedded Items
1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - a. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
    - b. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
    - c. Install dovetail anchor slots in concrete structures as indicated.
- C. Removing And Reusing Forms
1. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
    - a. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of, **as directed**, its 28-day design compressive strength.
    - b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
  2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
  3. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Owner.



D. Shores And Reshores

1. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
  - a. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
2. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
3. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

E. Vapor Retarders

1. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.
  - a. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
2. Bituminous Vapor Retarders: Place, protect, and repair vapor retarders according to manufacturer's written instructions.
3. Granular Course: Cover vapor retarder with granular fill **OR** fine-graded granular material, **as directed**, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).
  - a. Place and compact a 1/2-inch- (13-mm-) thick layer of fine-graded granular material over granular fill.

F. Steel Reinforcement

1. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - a. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
2. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
3. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
  - a. Weld reinforcing bars according to AWS D1.4, where indicated.
4. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
5. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
6. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.
7. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

G. Joints

1. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.
  - a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
  - c. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.



- d. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - e. Space vertical joints in walls, **as directed**. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - f. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - g. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  3. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
    - a. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
    - b. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
  4. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
    - a. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
    - b. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "Joint Sealants", are indicated.
    - c. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
  5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- H. Waterstops
1. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
  2. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.
- I. Concrete Placement
1. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
  2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Owner.
  3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
    - a. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
  4. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
    - a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
    - b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.



- c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- 5. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - a. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - b. Maintain reinforcement in position on chairs during concrete placement.
  - c. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - d. Slope surfaces uniformly to drains where required.
  - e. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- 6. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - a. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  - b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- 7. Hot-Weather Placement: Comply with ACI 301 and as follows:
  - a. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

#### J. Finishing Formed Surfaces

- 1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - a. Apply to concrete surfaces not exposed to public view.
- 2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - a. Apply to concrete surfaces exposed to public view, **OR** to receive a rubbed finish, **OR** to be covered with a coating or covering material applied directly to concrete, **as directed**.
- 3. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
  - a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
  - b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent





- surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
- c. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
  4. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
- K. Finishing Floors And Slabs
1. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
  2. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.
    - a. Apply scratch finish to surfaces indicated and to receive concrete floor toppings **OR** to receive mortar setting beds for bonded cementitious floor finishes, **as directed**.
  3. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
    - a. Apply float finish to surfaces indicated **OR** to receive trowel finish **OR** to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo, **as directed**.
  4. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighen until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
    - a. Apply a trowel finish to surfaces indicated **OR** exposed to view **OR** to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system, **as directed**.
    - b. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
      - 1) Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
      - 2) Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
      - 3) Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
      - 4) Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
    - c. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- (3.05-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed 1/4 inch (6 mm) **OR** 3/16 inch (4.8 mm) **OR** 1/8 inch (3.2 mm), **as directed**.
  5. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated **OR** where ceramic or quarry tile is to be installed by either thickset or thin-set method, **as directed**. While concrete is still plastic, slightly scarify surface with a fine broom.
    - a. Comply with flatness and levelness tolerances for trowel finished floor surfaces.
  6. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
    - a. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Owner before application.



7. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate **OR** aluminum granule, **as directed**, finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
  - a. Uniformly spread 25 lb/100 sq. ft. (12 kg/10 sq. m) of dampened slip-resistive aggregate **OR** aluminum granules, **as directed**, over surface in 1 or 2 applications. Tamp aggregate flush with surface, but do not force below surface.
  - b. After broadcasting and tamping, apply float finish.
  - c. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate **OR** aluminum granules, **as directed**.
8. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:
  - a. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. (49 kg/10 sq. m), **as directed**, unless greater amount is recommended by manufacturer.
  - b. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.
  - c. After final floating, apply a trowel finish. Cure concrete with curing compound recommended by dry-shake floor hardener manufacturer and apply immediately after final finishing.

#### L. Miscellaneous Concrete Items

1. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
2. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
3. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.
4. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

#### M. Concrete Protecting And Curing

1. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
2. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m 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.
3. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
4. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
5. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - a. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - 1) Water.
    - 2) Continuous water-fog spray.



- 3) Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
    - b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
      - 1) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
      - 2) Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
      - 3) Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.
    - c. 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.
      - 1) After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
    - d. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a 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. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.
- N. Liquid Floor Treatments
- 1. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
    - a. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
    - b. Do not apply to concrete that is less than three **OR** seven **OR** 14 **OR** 28, **as directed**, days' old.
    - c. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.
  - 2. Polished Concrete Floor Treatment: Apply polished concrete finish system to cured and prepared slabs to match.
    - a. Machine grind floor surfaces to receive polished finishes level and smooth and to depth required to reveal aggregate to match.
    - b. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
    - c. Continue polishing with progressively finer grit diamond polishing pads to gloss level to match approved mockup.
    - d. Control and dispose of waste products produced by grinding and polishing operations.
    - e. Neutralize and clean polished floor surfaces.
  - 3. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.
- O. Joint Filling
- 1. Prepare, clean, and install joint filler according to manufacturer's written instructions.
    - a. Defer joint filling until concrete has aged at least one **OR** six, **as directed**, month(s). Do not fill joints until construction traffic has permanently ceased.



2. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
3. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

P. Concrete Surface Repairs

1. Defective Concrete: Repair and patch defective areas when approved by the Owner. Remove and replace concrete that cannot be repaired and patched to the Owner's approval.
2. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
3. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - a. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - b. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  - c. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Owner.
4. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - a. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - b. After concrete has cured at least 14 days, correct high areas by grinding.
  - c. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  - d. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  - e. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - f. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  - g. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt,



and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

5. Perform structural repairs of concrete, subject to the Owner's approval, using epoxy adhesive and patching mortar.
6. Repair materials and installation not specified above may be used, subject to the Owner's approval.

Q. Field Quality Control

1. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
2. Inspections:
  - a. Steel reinforcement placement.
  - b. Steel reinforcement welding.
  - c. Headed bolts and studs.
  - d. Verification of use of required design mixture.
  - e. Concrete placement, including conveying and depositing.
  - f. Curing procedures and maintenance of curing temperature.
  - g. Verification of concrete strength before removal of shores and forms from beams and slabs.
3. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  - a. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
    - 1) When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - b. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - c. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete, **as directed**; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - d. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
  - e. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - f. Compression Test Specimens: ASTM C 31/C 31M.
    - 1) Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    - 2) Cast and field cure two sets of two standard cylinder specimens for each composite sample.
  - g. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - 1) Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    - 2) A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  - h. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  - i. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength



- and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
- j. Test results shall be reported in writing to the Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
  - k. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owner but will not be used as sole basis for approval or rejection of concrete.
  - l. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by the Owner. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by the Owner.
  - m. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  - n. Correct deficiencies in the Work that test reports and inspections indicate dos not comply with the Contract Documents.
4. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 **OR** 48, **as directed**, hours of finishing.
- R. Protection Of Liquid Floor Treatments
- 1. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 03110



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Task	Specification	Specification Description
03110	01204	No Specification Required

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## SECTION 03125 - CAST-IN-PLACE ARCHITECTURAL CONCRETE

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for cast-in-place architectural concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section specifies cast-in-place architectural concrete including form facings, reinforcement accessories, concrete materials, concrete mixture design, placement procedures, and finishes.

#### C. Definitions

1. Cast-in-Place Architectural Concrete: Formed concrete that is exposed to view on surfaces of completed structure or building and that requires special concrete materials, formwork, placement, or finishes to obtain specified architectural appearance.
2. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.
3. Design Reference Sample: Sample designated by the Owner in the Contract Documents that reflects acceptable surface quality and appearance of cast-in-place architectural concrete.
4. Reveal: Projection of coarse aggregate from matrix or mortar after completion of exposure operations.

#### D. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
  - b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - a. Indicate amounts of mixing water to be withheld for later addition at Project site.
4. Formwork Shop Drawings: Show formwork construction including form-facing joints, rustications, construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.
5. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints including construction joints.
6. Samples: For each of the following materials:
  - a. Form-facing panel.
  - b. Form ties.
  - c. Form liners.
  - d. Coarse- and fine-aggregate gradations.
  - e. Chamfers and rustications.
7. Material test reports **OR** certificates, **as directed**.



#### E. Quality Assurance

1. 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.
  - a. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
2. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
  - a. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
  - b. Personnel performing laboratory tests shall be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
3. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - a. ACI 301, "Specification for Structural Concrete," Sections 1 through 5 **OR** Sections 1 through 5 and Section 6, "Architectural Concrete", **as directed**.
  - b. ACI 303.1, "Specification for Cast-in-Place Architectural Concrete."
4. Field Sample Panels: After approval of verification sample and before casting architectural concrete, produce field sample panels to demonstrate the approved range of selections made under sample submittals. Produce a minimum of 3 sets of full-scale panels, cast vertically, approximately 48 by 48 by 6 inches (1200 by 1200 by 150 mm) minimum, to demonstrate the expected range of finish, color, and texture variations.
5. Preinstallation Conference: Conduct conference at Project site.

### 1.2 PRODUCTS

#### A. Form-Facing Materials

1. General: Comply with Division 03 Section "Cast-in-place Concrete" for formwork and other form-facing material requirements.
2. Form-Facing Panels for As-Cast **OR** Exposed-Aggregate, **as directed**, Finishes: Steel, glass-fiber-reinforced plastic, or other approved nonabsorptive panel materials that will provide continuous, true, and smooth architectural concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
3. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will provide surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.
4. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
5. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete.
6. Rustication Strips: Metal, rigid plastic, or dressed wood with sides beveled and back kerfed; nonstaining; in longest practicable lengths.
7. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch (19 by 19 mm), minimum; nonstaining; in longest practicable lengths.
8. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800, "Specification 810.1, Expanded Cellular Glazing Tape"; minimum 1/4 inch (6 mm) thick.
9. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or S, Grade NS, that adheres to form joint substrates.
10. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.



11. Form-Release Agent: Commercially formulated colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.
    - a. Formulate form-release agent with rust inhibitor for steel form-facing materials.
  12. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.
  13. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic **OR** internally disconnecting **OR** removable, **as directed**, ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
    - a. Furnish ties with tapered tie cone spreaders, **as directed**, that, when removed, will leave holes 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 1-1/4 inches (32 mm) **OR** 1-1/2 inches (38 mm), **as directed**, in diameter on concrete surface.
    - b. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches (38 mm), after exposing aggregate, **as directed**, from the architectural concrete surface.
    - c. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch (13 mm) in diameter, of color to match the Owner's sample **OR** selected by the Owner from manufacturer's full range, **as directed**.
    - d. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
- B. Steel Reinforcement And Accessories
1. General: Comply with Division 03 Section "Cast-in-place Concrete" for steel reinforcement and other requirements for reinforcement accessories.
  2. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
  3. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire fabric in place; manufacture according to CRSI's "Manual of Standard Practice."
    - a. Where legs of wire bar supports contact forms, use gray, all-plastic **OR** CRSI Class 1, gray, plastic-protected **OR** CRSI Class 2, stainless-steel, **as directed**, bar supports.
- C. Concrete Materials
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
    - a. Portland Cement: ASTM C 150, Type I **OR** II **OR** I/II **OR** III, **as directed**, gray **OR** white, **as directed**. Supplement with the following:, **as directed**
      - 1) Fly Ash: ASTM C 618, Class C **OR** F, **as directed**.
      - 2) Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
      - 3) Silica Fume: ASTM C 1240, amorphous silica.
    - b. Blended Hydraulic Cement: ASTM C 595, Type IS, portland blast-furnace slag **OR** IP, portland-pozzolan **OR** (PM), pozzolan-modified Portland **OR** I (SM), slag-modified Portland, **as directed**, cement.
  2. Normal-Weight Aggregates: ASTM C 33, Class 5S **OR** 5M **OR** 1N, **as directed**, coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials, **as directed**.
    - a. Maximum Coarse Aggregate Size: 1 inch (25 mm) **OR** 3/4 inch (19 mm) **OR** 1/2 inch (13 mm) **OR** 3/8 inch (10 mm), **as directed**.
    - b. Gradation: Uniformly **OR** Gap, **as directed**, graded.
  3. Normal-Weight Fine Aggregate: ASTM C 33 **OR** ASTM C 144, **as directed**, manufactured or natural sand, from same source for entire Project.
  4. Water: Potable, complying with ASTM C 94/C 94M except free of wash water from mixer washout operations.



## D. Admixtures

1. Air-Entraining Admixture: ASTM C 260.
2. 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.
  - a. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
  - b. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - d. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - e. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - f. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
3. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, **as directed**, nonfading, and resistant to lime and other alkalis.
  - a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.

## E. Curing Materials

1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.
2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
3. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
  - a. For integrally colored concrete, curing compound shall be pigmented type, **as directed**, approved by color pigment manufacturer.
  - b. For concrete indicated to be sealed, curing compound shall be compatible with sealer.

## F. Repair Materials

1. Bonding Agent: ASTM C 1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
2. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.
  - a. Types I and II, non-load bearing **OR** IV and V, load bearing, **as directed**, for bonding hardened or freshly mixed concrete to hardened concrete.

## G. Concrete Mixtures, General

1. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.
  - a. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.
2. Proportion concrete mixtures as follows:
  - a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa) **OR** 3000 psi (20.7 MPa), **as directed**.
  - b. Maximum Water-Cementitious Materials Ratio: 0.46.
  - c. Slump Limit: 3 inches (75 mm) **OR** 4 inches (100 mm) **OR** 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, **as directed**, plus or minus 1 inch (25 mm).
  - d. Air Content:
    - 1) 5-1/2 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
    - 2) 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) **OR** 3/4-inch (19-mm), **as directed**, nominal maximum aggregate size.
3. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica



- fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent, **as directed**.
4. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 **OR** 0.15 **OR** 0.30 **OR** 1.00, **as directed**, percent by weight of cement.
  5. Admixtures: Use admixtures according to manufacturer's written instructions.
  6. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

#### H. Concrete Mixing

1. Ready-Mixed or Site-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and furnish batch ticket information.
  - a. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
  - b. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

### 1.3 EXECUTION

#### A. Formwork

1. General: Comply with Division 03 Section "Cast-in-place Concrete" for formwork, embedded items, and shoring and reshoring.
2. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.
3. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  - a. Class A, 1/8 inch (3.2 mm) **OR** B, 1/4 inch (6 mm) **OR** C, 1/2 inch (13 mm), **as directed**.
4. Fabricate forms to result in cast-in-place architectural concrete that complies with ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
  - a. In addition to ACI 117, comply with the following tolerances: **<Insert tolerances.>**
5. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood rustications, keyways, reglets, recesses, and the like, for easy removal.
  - a. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
  - b. Do not use rust-stained steel form-facing material.
6. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
7. Chamfer **OR** Do not chamfer, **as directed**, exterior corners and edges of cast-in-place architectural concrete.
8. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.
9. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
10. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
11. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
12. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.
13. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.
14. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting.



Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

**B. Reinforcement And Inserts**

1. General: Comply with Division 03 Section "Cast-in-place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.
2. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

**C. Removing And Reusing Forms**

1. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
  - a. Schedule form removal to maintain surface appearance that matches approved field sample panels.
  - b. Cut off and grind glass-fiber-reinforced plastic form ties flush with surface of concrete.
2. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28-day design compressive strength **OR** at least 70 percent of 28-day design compressive strength, **as directed**. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
3. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.
4. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

**D. Joints**

1. Construction Joints: Install construction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.
  - a. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated.
  - b. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete, **as directed**. Align construction joint within rustications attached to form-facing material.
  - c. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - d. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - e. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - f. Use bonding agent **OR** epoxy-bonding adhesive, **as directed**, at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
2. Contraction Joints: Form weakened-plane contraction joints true to line with faces perpendicular to surface plane of cast-in-place architectural concrete so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Owner.

**E. Concrete Placement**

1. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not add water to concrete during delivery, at Project site, or during placement unless approved by the Owner.
3. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.



- a. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
  4. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.
    - a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
    - b. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
    - c. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.
  5. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
    - a. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
    - b. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
    - c. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
    - d. Do not use chemical accelerators unless otherwise specified and approved in design mixtures.
  6. Hot-Weather Placement: Comply with ACI 301 and as follows:
    - a. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
    - b. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
- F. Finishes, General
  1. Architectural Concrete Finish: Match the Owner's design reference sample, identified and described as indicated, to satisfaction of the Owner.
  2. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.
    - a. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.
  3. Maintain uniformity of special finishes over construction joints, unless otherwise indicated.
- G. As-Cast Formed Finishes
  1. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding specified limits on formed-surface irregularities.
  2. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair **OR** Do not repair, **as directed**, and patch tie holes and defects.
  3. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:
    - a. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
    - b. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland



- cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
- c. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match surrounding concrete. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.
  4. Form-Liner Finish: Produce a textured surface free of pockets, streaks, and honeycombs, and of uniform appearance, color, and texture.

#### H. Exposed-Aggregate Finishes

1. Scrubbed Finish: After concrete has achieved a compressive strength of from 1000 to 1500 psi (6.9 to 10.3 MPa), apply scrubbed finish. Wet concrete surfaces thoroughly and scrub with stiff fiber or wire brushes, using water freely, until top mortar surface is removed and aggregate is uniformly exposed. Rinse scrubbed surfaces with clean water. Maintain continuity of finish on each surface or area of Work. Remove only enough concrete mortar from surfaces to match design reference sample.
2. High-Pressure Water-Jet Finish: Perform high-pressure water jetting on concrete that has achieved a minimum compressive strength of 4500 psi (31 MPa). Coordinate with formwork removal to ensure that surfaces to be high-pressure water-jet finished are treated at same age for uniform results.
  - a. Surface Continuity: Perform high-pressure water-jet finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in reveal projection to match design reference sample.
3. Abrasive-Blast Finish: Perform abrasive blasting after compressive strength of concrete exceeds 2000 psi (13.8 MPa). Coordinate with formwork removal to ensure that surfaces to be abrasive blasted are treated at same age for uniform results.
  - a. Surface Continuity: Perform abrasive-blast finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances in depths of blast to match design reference sample.
  - b. Abrasive Blasting: Abrasive blast corners and edges of patterns carefully, using backup boards, to maintain uniform corner or edge line. Determine type of nozzle, nozzle pressure, and blasting techniques required to match design reference sample.
  - c. Depth of Cut: Use an abrasive grit of proper type and gradation to expose aggregate and surrounding matrix surfaces to match design reference sample, as follows:
    - 1) Brush: Remove cement matrix to dull surface sheen and expose face of fine aggregate; with no significant reveal.
    - 2) Light: Expose fine aggregate with occasional exposure of coarse aggregate and uniform color; with maximum reveal of 1/16 inch (1.5 mm).
    - 3) Medium: Generally expose coarse aggregate; with slight reveal, a maximum of 1/4 inch (6 mm).
    - 4) Heavy: Expose and reveal coarse aggregate to a maximum projection of one-third its diameter; with reveal range of 1/4 to 1/2 inch (6 to 13 mm).
4. Bushhammer Finish: Allow concrete to cure at least 14 days before starting bushhammer surface finish operations.
  - a. Surface Continuity: Perform bushhammer finishing in as continuous an operation as possible, maintaining continuity of finish on each surface or area of Work. Maintain required patterns or variances of cut as shown on Drawings or to match design reference sample or mockup.
  - b. Surface Cut: Maintain required depth of cut and general aggregate exposure. Use power tool with hammer attachments for large, flat surfaces, and use hand hammers for small areas, at corners and edges, and for restricted locations where power tools cannot reach.
  - c. Remove impressions of formwork and form facings with exception of tie holes.





- I. Concrete Protecting And Curing
  - 1. 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.
  - 2. Begin curing cast-in-place architectural concrete immediately after removing forms from **OR** applying as-cast formed finishes to, **as directed**, concrete. Cure according to ACI 308.1, by one or a combination of the following methods that will not mottle, discolor, or stain concrete:
    - a. Moisture Curing: Keep exposed surfaces of cast-in-place architectural concrete continuously moist for not less than seven days with the following materials:
      - 1) Water.
      - 2) Continuous water-fog spray.
      - 3) Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
    - b. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period; use cover material and waterproof tape.
    - c. Curing Compound: Mist concrete surfaces with water. Apply curing compound 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.
- J. Field Quality Control
  - 1. General: Comply with Division 03 Section "Cast-in-place Concrete" for field quality-control requirements.
- K. Repairs, Protection, And Cleaning
  - 1. Repair and cure damaged finished surfaces of cast-in-place architectural concrete when approved by the Owner. Match repairs to color, texture, and uniformity of surrounding surfaces and to repairs on approved mockups.
    - a. Remove and replace cast-in-place architectural concrete that cannot be repaired and cured to the Owner's approval.
  - 2. Protect corners, edges, and surfaces of cast-in-place architectural concrete from damage; use guards and barricades.
  - 3. Protect cast-in-place architectural concrete from staining, laitance, and contamination during remainder of construction period.
  - 4. Clean cast-in-place architectural concrete surfaces after finish treatment to remove stains, markings, dust, and debris.
  - 5. Wash and rinse surfaces according to concrete finish applicator's written recommendations. Protect other Work from staining or damage due to cleaning operations.
    - a. Do not use cleaning materials or processes that could change the appearance of cast-in-place architectural concrete finishes.

END OF SECTION 03125



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
03125	03110	Cast-In-Place Concrete
03210	03110	Cast-In-Place Concrete
03220	03110	Cast-In-Place Concrete
03290	03110	Cast-In-Place Concrete
03302	03110	Cast-In-Place Concrete
03303	03110	Cast-In-Place Concrete
03311	03110	Cast-In-Place Concrete
03311	03125	Cast-In-Place Architectural Concrete



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## SECTION 03360 - EXPOSED AGGREGATE SURFACE CONCRETE WALLS

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of exposed aggregate surface concrete walls. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Submit product data and manufacturer's application instruction.
2. Shop drawings shall be submitted for approval.

### 1.2 PRODUCTS

#### A. Concrete Materials and Mixing

1. Portland Cement: ASTM C 150, Type 1 or 1A.
  - a. Shrinkage-Compensating Cement: Portland cement containing a stable expansive chemical compound such as calcium sulfoaluminate.
  - b. Aggregate: ASTM C 33; aggregate for exposed aggregate concrete shall match existing, if appropriate.
  - c. Admixtures: Submit manufacturer's literature for all admixtures proposed for the work.
  - d. Curing Compounds: ASTM C 309, Type 1.
  - e. Epoxy Bonding Agent: Sika or approved equal.

#### B. Concrete Formwork, Reinforcement, and Accessories

1. Formwork: Plywood form and liners shall be minimum grade B-B High Density Concrete Form Overlay, Class I, complying with ANSI A199.1.
2. Reinforcement:
  - a. Reinforcement Bars: ASTM A 615, Grade 40 or Grade 60.
  - b. Welded Wire Fabric: ASTM A 185. Where welded wire fabric is needed, use No. 6 gauge wire at 6-inch spacing in each direction.
  - c. Accessories for proper installation of reinforcement shall comply with CRSI "Manual of Standard Practice for Reinforced Concrete Construction."
  - d. Reinforcement fabrication shall comply with ACI 318 and ACI 315.

#### C. Curing and Climatic Conditions

1. Comply with ACI 306 and ACI 305 for protecting and curing concrete in cold and hot weather.
2. Immediately after finishing, begin curing flatwork by covering with constantly saturated moisture retaining fabrics, impervious sheeting, or membrane curing compounds.
3. Apply membrane curing compounds as required.

### 1.3 EXECUTION

#### A. Preparation when attaching to existing surfaces:

1. Remove all defective material by chipping and cutting to sound concrete in order to secure a solid foundation.
2. Square cut or undercut the edges to a minimum depth of one inch to form key.
3. Cut concrete out from behind exposed reinforcing bars and rods.
4. All exposed reinforcing shall be cleaned of rust and primed.



B. Installation

1. Formwork requirements:
  - a. Formwork shall comply with ACI 347. Joints in forms shall be horizontal or vertical.
  - b. Use plywood, fiberglass, or metal forms.
2. Reinforcement shall be repaired when rusted through. Rods at least 12 inches long shall be wired to the failed rods. In closing gaps, rods shall lap existing rods by at least 12 inches or 30 diameters, whichever is greater.
3. Mixing and transporting concrete: Ready-mixed concrete shall be mixed and delivered to the project in compliance with ASTM C 94. Job-mixed concrete shall comply with the requirements of ACI 318.
4. Mixing epoxy-resin patching mortar: Mix thoroughly with a power mixer at low speeds (150 - 400 rpm) until material attains uniform color and consistency (minimum time of two to three minutes at 70 F).

END OF SECTION 03360



## SECTION 03360a - RUSTICATED CONCRETE FINISHES

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of rusticated concrete finishes. Products shall match existing materials and/or shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Submittals

1. Product Data: For each type of product indicated.
2. Sample: A sample of finish expected shall be erected on site. Completed work shall approximate the sample. Work determined by the contracting officer not to be similar shall be removed and replaced without further expense to the Owner.

### 1.2 PRODUCTS

- A. Overlaid Plywood: DOC PS 1, B-B High Density Overlaid Concrete Form, Class I.
- B. Plywood: DOC PS 1, B-B (Concrete Form) Plywood, Class I, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection mark.
- C. Chamfer Strips: Clear white pine with surface against concrete to be planed, metal, PVC, or rubber.
- D. Form Liners: Provide commercially available molds and form-facing materials of metal, plastic, mood, or another material that is nonreactive with concrete and dimensionally stable to produce repetitive concrete surfaces.

### 1.3 EXECUTION

- A. Form Construction: Forms shall be constructed to provide required sizes, shapes, lines, and dimensions and to provide continuous, straight, smooth exposed surfaces. Forms shall be fabricated for easy removal without hammering or prying against concrete surfaces. The number of joints shall be minimized. Joints shall be made watertight to prevent leakage of cement paste. Provisions shall be made for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, inserts, and other features required in the work.
- B. Form Coatings: Forms shall be oiled with form-coating compounds that will not bond with, stain, nor adversely effect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.
- C. Finish: Fins and other projections shall be completely removed and smoothed. A smooth rubbed finish shall be provided not less than one day after form removal.

END OF SECTION 03360a



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
03360	03110	Cast-In-Place Concrete

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**SECTION 03370 - SHOTCRETE****1.1 GENERAL****A. Description Of Work**

1. This specification covers the furnishing and installation of materials for shotcrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

**B. Summary**

1. This Section includes shotcrete applied by dry-mix or wet-mix process.

**C. Definitions**

1. Shotcrete: Mortar or concrete pneumatically projected onto a surface at high velocity.
2. Dry-Mix Shotcrete: Shotcrete with most of the water added at nozzle.
3. Wet-Mix Shotcrete: Shotcrete with ingredients, including mixing water, mixed before introduction into delivery hose.

**D. Submittals**

1. Product Data: For manufactured materials and products including reinforcement and forming accessories, shotcrete materials, admixtures, and curing compounds.
2. LEED Submittal:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
3. Shop Drawings: For details of fabricating, bending, and placing reinforcement. Include support and anchor details, number and location of splices, and special reinforcement required for openings through shotcrete structures.
4. Samples: Approximately 24 by 24 by 2 inches (600 by 600 by 50 mm), to illustrate quality of finishes, colors, and textures of exposed surfaces of shotcrete.
5. Design Mixes: For each shotcrete mix.
6. Material Test Reports: For shotcrete materials.
7. Material Certificates: For each material item, signed by manufacturers.
8. Field quality-control test reports.

**E. Quality Assurance**

1. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, and acceptable to authorities having jurisdiction, **as directed**.
2. Comply with provisions of the following, unless more stringent requirements are indicated:
  - a. ACI 301, "Specifications for Structural Concrete."
  - b. ACI 506.2, "Specification for Shotcrete."
3. Preinstallation Conference: Conduct conference at Project site.

**F. Project Conditions**

1. Cold-Weather Shotcreting: Protect shotcrete work from physical damage or reduced strength caused by frost, freezing, or low temperatures according to ACI 306.1 and as follows:
  - a. Discontinue shotcreting when ambient temperature is 40 deg F (4.4 deg C) and falling. Uniformly heat water and aggregates before mixing to obtain a shotcrete shooting temperature of not less than 50 deg F (10 deg C) and not more than 90 deg F (32 deg C).
  - b. Do not use frozen materials or materials containing ice or snow.
  - c. Do not place shotcrete on frozen surfaces or surfaces containing frozen materials.
  - d. Do not use calcium chloride, salt, or other materials containing antifreeze agents.



2. Hot-Weather Shotcreting: Mix, place, and protect shotcrete according to ACI 305R when hot-weather conditions and high temperatures would seriously impair quality and strength of shotcrete, and as follows:
  - a. Cool ingredients before mixing to maintain shotcrete temperature at time of placement below 100 deg F (38 deg C) for dry mix or 90 deg F (32 deg C) for wet mix.
  - b. Reduce temperature of reinforcing steel and receiving surfaces below 100 deg F (38 deg C) before shotcreting.

## 1.2 PRODUCTS

### A. Form Materials

1. Forms: Form-facing panels that will provide continuous, straight, smooth, concrete surfaces. Furnish panels in largest practicable sizes to minimize number of joints.

### B. Reinforcing Materials

1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed** percent.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
4. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class II, zinc coated, hot-dip galvanized after fabrication and bending, as follows:
  - a. Steel Reinforcement: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed.
5. Plain-Steel Wire: ASTM A 82, as drawn **OR** galvanized, **as directed**.
6. Plain-Steel-Welded Wire Fabric: ASTM A 185, fabricated from as-drawn **OR** galvanized, **as directed**, steel wire into flat sheets.
7. Deformed-Steel-Welded Wire Fabric: ASTM A 497, flat sheet.
8. Supports: Bolsters, chairs, spacers, ties, and other devices for spacing, supporting, and fastening reinforcing steel in place according to CRSI's "Manual of Standard Practice" and as follows:
  - a. For uncoated reinforcement, use all-plastic **OR** CRSI Class 1, plastic-protected **OR** CRSI Class 2, stainless-steel, **as directed**, bar supports.
  - b. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire **OR** all-plastic, **as directed**, bar supports.
  - c. Retain paragraph and subparagraph below if devices are required to anchor, support, or space steel reinforcement.
9. Reinforcing Anchors: ASTM A 36/A 36M, unheaded rods or ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), hex-head bolts; carbon steel; and carbon-steel nuts.
  - a. Finish: Plain, uncoated **OR** Hot-dip zinc coating, ASTM A 153/A 153M, Class C, **as directed**.

### C. Shotcrete Materials

1. Portland Cement: ASTM C 150, Type I **OR** III, **as directed**. Use only one brand and type of cement for Project.
  - a. Fly Ash: ASTM C 618, Class C or F.
  - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
2. Blended Hydraulic Cement: ASTM C 595, Type IS **OR** IP **OR** I(PM) **OR** I(SM), **as directed**.
3. Silica Fume: ASTM C 1240, amorphous silica.
4. Normal-Weight Aggregates: ASTM C 33, from a single source, and as follows:
  - a. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) **OR** 2 with 100 percent passing 1/2-inch (13-mm), **as directed**, sieve.
  - b. Coarse-Aggregate Class: 3S **OR** 3M **OR** 1N, **as directed**.
5. Lightweight Aggregates: ASTM C 330.



- a. Aggregate Gradation: ACI 506R, Gradation No. 1 with 100 percent passing 3/8-inch (10-mm) **OR** 2 with 100 percent passing 1/2-inch (13-mm), **as directed** sieve.
  6. Coloring Agent: ASTM C 979, synthetic mineral-oxide pigments or colored, water-reducing admixtures, free of carbon black; color stable, nonfading, and resistant to lime and other alkalis.
    - a. Color: As indicated by manufacturer's designation **OR** Match the Owner's sample **OR** As selected by the Owner from manufacturer's full range, **as directed**.
  7. Water: Potable, complying with ASTM C 94/C 94M, free from deleterious materials that may affect color stability, setting, or strength of shotcrete.
  8. Carbon-Steel Fiber: ASTM C 1116, Type 1, carbon-steel fiber and ASTM A 820, Type 1, cold-drawn wire **OR** cut sheet, **as directed**, not less than 1 inch (25 mm) long.
  9. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in shotcrete, complying with ASTM C 1116, Type III, not less than 3/4 inch (19 mm) long.
  10. Ground Wire: High-strength steel wire, 0.8 to 1 mm in diameter.
  11. Joint Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork.
- D. Chemical Admixtures
1. General: ASTM C 1141, Class A or B, but limited to the following admixture materials. Provide admixtures for shotcrete that contains not more than 0.1 percent chloride ions. Certify compatibility of admixtures with each other and with other cementitious materials.
    - a. Air-Entraining Admixture: ASTM C 260.
    - b. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
    - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
    - d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
    - e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
    - f. Accelerating Admixture: ASTM C 494/C 494M, Type C.
- E. Curing Materials
1. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
  2. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
  3. Water: Potable.
  4. Clear, Waterborne **OR** Solvent-Borne, **as directed**, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- F. Shotcrete Mixtures, General
1. Prepare design mixes for each type and strength of shotcrete.
    - a. Limit use of fly ash **OR** ground granulated blast-furnace slag **OR** silica fume, **as directed**, to not exceed, in combination, 25 percent of portland cement by weight.
  2. Limit water-soluble chloride ions to maximum percentage by weight of cement or cementitious materials permitted by ACI 301.
  3. Admixtures: When included in shotcrete design mixes, use admixtures and retarding admixtures according to manufacturer's written instructions.
  4. Carbon-Steel Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd. (30 kg/cu. m) **OR** 100 lb/cu. yd. (60 kg/cu. m), **as directed**.
  5. Synthetic Fiber: Uniformly disperse in shotcrete mix, according to manufacturer's written instructions, at a rate of 1.5 lb/cu. yd. (0.90 kg/cu. m) **OR** 5 lb/cu. yd. (3 kg/cu. m), **as directed**.
  6. Design-Mix Adjustments: Subject to compliance with requirements, shotcrete design-mix adjustments may be proposed when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.
- G. Shotcrete Mixtures
1. Proportion dry mixtures by field test data methods and wet mixtures according to ACI 211.1 and ACI 301, using materials to be used on Project, to provide shotcrete with the following properties:
    - a. Compressive Strength (28 Days): 5000 psi (34.5 MPa) **OR** 4500 psi (31 MPa) **OR** 4000 psi (27.6 MPa) **OR** 3500 psi (24.1 MPa), **as directed**.



- b. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight, wet-mix shotcrete having an air content before pumping of 7 **OR** 8, **as directed**, percent with a tolerance of plus or minus 1-1/2 percent.

#### H. Shotcrete Equipment

1. Mixing Equipment: Capable of thoroughly mixing shotcrete materials in sufficient quantities to maintain continuous placement.
2. Dry-Mix Delivery Equipment: Capable of discharging aggregate-cement mixture into delivery hose under close control and maintaining continuous stream of uniformly mixed materials at required velocity to discharge nozzle. Equip discharge nozzle with manually operated water-injection system for directing even distribution of water to aggregate-cement mixture.
  - a. Provide uniform, steady supply of clean, compressed air to maintain constant nozzle velocity while simultaneously operating blow pipe for cleaning away rebound.
  - b. Provide water supply with uniform pressure at discharge nozzle to ensure uniform mixing with aggregate-cement mix. Provide water pump to system if line water pressure is inadequate.
3. Wet-Mix Delivery Equipment: Capable of discharging aggregate-cement-water mixture accurately, uniformly, and continuously.

#### I. Batching And Mixing

1. Dry-Mix Process: Measure mix proportions by weight batching according to ASTM C 94/C 94M or by volume batching complying with ASTM C 685/C 685M requirements.
  - a. In volume batching, adjust fine-aggregate volume for bulking. Test fine-aggregate moisture content at least once daily to determine extent of bulking.
  - b. Prepackaged shotcrete materials may be used at Contractor's option. Predampen prepackaged shotcrete materials and mix before use.
2. Wet-Mix Process: Measure, batch, mix, and deliver shotcrete according to ASTM C 94/C 94M and ASTM C 1116, **as directed**, and furnish batch ticket information.
  - a. Comply with ASTM C 685/C 685M when shotcrete ingredients are delivered dry and proportioned and mixed on-site.

### 1.3 EXECUTION

#### A. Preparation

1. Concrete or Masonry: Before applying shotcrete, remove unsound or loose materials and contaminants that may inhibit shotcrete bonding. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces before shotcreting.
  - a. Abrasive blast or hydroblast existing surfaces that do not require chipping to remove paint, oil, grease, or other contaminants and to provide roughened surface for proper shotcrete bonding.
2. Earth: Compact and trim to line and grade before placing shotcrete. Do not place shotcrete on frozen surfaces. Dampen surfaces before shotcreting.
3. Rock: Clean rock surfaces of loose materials, mud, and other foreign matter that might weaken shotcrete bonding.
4. Steel: Clean steel surfaces by abrasive blasting according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

#### B. Forms

1. General: Design, erect, support, brace, and maintain forms, according to ACI 301, to support shotcrete and construction loads and to facilitate shotcreting. Construct forms so shotcrete members and structures are secured to prevent excessive vibration or deflection during shotcreting.



- a. Fabricate forms to be readily removable without impact, shock, or damage to shotcrete surfaces and adjacent materials.
    - b. Construct forms to required sizes, shapes, lines, and dimensions using ground wires and depth gages to obtain accurate alignment, location, and grades in finished structures. Construct forms to prevent mortar leakage but permit escape of air and rebound during shotcreting. Provide for openings, offsets, blocking, screeds, anchorages, inserts, and other features required in the Work.
  2. Form openings, chases, recesses, bulkheads, keyways, and screeds in formwork. Determine sizes and locations from trades providing such items. Accurately place and securely support items built into forms.
- C. Steel Reinforcement
  1. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
  2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that weaken shotcrete bonding.
  3. Securely embed reinforcing anchors into existing substrates, located as required.
  4. Accurately position, support, and rigidly secure reinforcement against displacement by formwork, construction, or shotcreting. Locate and support reinforcement by metal chairs, runners, bolsters, spacers, and hangers, as required.
  5. Place reinforcement to obtain minimum coverage for shotcrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during shotcreting. Set wire ties with ends directed into shotcrete, not toward exposed shotcrete surfaces.
  6. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- D. Joints
  1. Construction Joints: Locate and install construction joints tapered to a 1:1 slope where joint is not subject to compression loads and square where joint is perpendicular to main reinforcement. Continue reinforcement through construction joints, unless otherwise indicated.
  2. Contraction Joints: Construct contraction joints in shotcrete using saw cuts 1/8-inch- (3-mm-) wide-by-1/3 slab depth or joint-filler strips 1/4-inch- (6-mm-) wide-by-1/3 shotcrete depth, unless otherwise indicated.
    - a. After shotcrete has cured, remove strip inserts and clean groove of loose debris.
    - b. Space joints at 15 feet (4.5 m) o.c. **OR** centers indicated, **as directed**, horizontally and vertically.
    - c. Tool edges round on each side of strip inserts if floated or troweled finishes are required.
- E. Alignment Control
  1. Ground Wires: Install ground wires to establish thickness and planes of shotcrete surfaces. Install ground wires at corners and offsets not established by forms. Pull ground wires taut and position adjustment devices to permit additional tightening.
- F. Embedded Items
  1. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by shotcrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
- G. Application
  1. Apply temporary protective coverings and protect adjacent surfaces against deposit of rebound and overspray or impact from nozzle stream.
  2. Moisten wood forms immediately before placing shotcrete where form coatings are not used.
  3. Apply shotcrete according to ACI 506.2.
  4. Apply dry-mix shotcrete materials within 45 minutes after predampening and wet-mix shotcrete materials within 90 minutes after batching.



5. Deposit shotcrete continuously in multiple passes, to required thickness, without cold joints and laminations developing. Place shotcrete with nozzle held perpendicular to receiving surface. Begin shotcreting in corners and recesses.
6. Remove and dispose of rebound and overspray materials during shotcreting to maintain clean surfaces and to prevent rebound entrapment.
7. Maintain reinforcement in position during shotcreting. Place shotcrete to completely encase reinforcement and other embedded items. Maintain steel reinforcement free of overspray and prevent buildup against front face during shotcreting.
8. Do not place subsequent lifts until previous lift of shotcrete is capable of supporting new shotcrete.
9. Do not permit shotcrete to sag, slough, or dislodge.
10. Remove hardened overspray, rebound, and laitance from shotcrete surfaces to receive additional layers of shotcrete; dampen surfaces before shotcreting.
11. Do not disturb shotcrete surfaces before beginning finishing operations.
12. Remove ground wires or other alignment control devices after shotcrete placement.
13. Shotcrete Core Grade: Apply shotcrete to achieve mean core grades not exceeding 2.5 according to ACI 506.2, with no single core grade exceeding 3.0.
14. Installation Tolerances: Place shotcrete without exceeding installation tolerances permitted by ACI 117R, increased by a factor of 2.

#### H. Surface Finishes

1. General: Finish shotcrete according to descriptions in ACI 506R for the following finishes:
2. Natural Finish:
  - a. Gun Finish: Natural undisturbed finish.
  - b. Rod Finish: Rough-textured finish obtained by cutting or screeding exposed face of shotcrete to plane by rod or straightedge after initial set, and wood-float finished **OR** steel-trowel finished **as directed**.
  - c. Broom Finish: Rough-textured finish obtained by screeding exposed face of shotcrete to required plane by rod, cutting screed, or trowel, and brooming after initial set.
3. Flash-Coat Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finely textured finish.
4. Flash-Coat and Final Finish: After screeding and rodding surface, apply up to 1/4-inch (6-mm) coat of shotcrete using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply wood-float **OR** rubber-float **OR** brush-float **OR** steel-trowel, **as directed**, finish.
5. Finish-Coat Finish: After screeding and rodding surface, apply shotcrete finish coat, 1/4 to 1 inch (6 to 25 mm) thick, using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve to provide a finish of uniform texture and appearance.
6. Finish-Coat and Final Finish: After screeding and rodding surface, apply shotcrete finish coat, 1/4 to 1 inch (6 to 25 mm) thick, using ACI 506R, Gradation No. 1, fine-screened sand modified with maximum aggregate size not exceeding No. 4 (4.75-mm) sieve and apply wood-float **OR** rubber-float **OR** brush-float **OR** steel-trowel, **as directed**, finish.

#### I. Curing

1. Protect freshly placed shotcrete from premature drying and excessive cold or hot temperatures.
2. Start initial curing as soon as free water has disappeared from shotcrete surface after placing and finishing.
3. Curing Exposed Surfaces: Cure shotcrete by one of the following methods:
  - a. Moisture Curing: Keep surfaces continuously moist for at least seven days with water, continuous water-fog spray, water-saturated absorptive covers, or moisture-retaining covers. Lap and seal sides and ends of covers.





- b. Curing Compound: Apply curing compound uniformly in continuous operation by power spray 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.
            - 1) Apply curing compound to natural- or gun-finished shotcrete at rate of 1 gal./100 sq. ft. (1 L/2.5 sq. m).
  - 4. Curing Formed Surfaces: Cure formed shotcrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
- J. Form Removal
- 1. Forms not supporting weight of shotcrete may be removed after curing at not less than 50 deg F (10 deg C) for 24 consecutive hours after gunning, provided shotcrete is hard enough not to be damaged by form-removal operations and provided curing and protecting operations are maintained.
    - a. Leave forms supporting weight of shotcrete in place until shotcrete has attained design compressive strength. Determine compressive strength of in-place shotcrete by testing representative field-cured specimens of shotcrete.
    - b. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
  - 2. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are unacceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.
- K. Field Quality Control
- 1. Engage a qualified independent testing agency to sample materials, visually grade cores, perform tests, and submit reports during shotcreting.
  - 2. Air Content: ASTM C 173/C 173M, volumetric method or ASTM C 231, pressure method; 1 test for each compressive-strength test for each mix of air-entrained, wet-mix shotcrete measured before pumping.
  - 3. Shotcrete Temperature: ASTM C 1064/C 1064M; 1 test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and 1 test for each set of compressive-strength specimens.
  - 4. Test Panels: Make a test panel, reinforced as in structure, for each shotcrete mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Produce test panels with dimensions of 24 by 24 inches (600 by 600 mm) minimum and of average thickness of shotcrete, but not less than 4-1/2 inches (115 mm). From each test panel, testing agency will obtain six test specimens: one set of three specimens unreinforced and one set of three specimens reinforced.
    - a. Test each set of unreinforced specimens for compressive strength according to ASTM C 1140 and construction testing requirements in ACI 506.2.
    - b. Visually inspect each set of reinforced shotcrete cores taken from test panels and determine mean core grades according to ACI 506.2.
  - 5. In-Place Shotcrete: Take a set of 3 unreinforced cores for each mix and for each workday or for every 50 cu. yd. (38 cu. m) of shotcrete placed; whichever is less. Test cores for compressive strength according to ACI 506.2 and ASTM C 42. Do not cut steel reinforcement.
  - 6. Strength of shotcrete will be considered satisfactory when mean compressive strength of each set of 3 unreinforced cores equals or exceeds 85 percent of specified compressive strength, with no individual core less than 75 percent of specified compressive strength.
    - a. Mean compressive strength of each set of 3 unreinforced cubes shall equal or exceed design compressive strength with no individual cube less than 88 percent of specified compressive strength.
- L. Repairs
- 1. Remove and replace shotcrete that is delaminated or exhibits laminations, voids, or sand/rock pockets exceeding limits for specified core grade of shotcrete.



- a. Remove unsound or loose materials and contaminants that may inhibit bond of shotcrete repairs. Chip or scarify areas to be repaired to extent necessary to provide sound substrate. Cut edges square and 1/2 inch (13 mm) deep at perimeter of work, tapering remaining shoulder at 1:1 slope into cavity to eliminate square shoulders. Dampen surfaces and apply new shotcrete.
  2. Repair core holes from in-place testing according to repair provisions in ACI 301 and match adjacent finish, texture, and color.
- M. Cleaning
1. Remove and dispose of rebound and overspray materials from final shotcrete surfaces and areas not intended for shotcrete placement.

END OF SECTION 03370



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Task	Specification	Specification Description
03390	03110	Cast-In-Place Concrete

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## SECTION 03620 - PLANT-PRECAST STRUCTURAL CONCRETE

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for plant-precast structural concrete. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. Section Includes:
  - a. Precast structural concrete.
  - b. Precast structural concrete with thin-brick or stone facings.
  - c. Precast structural concrete with commercial architectural finish.

#### C. Definition

1. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, preapproved by the Owner.

#### D. Performance Requirements

1. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.
  - a. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

#### E. Submittals

1. Product Data: For each type of product indicated.
2. LEED Submittals:
  - a. Product Data for Credit MR 4.1 and Credit MR 4.2, **as directed**: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
    - 1) Include statement indicating costs for each product having recycled content.
  - b. Design Mixtures for Credit ID 1.1: For each concrete mixture containing fly ash as a replacement for portland cement or other portland cement replacements and for equivalent concrete mixtures that do not contain portland cement replacements.
3. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
4. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units.
5. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
6. Qualification Data: For Installer **OR** fabricator **OR** testing agency, **as directed**.
7. Welding certificates.
8. Material Certificates.
9. Material Test Reports.
10. Source quality-control reports.
11. Field quality-control and special inspection, **as directed**, reports.



#### F. Quality Assurance

1. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
  - a. Participates in PCI's Plant Certification program and is designated a PCI-certified plant as follows:
    - 1) Group C, Category C1 - Precast Concrete Products (no prestressed reinforcement) **OR** Category C2 - Prestressed Hollowcore and Repetitively Produced Products **OR** Category C3 - Prestressed Straight Strand Structural Members **OR** Category C4 - Prestressed Deflected Strand Structural Members, **as directed**.
    - 2) Group CA, Category C1A - Precast Concrete Products (no prestressed reinforcement) **OR** Category C2A - Prestressed Hollowcore and Repetitively Produced Products **OR** Category C3A - Prestressed Straight-Strand Structural Members **OR** Category C4A - Prestressed Deflected-Strand Structural Members, **as directed**.
2. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.
3. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."
4. Welding Qualifications: Qualify procedures and personnel according to the following:
  - a. AWS D1.1/D.1.1M, "Structural Welding Code - Steel."
  - b. AWS D1.4, "Structural Welding Code - Reinforcing Steel."
5. Fire-Resistance Calculations: Where indicated, provide precast structural concrete units whose fire resistance meets the prescriptive requirements of authorities having jurisdiction or has been calculated according to ACI 216.1/TMS 0216.1, "Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies," **OR** PCI MNL 124, "Design for Fire Resistance of Precast Prestressed Concrete," **as directed**, and is acceptable to authorities having jurisdiction.
6. Preinstallation Conference: Conduct conference at Project site.

#### G. Delivery, Storage, And Handling

1. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.
2. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.
  - a. Store units with dunnage across full width of each bearing point unless otherwise indicated.
  - b. Place adequate dunnage of even thickness between each unit.
  - c. Place stored units so identification marks are clearly visible, and units can be inspected.
3. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.
4. Lift and support units only at designated points shown on Shop Drawings.

#### H. Coordination

1. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

### 1.2 PRODUCTS

#### A. Mold Materials



1. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.
    - a. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
  2. Form Liners: Units of face design, texture, arrangement, and configuration indicated **OR** to match those used for precast concrete design reference sample, **as directed**. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.
  3. Surface Retarder: Chemical set retarder, capable of temporarily delaying final hardening of newly placed concrete mixture to depth of reveal specified.
- B. Reinforcing Materials
1. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 **OR** 60, **as directed**, percent.
  2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
  3. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
  4. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 767/A 767M, Class II zinc coated, hot-dip galvanized, and chromate wash treated after fabrication and bending, **as directed**.
  5. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, ASTM A 775/A 775M **OR** ASTM A 934/A 934M, **as directed**, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.
  6. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 (Grade 420) **OR** ASTM A 706/A 706M, **as directed**, deformed bars, assembled with clips.
  7. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel **OR** galvanized-steel, **as directed**, wire into flat sheets.
  8. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
  9. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A coated, plain **OR** deformed, **as directed**, flat sheet, Type 1 bendable **OR** Type 2 nonbendable, **as directed**, coating.
  10. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.
- C. Prestressing Tendons
1. Pretensioning Strand: ASTM A 416/A 416M, Grade 250 (Grade 1720) or Grade 270 (Grade 1860), uncoated, 7-wire **OR** ASTM A 886/A 886M, Grade 270 (Grade 1860), indented, 7-wire, **as directed**, low-relaxation strand.
  2. Unbonded Post-Tensioning Strand: ASTM A 416/A 416M, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.
    - a. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.6 and sheath with polypropylene tendon sheathing complying with ACI 423.6. Include anchorage devices and coupler assemblies.
  3. Post-Tensioning Bars: ASTM A 722, uncoated high-strength steel bar.
- D. Concrete Materials
1. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
    - a. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
  2. Supplementary Cementitious Materials:
    - a. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
    - b. Metakaolin Admixture: ASTM C 618, Class N.



- c. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
- d. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- 3. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with Class 5S **OR** Class 5M **OR** Class 4S **OR** Class 4M, **as directed**. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
  - a. Face-Mixture-Coarse Aggregates: Selected, hard, and durable; free of material that reacts with cement or causes staining; to match selected finish sample.
    - 1) Gradation: Uniformly graded **OR** Gap graded **OR** To match design reference sample, **as directed**.
  - b. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate unless otherwise approved by the Owner.
- 4. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C 330, with absorption less than 11 percent.
- 5. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- 6. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
- 7. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- 8. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
  - a. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
  - b. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - c. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - d. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
  - e. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - f. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - g. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M.
- 9. Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

#### E. Steel Connection Materials

- 1. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- 2. Carbon-Steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
- 3. Carbon-Steel Plate: ASTM A 283/A 283M.
- 4. Malleable-Iron Castings: ASTM A 47/A 47M.
- 5. Carbon-Steel Castings: ASTM A 27/A 27M, Grade 60-30 (Grade 415-205).
- 6. High-Strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
- 7. Carbon-Steel Structural Tubing: ASTM A 500, Grade B.
- 8. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65 (Grade 450).
- 9. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
- 10. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563 (ASTM A 563M); and flat, unhardened steel washers, ASTM F 844.
- 11. High-Strength Bolts and Nuts: ASTM A 325 (ASTM A 325M) or ASTM A 490 (ASTM A 490M), Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563 (ASTM A 563M); and hardened carbon-steel washers, ASTM F 436 (ASTM F 436M).
  - a. Do not zinc coat ASTM A 490 (ASTM A 490M) bolts.
- 12. Zinc-Coated Finish: For exterior steel items, steel in exterior walls, **as directed**, and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M





or ASTM A 153/A 153M **OR** electrodeposition according to ASTM B 633, SC 3, Types 1 and 2, **as directed**.

- a. For steel shapes, plates, and tubing to be galvanized, limit silicon content of steel to less than 0.03 percent or to between 0.15 and 0.25 percent or limit sum of silicon and 2.5 times phosphorous content to 0.09 percent.
  - b. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.
13. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 **OR** SSPC-Paint 25, **as directed**, according to SSPC-PA 1.
14. Welding Electrodes: Comply with AWS standards.
15. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

F. Stainless-Steel Connection Materials

1. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
2. Stainless-Steel Bolts and Studs: ASTM F 593, Alloy 304 or 316, hex-head bolts and studs; stainless-steel nuts; and flat, stainless-steel washers. Lubricate threaded parts of stainless-steel bolts with an antiseize thread lubricant during assembly.
3. Stainless-Steel-Headed Studs: ASTM A 276, with minimum mechanical properties of PCI MNL 116.

G. Bearing Pads

1. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application, **as directed**:
  - a. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100 percent polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, 50 to 70 Shore, Type A durometer hardness, ASTM D 2240; minimum tensile strength 2250 psi (15.5 MPa), ASTM D 412.
  - b. Random-Oriented, Fiber-Reinforced Elastomeric Pads: Preformed, randomly oriented synthetic fibers set in elastomer. 70 to 90 Shore, Type A durometer hardness, ASTM D 2240; capable of supporting a compressive stress of 3000 psi (20.7 MPa) with no cracking, splitting, or delaminating in the internal portions of pad. Test 1 specimen for every 200 pads used in Project.
  - c. Cotton-Duck-Fabric-Reinforced Elastomeric Pads: Preformed, horizontally layered cotton-duck fabric bonded to an elastomer; 80 to 100 Shore, Type A durometer hardness, ASTM D 2240; complying with AASHTO's "AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications," Division II, Section 18.10.2; or with MIL-C-882E.
  - d. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to stainless- or mild-steel plate, of type required for in-service stress.
  - e. High-Density Plastic: Multimer, nonleaching, plastic strip.

H. Grout Materials

1. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
2. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time.
3. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

I. Thin-Brick Units And Accessories



1. Thin-Brick Units: ASTM C 216, Type FBX or ASTM C 1088, Grade Exterior, Type TBX, not less than 1/2 inch (13 mm) **OR** 3/4 inch (19 mm) **OR** 1 inch (25 mm), **as directed**, thick with a tolerance of plus or minus 1/16 inch (1.6 mm), and as follows:
  - a. Face Color and Texture: Match the Owner's samples **OR** Medium brown, wire cut **OR** Full-range red, sand molded **OR** Gray, velour, **as directed**.
  - b. Face Size:
    - 1) 2-1/4 inches (57 mm) high by 8 inches (203 mm) long.
    - 2) 2-1/4 inches (57 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
    - 3) 2-3/4 to 2-13/16 inches (70 to 71 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
    - 4) 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 7-1/2 to 7-5/8 inches (190 to 194 mm) long.
    - 5) 3-1/2 to 3-5/8 inches (89 to 92 mm) high by 11-1/2 to 11-5/8 inches (292 to 295 mm) long.
  - c. Where indicated to "match existing," provide thin brick matching color, texture, and face size of existing adjacent brick work.
  - d. Face Size:
    - 1) 57 mm high by 190 mm long.
    - 2) 70 mm high by 190 mm long.
    - 3) 90 mm high by 190 mm long.
    - 4) 90 mm high by 290 mm long.
  - e. Special Shapes: Include corners, edge corners, and end edge corners.
  - f. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute; ASTM C 67.
  - g. Efflorescence: Tested according to ASTM C 67 and rated "not effloresced."
  - h. Surface Coating: Thin brick with colors or textures applied as coatings shall withstand 50 cycles of freezing and thawing; ASTM C 67 with no observable difference in applied finish when viewed from 10 feet (3 m).
  - i. Back Surface Texture: Scored, combed, wire roughened, ribbed, keybacked, or dovetailed.
2. Sand-Cement Mortar: Portland cement, ASTM C 150, Type I, and clean, natural sand, ASTM C 144. Mix at ratio of 1 part cement to 4 parts sand, by volume, with minimum water required for placement.
3. Latex-Portland Cement Pointing Grout: ANSI A118.6 and as follows:
  - a. Dry-grout mixture, factory prepared, of portland cement, graded aggregate, and dry, redispersible, ethylene-vinyl-acetate additive for mixing with water; uniformly colored.
  - b. Commercial portland cement grout, factory prepared, with liquid styrene-butadiene rubber or acrylic-resin latex additive; uniformly colored.
  - c. Colors: As indicated by manufacturer's designations **OR** Match the Owner's samples **OR** As selected by the Owner from manufacturer's full range, **as directed**.

J. Stone Materials And Accessories

1. Stone facing for precast structural concrete is specified in Division 04 Section "Dimension Stone Cladding".
2. Anchors: Stainless steel, ASTM A 666, Type 304, of temper and diameter required to support loads without exceeding allowable design stresses.
  - a. Fit each anchor leg with neoprene grommet collar of width at least twice the diameter and of length at least five times the diameter of anchor.
3. Sealant Filler: ASTM C 920, low-modulus, multicomponent, nonsag urethane sealant complying with requirements in Division 07 Section "Joint Sealants" and that is nonstaining to stone substrate.
4. Epoxy Filler: ASTM C 881/C 881M, 100 percent solids, sand-filled nonshrinking, nonstaining of type, class, and grade to suit application.
  - a. Elastomeric Anchor Sleeve: 1/2 inch (13 mm) long; 60 Shore, Type A durometer hardness; ASTM D 2240.



5. Bond Breaker: Preformed, compressible, resilient, nonstaining, nonwaxing, closed-cell polyethylene foam pad, nonabsorbent to liquid and gas, 1/8 inch (3.2 mm) thick **OR** Polyethylene sheet, ASTM D 4397, 6 to 10 mils (0.15 to 0.25 mm) thick, **as directed**.
- K. Insulated Flat Wall Panel Accessories
1. Molded-Polystyrene Board Insulation: ASTM C 578, Type I, 0.90 lb/cu. ft. (15 kg/cu. m) **OR** Type VIII, 1.15 lb/cu. ft. (18 kg/cu. m) **OR** Type II, 1.35 lb/cu. ft. (22 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as directed by the Owner.
  2. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 1.60 lb/cu. ft. (26 kg/cu. m) **OR** Type X, 1.30 lb/cu. ft. (21 kg/cu. m) **OR** Type VI, 1.80 lb/cu. ft. (29 kg/cu. m), **as directed**; square **OR** ship-lap, **as directed**, edges; with R-value and thickness as directed by the Owner.
  3. Polyisocyanurate Board Insulation: ASTM C 591, Type I, 1.8 lb/cu. ft. (29 kg/cu. m) **OR** Type IV, 2 lb/cu. ft. (32 kg/cu. m) **OR** Type II, 2.5 lb/cu. ft. (40 kg/cu. m), **as directed**, unfaced, with R-value and thickness as directed by the Owner.
  4. Wythe Connectors: Glass-fiber connectors **OR** Vinyl-ester polymer connectors **OR** Polypropylene pin connectors **OR** Stainless-steel pin connectors **OR** Bent galvanized reinforcing bars **OR** Galvanized welded wire trusses **OR** Galvanized bent wire connectors **OR** Cylindrical metal sleeve anchors, **as directed**, manufactured to connect wythes of precast concrete panels.
- L. Concrete Mixtures
1. Prepare design mixtures for each type of precast concrete required.
    - a. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
    - b. Limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; metakaolin and silica fume to 10 percent of portland cement by weight.
  2. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
  3. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested according to ASTM C 1218/C 1218M.
  4. Normal-Weight Concrete Mixtures: Proportion face mixtures **OR** face and backup mixtures **OR** full-depth mixture, **as directed**, by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
    - a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
    - b. Maximum Water-Cementitious Materials Ratio: 0.45.
  5. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.
  6. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods according to ACI 211.2, with materials to be used on Project, to provide lightweight concrete with the following properties:
    - a. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
    - b. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft. (1842 kg/cu. m), plus or minus 3 lb/cu. ft. (48 kg/cu. m), according to ASTM C 567.
  7. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 116.
  8. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
  9. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.
- M. Mold Fabrication
1. Molds: Accurately construct molds, mortar tight, of sufficient strength to withstand pressures due to concrete-placement operations and temperature changes and for prestressing and



detensioning operations. Coat contact surfaces of molds with release agent before reinforcement is placed. Avoid contamination of reinforcement and prestressing tendons by release agent.

- a. Place form liners accurately to provide finished surface texture indicated. Provide solid backing and supports to maintain stability of liners during concrete placement. Coat form liner with form-release agent.
2. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
  - a. Form joints are not permitted on faces exposed to view in the finished work.
  - b. Edge and Corner Treatment: Uniformly chamfered **OR** radiused, **as directed**.

N. Thin-Brick Facings

1. Place form-liner templates accurately to provide grid for thin-brick facings. Provide solid backing and supports to maintain stability of liners while placing thin bricks and during concrete placement.
2. Securely place thin-brick units face down into form-liner pockets and place concrete backing mixture.
3. Completely fill joint cavities between thin-brick units with sand-cement mortar, and place precast concrete backing mixture while sand-cement mortar is still fluid enough to ensure bond.
4. Mix and install pointing grout according to ANSI A108.10. Completely fill joint cavities between thin-brick units with pointing grout, and compress into place without spreading pointing grout onto faces of thin-brick units. Remove excess pointing grout immediately to prevent staining of brick.
  - a. Tool joints to a slightly concave shape **OR** grapevine shape **OR** V-shape, **as directed**, when pointing grout is thumbprint hard.
5. Clean faces and joints of brick facing.

O. Stone Facings

1. Clean stone surfaces before placing in molds to remove soil, stains, and foreign materials. Use cleaning methods and materials recommended by stone supplier.
2. Accurately position stone facings to comply with requirements and in locations indicated on Shop Drawings. Install anchors, supports, and other attachments indicated or necessary to secure stone in place. Keep concrete reinforcement a minimum of 3/4 inch (19 mm) from the back surface of stone. Use continuous spacers to obtain uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
  - a. Stone to Precast Anchorages: Provide anchors in numbers, types and locations required to satisfy specified performance criteria, but not less than 2 anchors per stone unit of less than 2 sq. ft. (0.19 sq. m) in area and 4 anchors per unit of less than 12 sq. ft. (1.1 sq. m) in area; for units larger than 12 sq. ft. (1.1 sq. m) in area, provide anchors spaced not more than 24 inches (600 mm) o.c. horizontally and vertically. Locate anchors a minimum of 6 inches (150 mm) from stone edge.
3. Fill anchor holes with sealant filler and install anchors **OR** epoxy filler and install anchors with elastomeric anchor sleeve at back surface of stone, **as directed**.
  - a. Install polyethylene sheet to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface.
  - b. Install 1/8-inch (3-mm) polyethylene-foam bond breaker to prevent bond between back of stone facing and concrete substrate and to ensure no passage of precast matrix to stone surface. Maintain minimum projection requirements of stone anchors into concrete substrate.

P. Fabrication

1. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.



- a. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."
2. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
3. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
4. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without the Owner's approval.
5. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
  - a. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
  - b. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
  - c. Place reinforcement to maintain at least 3/4-inch (19-mm) minimum coverage. Increase cover requirements according to ACI 318 (ACI 318M) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
  - d. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch (19-mm) minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches (38 mm) when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
  - e. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
6. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.
7. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
  - a. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
  - b. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
  - c. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
  - d. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.
  - e. Protect strand ends and anchorages with a minimum of 1-inch- (25-mm-) thick, nonmetallic, nonshrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.
8. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
9. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
10. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
  - a. Place backup concrete mixture to ensure bond with face-mixture concrete.



11. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.
  - a. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants."
12. Comply with ACI 306.1 procedures for cold-weather concrete placement.
13. Comply with PCI MNL 116 procedures for hot-weather concrete placement.
14. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.
15. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
16. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet the Owner's approval.

Q. Casting Insulated Wall Panels

1. Cast and screed wythe supported by mold.
2. Place insulation boards abutting edges and ends of adjacent boards. Insert wythe connectors through insulation, and consolidate concrete around connectors according to connector manufacturer's written instructions.
3. Cast and screed top wythe to meet required finish.

R. Fabrication Tolerances

1. Fabricate precast structural concrete units straight and true to size and shape with exposed edges and corners precise and true so each finished unit complies with PCI MNL 116 product dimension tolerances.
2. Brick-Faced Precast Structural Concrete Units: Restrict the following misalignments to 2 percent of number of bricks in a unit:
  - a. Alignment of Mortar Joints:
    - 1) Jog in Alignment: 1/8 inch (3 mm).
    - 2) Alignment with Panel Centerline: Plus or minus 1/8 inch (3 mm).
  - b. Variation in Width of Exposed Mortar Joints: Plus or minus 1/8 inch (3 mm).
  - c. Tipping of Individual Bricks from the Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.
  - d. Exposed Brick Surface Parallel to Primary Control Surface of Panel: Plus 1/4 inch (6 mm); minus 1/8 inch (3 mm).
  - e. Individual Brick Step in Face from Panel Plane of Exposed Brick Surface: Plus 1/16 inch (1.6 mm); minus 1/4 inch (6 mm) less than or equal to depth of form-liner joint.
3. Stone Veneer-Faced Precast Structural Concrete Units:
  - a. Variation in Cross-Sectional Dimensions: For thickness of walls from dimensions indicated: Plus or minus 1/4 inch (6 mm).
  - b. Variation in Joint Width: 1/8 inch in 36 inches (3 mm in 900 mm) or a quarter of nominal joint width, whichever is less.
  - c. Variation in Plane between Adjacent Stone Units (Lipping): 1/16-inch (1.6-mm) difference between planes of adjacent units.

S. Commercial Finishes

1. Commercial Grade: Remove fins and large protrusions and fill large holes. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch (5 mm).



2. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch (13 mm) caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch (6 mm) in width that occur more than once per 2 sq. in. (1300 sq. mm). Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch (3 mm).
3. Grade B Finish: Fill air pockets and holes larger than 1/4 inch (6 mm) in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch (3 mm) in width that occur more than once per 2 sq. in. (1300 sq. mm). Grind smooth form offsets or fins larger than 1/8 inch (3 mm). Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.
4. Grade A Finish: Fill surface blemishes with the exception of air holes 1/16 inch (1.6 mm) in width or smaller, and form marks where the surface deviation is less than 1/16 inch (1.6 mm). Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.
5. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.
6. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.
7. Apply roughened surface finish according to ACI 318 (ACI 318M) to precast concrete units that will receive concrete topping after installation.

T. Commercial Architectural Finishes

1. Manufacture member faces free of joint marks, grain, and other obvious defects with corners, including false joints, uniform, straight, and sharp. Finish exposed-face surfaces of precast concrete units to match approved design reference sample **OR** sample panels, **as directed**, and as follows:
  - a. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
  - b. Smooth-Surface Finish: Provide surfaces free of excessive air voids, sand streaks, and honeycombs, with uniform color and texture.
  - c. Textured-Surface Finish: Impart by form liners or inserts to provide surfaces free of pockets, streaks, and honeycombs, with uniform color and texture.
  - d. Bushhammer Finish: Use power or hand tools to remove matrix and fracture coarse aggregates.
  - e. Exposed-Aggregate Finish: Use chemical-retarding agents applied to concrete molds and washing and brushing procedures to expose aggregate and surrounding matrix surfaces after form removal.
  - f. Abrasive-Blast Finish: Use abrasive grit, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces.
  - g. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attack.
  - h. Honed Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
  - i. Polished Finish: Use continuous mechanical abrasion with fine grit, followed by filling and rubbing procedures.
  - j. Sand-Embedment Finish: Use selected stones placed in a sand bed in bottom of mold, with sand removed after curing.

U. Source Quality Control

1. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.
  - a. Test and inspect self-consolidating concrete according to PCI TR-6.



2. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
3. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 (ACI 318M) requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C 42/C 42M.
  - a. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by the Owner.
  - b. Cores will be tested in an air-dry condition or, if units will be wet under service conditions, test cores after immersion in water in a wet condition.
  - c. Strength of concrete for each series of 3 cores will be considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
  - d. Test results will be made in writing on same day that tests are performed, with copies to the Owner, Contractor, and precast concrete fabricator. Test reports will include the following:
    - 1) Project identification name and number.
    - 2) Date when tests were performed.
    - 3) Name of precast concrete fabricator.
    - 4) Name of concrete testing agency.
    - 5) Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
4. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
5. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to the Owner's approval. the Owner reserves the right to reject precast units that do not match approved samples and sample panels.

### 1.3 EXECUTION

#### A. Installation

1. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
2. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connection.
  - a. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
  - b. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
  - c. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
  - d. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
3. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
  - a. Do not permit connections to disrupt continuity of roof flashing.
4. Field cutting of precast units is not permitted without approval of the the Owner.





5. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.
  6. Welding: Comply with applicable AWS D1.1/D1.1M and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
    - a. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
    - b. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil- (0.1-mm-) thick coat of galvanized repair paint to galvanized surfaces according to ASTM A 780.
    - c. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and reprime damaged painted surfaces.
    - d. Remove, reweld, or repair incomplete and defective welds.
  7. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
    - a. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot. For friction connections, apply specified bolt torque and check 25 percent of bolts at random by calibrated torque wrench.
  8. Grouting: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain grout in place until hard enough to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled.
    - a. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
    - b. Fill joints completely without seepage to other surfaces.
    - c. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
    - d. Place grout end cap or dam in voids at ends of hollow-core slabs.
    - e. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
    - f. Keep grouted joints damp for not less than 24 hours after initial set.
- B. Erection Tolerances
1. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
  2. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by the Owner.
- C. Field Quality Control
1. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
    - a. Erection of precast structural concrete members.
  2. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  3. Field welds will be visually inspected and nondestructive tested according to ASTM E 165 or ASTM E 709. High-strength bolted connections will be subject to inspections.
  4. Testing agency will report test results promptly and in writing to Contractor and the Owner.
  5. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
  6. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  7. Prepare test and inspection reports.
- D. Repairs
1. Repair precast structural concrete units if permitted by the Owner.
    - a. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.



2. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
3. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
4. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
5. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by the Owner.

E. Cleaning

1. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
2. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
  - a. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Clean soiled precast concrete surfaces with detergent and water, using stiff fiber brushes and sponges, and rinse with clean water. Protect other work from staining or damage due to cleaning operations.
  - b. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03620



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<b>Task</b>	<b>Specification</b>	<b>Specification Description</b>
03630	01204	No Specification Required
03640	01204	No Specification Required
03640	03620	Plant-Precast Structural Concrete



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## SECTION 03920 - CONCRETE REHABILITATION

### 1.1 GENERAL

#### A. Description Of Work

1. This specification covers the furnishing and installation of materials for concrete rehabilitation. Products shall be as follows or as directed by the Owner. Installation procedures shall be in accordance with the product manufacturer's recommendations. Demolition and removal of materials shall be as required to support the work.

#### B. Summary

1. This Section includes the following:
  - a. Removal of deteriorated concrete and reinforcement and subsequent replacement and patching.
  - b. Floor joint repair.
  - c. Epoxy crack injection.
  - d. Corrosion-inhibiting treatment.
  - e. Polymer overlays.
  - f. Polymer sealers.
  - g. Steel structural reinforcement.
  - h. Composite structural reinforcement.

#### C. Submittals

1. Product Data: For each type of product indicated. Include material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
2. Formwork and Shoring Drawings: Prepared by or under the supervision of a qualified professional engineer detailing formwork and temporary shoring and supports. Include schedule and sequence for erection and removal relative to removal of deteriorated concrete and reinforcement and subsequent repair and reinforcement.
3. Samples: Cured Samples of overlay and patching materials.
4. Rehabilitation Program: For each phase of rehabilitation process, including protection of surrounding materials and Project site during operations. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work.
  - a. If alternative materials and methods to those indicated are proposed for any phase of rehabilitation work, submit substitution request and provide a written description of proposed materials and methods, including evidence of successful use on other comparable projects, and a testing program to demonstrate their effectiveness for this Project.

#### D. Delivery, Storage, And Handling

1. Deliver materials to Project site in manufacturer's original and unopened containers, labeled with type and name of products and manufacturers.
2. Comply with manufacturer's written instructions for minimum and maximum temperature requirements and other conditions for storage.
3. Store cementitious materials off the ground, under cover, and in a dry location.
4. Store aggregates, covered and in a dry location, where grading and other required characteristics can be maintained and contamination avoided.

#### E. Project Conditions

1. Environmental Limitations for Epoxies: Do not apply when air and substrate temperatures are outside limits permitted by manufacturer. During hot weather, cool epoxy components before mixing, store mixed products in shade, and cool unused mixed products to retard setting. Do not apply to wet substrates unless approved by manufacturer.



- a. Use only Class A epoxies when substrate temperatures are below or are expected to go below 40 deg F (5 deg C) within 8 hours.
- b. Use only Class A or B epoxies when substrate temperatures are below or are expected to go below 60 deg F (16 deg C) within 8 hours.
- c. Use only Class C epoxies when substrate temperatures are above and are expected to stay above 60 deg F (16 deg C) for 8 hours.
2. Cold-Weather Requirements for Cementitious Materials:
  - a. Do not apply unless air temperature is above 40 deg F (5 deg C) and will remain so for at least 48 hours after completion of Work.  
**OR**  
 Comply with the following procedures:
    - 1) When air temperature is below 40 deg F (5 deg C), heat patching material ingredients and existing concrete to produce temperatures between 40 and 90 deg F (5 and 32 deg C).
    - 2) When mean daily air temperature is between 25 and 40 deg F (minus 4 and plus 5 deg C), cover completed Work with weather-resistant insulating blankets for 48 hours after repair or provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
    - 3) When mean daily air temperature is below 25 deg F (minus 4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for 48 hours after repair.
3. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90 deg F (32 deg C) and above.
4. Environmental Limitations for High-Molecular-Weight Methacrylate Sealers: Do not apply when concrete surface temperature is below 55 deg F (13 deg C) or above 75 deg F (24 deg C) **OR** 90 deg F (32 deg C), **as directed**. Apply only to dry substrates **OR** substrates that have been dry for at least 72 hours.

## 1.2 PRODUCTS

### A. Bonding Agents

1. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Product that consists of water-insensitive epoxy adhesive, portland cement, and water-based solution of corrosion-inhibiting chemicals that forms a protective film on steel reinforcement.
2. Epoxy Bonding Agent: ASTM C 881/C 881M, Type II **OR** V, **as directed**.
  - a. Thin Film Open Time: Not less than two **OR** six **OR** 24, **as directed**, hours.
3. Latex Bonding Agent: ASTM C 1059, Type I **OR** II **OR** II at exterior locations and where indicated, Type I at other locations, **as directed**.
4. Mortar Scrub-Coat: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 1 part fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.

### B. Patching Mortar

1. Patching Mortar, General:
  - a. Overhead Patching Mortar: For overhead repairs, use patching mortar recommended by manufacturer for overhead use and as specified in this Article.
  - b. Coarse Aggregate for Adding to Patching Mortar: Washed aggregate complying with ASTM C 33, Size No. 8, Class 5S. Add only as permitted by patching mortar manufacturer.
2. Job-Mixed Patching Mortar: 1 part portland cement complying with ASTM C 150, Type I, II, or III and 2-1/2 parts fine aggregate complying with ASTM C 144, except 100 percent passing a No. 16 (1.18-mm) sieve.



3. Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928.
4. Polymer-Modified, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.
5. Polymer-Modified, Silica-Fume-Enhanced, Cementitious Patching Mortar: Packaged, dry mix complying with ASTM C 928, that contains silica fume complying with ASTM C 1240 and a non-redispersible latex additive as either a dry powder or a separate liquid that is added during mixing.

C. Concrete

1. Concrete Materials and Admixtures: Comply with Division 03 Section "Cast-in-place Concrete".
2. Steel and Fiber Reinforcement and Reinforcement Accessories: Comply with Division 03 Section "Cast-in-place Concrete".
3. Form-Facing Materials: Comply with Division 03 Section "Cast-in-place Concrete".
4. Shotcrete: Comply with Division 03 Section "Shotcrete".
5. Preplaced Aggregate: Washed aggregate complying with ASTM C 33, Class 5S, with 95 to 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 40 to 80 percent passing a 1-inch (25-mm) sieve, 20 to 45 percent passing a 3/4-inch (19-mm) sieve, 0 to 10 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve **OR** 100 percent passing a 1-1/2-inch (37.5-mm) sieve, 95 to 100 percent passing a 1-inch (25-mm) sieve, 40 to 80 percent passing a 3/4-inch (19-mm) sieve, 0 to 15 percent passing a 1/2-inch (12.5-mm) sieve, and 0 to 2 percent passing a 3/8-inch (9.5-mm) sieve, **as directed**.
6. Fine Aggregate for Grout Used with Preplaced Aggregate: Fine aggregate complying with ASTM C 33, but with 100 percent passing a No. 8 (2.36-mm) sieve, 95 to 100 percent passing a No. 16 (1.18-mm) sieve, 55 to 80 percent passing a No. 30 (0.6-mm) sieve, 30 to 55 percent passing a No. 50 (0.3-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, 0 to 10 percent passing a No. 200 (0.075-mm) sieve, and having a fineness modulus of 1.30 to 2.10.
7. Grout Fluidifier for Grout Used with Preplaced Aggregate: ASTM C 937.
8. Portland Cement for Grout Used with Preplaced Aggregate: ASTM C 150.
9. Pozzolans for Grout Used with Preplaced Aggregate: ASTM C 618.

D. Miscellaneous Materials

1. Epoxy Joint Filler: 2-component, semirigid, 100 percent solids, epoxy resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
2. Polyurea Joint Filler: 2-component, semirigid, 100 percent solids, polyurea resin with a Type A Shore durometer hardness of at least 80 per ASTM D 2240.
3. Epoxy Crack Injection Adhesive: ASTM C 881/C 881M, Type I **OR** IV, **as directed**, Grade 1, except for gel time **OR** solvent free, **as directed**.
4. Capping Adhesive: Product manufactured for use with crack injection adhesive by same manufacturer.
5. Corrosion-Inhibiting Treatment Materials: Water-based solution of alkaline corrosion-inhibiting chemicals that penetrates concrete by diffusion and forms a protective film on steel reinforcement.
6. Polymer Overlay: Epoxy adhesive complying with ASTM C 881/C 881M, Type III.
7. Aggregate for Use with Polymer Overlay: Oven-dried, washed silica sand complying with ACI 503.3.
8. Polymer Sealer: Low-viscosity epoxy or high-molecular-weight methacrylate penetrating sealer recommended by manufacturer for application to exterior concrete traffic surfaces.
9. Methylmethacrylate Sealer/Brighteners: Clear low-viscosity sealer recommended by manufacturer for sealing exterior exposed-aggregate concrete, and formulated to bring out color of aggregates and give concrete a wet look.
10. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
  - a. After fabricating, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."



- b. For minimum protection to steel after preparation, apply one coat of lead- and chromate-free, modified-alkyd primer complying with MPI#76 and one coat of alkyd-gloss enamel complying with MPI#96.
- c. After preparation, apply two-coat high-performance coating system consisting of organic zinc-rich primer, complying with SSPC-Paint 20 or SSPC-Paint 29 and topcoat of high-build, urethane or epoxy coating recommended by manufacturer for application over specified zinc-rich primer. Comply with coating manufacturer's written directions and with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
- 11. Bolts, Nuts, and Washers: Carbon steel; ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), for bolts; ASTM A 563 (ASTM A 563M), Grade A, for nuts; and ASTM F 436 (ASTM F 436M) for washers; hot-dip or mechanically zinc coated.
- 12. Postinstalled Anchors: Chemical or expansion anchors, made from stainless-steel components complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Alloy Group A1 or A4) for bolts and nuts; ASTM A 666 or ASTM A 276, Type 304 or 316, for anchors, with capability to sustain, without failure, a load equal to four times the load imposed, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
- 13. Composite Structural Reinforcement: Manufacturer's system consisting of carbon **OR** glass, **as directed**, fiber reinforcement in the form of preimpregnated sheets or tow sheet with field-applied saturant, and epoxy primers, fillers, adhesives, saturants, and topcoats, designed for use as external structural reinforcement for concrete.

#### E. Mixes

- 1. Mix products, in clean containers, according to manufacturer's written instructions.
  - a. Add clean silica sand and coarse aggregates to products only as recommended by manufacturer.
  - b. Do not add water, thinners, or additives unless recommended by manufacturer.
  - c. When practical, use manufacturer's premeasured packages to ensure that materials are mixed in proper proportions. When premeasured packages are not used, measure ingredients using graduated measuring containers; do not estimate quantities or use shovel or trowel as unit of measure.
  - d. Do not mix more materials than can be used within recommended open time. Discard materials that have begun to set.
- 2. Mortar Scrub-Coat: Mix with enough water to provide consistency of thick cream.
- 3. Dry-Pack Mortar: Mix with just enough liquid to form damp cohesive mixture that can be squeezed by hand into a ball but is not plastic.
- 4. Concrete: Comply with Division 03 Section "Cast-in-place Concrete".
- 5. Shotcrete: Comply with Division 03 Section "Shotcrete".
- 6. Grout for Use with Preplaced Aggregate: Proportion according to ASTM C 938. Add grout fluidifier to mixing water followed by cementitious materials and then fine aggregate.

### 1.3 EXECUTION

#### A. Examination

- 1. Notify the Owner seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
- 2. Locate areas of deteriorated or delaminated concrete using hammer or chain drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb, unless otherwise indicated.
- 3. Locate at least three reinforcing bars using a pachometer, and drill test holes to determine depth of cover. Calibrate pachometer, using depth of cover measurements, and verify depth of cover in removal areas using pachometer.



**B. Preparation**

1. Protect people, motor vehicles, equipment, surrounding construction, Project site, plants, and surrounding buildings from injury resulting from concrete rehabilitation work.
  - a. Erect and maintain temporary protective covers over pedestrian walkways and at points of entrance and exit for people and vehicles, unless such areas are made inaccessible during the course of concrete rehabilitation work. Construct covers of tightly fitted, 3/4-inch (19-mm) exterior-grade plywood supported at 16 inches (405 mm) o.c. and covered with asphalt roll roofing.
  - b. Protect adjacent equipment and surfaces by covering them with heavy polyethylene film and waterproof masking tape or a liquid strippable masking agent. If practical, remove items, store, and reinstall after potentially damaging operations are complete.
  - c. Neutralize and collect alkaline and acid wastes according to requirements of authorities having jurisdiction, and dispose of by legal means off Owner's property.
  - d. Dispose of runoff from wet operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.
  - e. Collect runoff from wet operations and dispose of by legal means off Owner's property.
2. Shoring: Install temporary supports before beginning concrete removal.
3. Concrete Removal:
  - a. Saw-cut perimeter of areas indicated for removal to a depth of at least 1/2 inch (13 mm). Make cuts perpendicular to concrete surfaces and no deeper than cover on reinforcement.
  - b. Remove deteriorated and delaminated concrete by breaking up and dislodging from reinforcement.
  - c. Remove additional concrete, if necessary, to provide a depth of removal of at least 1/2 inch (13 mm) over entire removal area.
  - d. Where half or more of the perimeter of reinforcing bar is exposed, bond between reinforcing bar and surrounding concrete is broken, or reinforcing bar is corroded, remove concrete from entire perimeter of bar and to provide at least a 3/4-inch (19-mm) clearance around bar.
  - e. Test areas where concrete has been removed by tapping with hammer, and remove additional concrete until unsound and disbonded concrete is completely removed.
  - f. Provide fractured aggregate surfaces with a profile of at least 1/8 inch (3 mm) that are approximately perpendicular or parallel to original concrete surfaces. At columns and walls, make top and bottom surfaces level, unless otherwise directed.
  - g. Thoroughly clean removal areas of loose concrete, dust, and debris.
4. Reinforcing Bar Preparation: Remove loose and flaking rust from reinforcing bars by high-pressure water cleaning **OR** abrasive blast cleaning **OR** needle scaling **OR** wire brushing, **as directed**, until only tightly bonded light rust remains.
  - a. Where section loss of reinforcing bar is more than 25 percent, or 20 percent in 2 or more adjacent bars, cut bars and remove and replace. Remove additional concrete as necessary to provide at least 3/4-inch (19-mm) clearance at existing and replacement bars. Splice replacement bars to existing bars according to ACI 318 (ACI 318M), by lapping, welding, or using mechanical couplings.
5. Preparation of Floor Joints for Repair: Saw-cut joints full width to edges and depth of spalls, but not less than 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**, deep. Clean out debris and loose concrete; vacuum or blow clear with compressed air.
6. Surface Preparation for Corrosion-Inhibiting Treatment: Clean concrete by low-pressure water cleaning **OR** detergent scrubbing **OR** sand blasting, **as directed**, to remove dirt, oils, films, and other materials detrimental to treatment application. Allow surface to dry before applying corrosion-inhibiting treatment.
7. Surface Preparation for Overlays: Remove delaminated material and deteriorated concrete surface material. Roughen surface of concrete by sand blasting **OR** shot blasting **OR** scarifying **OR** needle scaling **OR** high-pressure water jetting **OR** scabbling **OR** flame blasting **OR** milling, **as directed**, to produce a surface profile matching CSP 3 **OR** 4 **OR** 5 **OR** 6 **OR** 7 **OR** 8 **OR** 9, **as directed**, per ICRI 03732. Sweep and vacuum roughened surface to remove debris followed by low-pressure water cleaning.



8. Surface Preparation for Sealers: Clean concrete by shot blasting **OR** low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to sealer application.
9. Surface Preparation for Sealers: Acid etch surface of concrete to produce a surface profile matching CSP 1 per ICRI 03732. Prepare surface for acid etching by detergent scrubbing to remove oils and films that may prevent acid penetration.
  - a. Remove excess acid solution, reaction products, and debris by squeegeeing or vacuuming.
  - b. Scrub surface with an alkaline detergent, rinse, and squeegee or vacuum.
  - c. Check acidity of surface with pH test paper and continue rinsing until pH is acceptable.
  - d. When pH is acceptable and surface is clean, vacuum dry.
10. Surface Preparation for Composite Structural Reinforcement: Remove delaminated material and deteriorated concrete surface material. Clean concrete where reinforcement and epoxy patching mortar is to be applied by low-pressure water cleaning **OR** detergent scrubbing, **as directed**, to remove dirt, oils, films, and other materials detrimental to epoxy application. Roughen surface of concrete by sand blasting.

#### C. Application

1. General: Comply with manufacturer's written instructions and recommendations for application of products, including surface preparation.
2. Epoxy-Modified, Cementitious Bonding and Anticorrosion Agent: Apply to reinforcing bars and concrete by stiff brush or hopper spray according to manufacturer's written instructions. Apply to reinforcing bars in two coats, allowing first coat to dry two to three hours before applying second coat. Allow to dry before placing patching mortar or concrete.
3. Epoxy Bonding Agent: Apply to reinforcing bars and concrete by brush, roller, or spray according to manufacturer's written instructions, leaving no pinholes or other uncoated areas. Apply to reinforcing bars in at least two coats, allowing first coat to dry before applying second coat. Apply patching mortar or concrete while epoxy is still tacky. If epoxy dries, recoat before placing patching mortar or concrete.
4. Latex Bonding Agent, Type II: Mix with portland cement and scrub into concrete surface according to manufacturer's written instructions. Apply patching mortar or concrete while bonding agent is still wet. If bonding agent dries, recoat before placing patching mortar or concrete.
5. Latex Bonding Agent, Type I: Apply to concrete by brush roller or spray. Allow to dry before placing patching mortar or concrete.
6. Mortar Scrub-Coat: Dampen repair area and surrounding concrete 6 inches (150 mm) beyond repair area. Remove standing water and apply scrub-coat with a brush, scrubbing it into surface and thoroughly coating repair area. If scrub-coat dries, recoat before applying patching mortar or concrete.
7. Patching Mortar: Unless otherwise recommended by manufacturer, apply as follows:
  - a. Wet substrate thoroughly and then remove standing water. Scrub a slurry of neat patching mortar mixed with latex bonding agent into substrate, filling pores and voids.
  - b. Place patching mortar by troweling toward edges of patch to force intimate contact with edge surfaces. For large patches, fill edges first and then work toward center, always troweling toward edges of patch. At fully exposed reinforcing bars, force patching mortar to fill space behind bars by compacting with trowel from sides of bars.
  - c. For vertical patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm) **OR** 3 inches (75 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
  - d. For overhead patching, place material in lifts of not more than 1 inch (25 mm) **OR** 1-1/2 inches (38 mm) **OR** 2 inches (50 mm), **as directed**, nor less than 1/8 inch (3 mm) **OR** 1/4 inch (6 mm), **as directed**. Do not feather edge.
  - e. After each lift is placed, consolidate material and screed surface.
  - f. Where multiple lifts are used, score surface of lifts to provide a rough surface for application of subsequent lifts. Allow each lift to reach final set before placing subsequent lifts.



- g. Allow surfaces of lifts that are to remain exposed to become firm and then finish to a smooth **OR** rough, **as directed**, surface with a wood or sponge float **OR** broom or burlap drag, **as directed**.
  - h. Wet-cure cementitious patching materials, including polymer-modified, cementitious patching materials, for not less than seven days by water-fog spray or water-saturated absorptive cover.
- 8. Dry-Pack Mortar: Use for deep cavities and where indicated. Unless otherwise recommended by manufacturer, apply as follows:
  - a. Provide forms where necessary to confine patch to required shape.
  - b. Wet substrate and forms thoroughly and then remove standing water.
  - c. Place dry-pack mortar into cavity by hand, and compact into place with a hardwood drive stick and mallet or hammer. Do not place more material at a time than can be properly compacted. Continue placing and compacting until patch is approximately level with surrounding surface.
  - d. After cavity is filled and patch is compacted, trowel surface to match profile and finish of surrounding concrete. A thin coat of patching mortar may be troweled into the surface of patch to help obtain required finish.
  - e. Wet-cure patch for not less than seven days by water-fog spray or water-saturated absorptive cover.
- 9. Concrete: Place according to Division 03 Section "Cast-in-place Concrete" and as follows:
  - a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
  - b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
  - c. Use vibrators to consolidate concrete as it is placed.
  - d. At unformed surfaces, screed concrete to produce a surface that when finished with patching mortar will match required profile and surrounding concrete.
  - e. Where indicated place concrete by form and pump method.
    - 1) Design and construct forms to resist pumping pressure in addition to weight of wet concrete. Seal joints and seams in forms and junctions of forms with existing concrete.
    - 2) Pump concrete into place, releasing air from forms as concrete is introduced. When formed space is full, close air vents and pressurize to 14 psi (96 kPa).
  - f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
  - g. Fill placement cavities with dry-pack mortar and repair voids with patching mortar. Finish to match surrounding concrete.
- 10. Shotcrete: Place according to Division 03 Section "Shotcrete" and as follows:
  - a. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
  - b. Apply latex bonding agent **OR** Type I, latex bonding agent **OR** mortar scrub-coat, **as directed**, to concrete substrate.
  - c. Screed and finish shotcrete to produce a surface matching required profile and surrounding concrete.
- 11. Grouted Preplaced Aggregate Concrete: Use for column and wall repairs **OR** where indicated, **as directed**. Place as follows:
  - a. Design and construct forms to resist pumping pressure in addition to weight of wet grout. Seal joints and seams in forms and junctions of forms with existing concrete.
  - b. Apply epoxy-modified, cementitious bonding and anticorrosion agent **OR** epoxy bonding agent, **as directed**, to reinforcement and concrete substrate.
  - c. Place aggregate in forms, consolidating aggregate as it is placed. Pack aggregate into upper areas of forms to achieve intimate contact with concrete surfaces.
  - d. Fill forms with water to thoroughly dampen aggregate and substrates. Drain water from forms before placing grout.



- e. Pump grout into place at bottom of preplaced aggregate, forcing grout upward. Release air from forms at top as grout is introduced. When formed space is full and grout flows from air vents, close vents and pressurize to 14 psi (96 kPa).
- f. Wet-cure concrete for not less than seven days by leaving forms in place or keeping surfaces continuously wet by water-fog spray or water-saturated absorptive cover.
- g. Repair voids with patching mortar and finish to match surrounding concrete.
- 12. Joint Filler: Install in nonmoving floor joints where indicated.
  - a. Install filler to a depth of at least 3/4 inch (19 mm) **OR** 1 inch (25 mm) **OR** 2 inches (50 mm), **as directed**. Use fine silica sand no more than 1/4 inch (6 mm) deep to close base of joint. Do not use sealant backer rods or compressible fillers below joint filler.
  - b. Install filler so that when cured, it is flush at top surface of adjacent concrete. If necessary, overfill joint and remove excess when filler has cured.
- 13. Epoxy Crack Injection: Comply with manufacturer's written instructions and the following:
  - a. Clean areas to receive capping adhesive of oil, dirt, and other substances that would interfere with bond, and clean cracks with oil-free compressed air or low-pressure water to remove loose particles.
  - b. Place injection ports as recommended by epoxy manufacturer, spacing no farther apart than thickness of member being injected. Seal injection ports in place with capping adhesive.
  - c. Seal cracks at exposed surfaces with a ribbon of capping adhesive at least 1/4 inch (6 mm) thick by 1 inch (25 mm) wider than crack.
  - d. Inject cracks wider than 0.003 inch (0.075 mm) to a depth of 8 inches (200 mm) or to a width of less than 0.003 inch (0.075 mm), whichever is less.
  - e. Inject epoxy adhesive, beginning at widest part of crack and working toward narrower parts. Inject adhesive into ports to refusal, capping adjacent ports when they extrude epoxy. Cap injected ports and inject through adjacent ports until crack is filled.
  - f. After epoxy adhesive has set, remove injection ports and grind surfaces smooth.
- 14. Corrosion-Inhibiting Treatment: Apply by brush, roller, or airless spray in two coats at manufacturer's recommended application rate. Remove film of excess treatment by high-pressure washing before patching treated concrete or applying a sealer or overlay.
- 15. Polymer Overlay: Apply according to ACI 503.3.
  - a. Apply to traffic-bearing surfaces, including parking areas and walks.
- 16. Polymer Sealer: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
  - a. Apply to traffic-bearing surfaces, including parking areas and walks.
- 17. Methylmethacrylate Sealer/Brighteners: Apply by brush, roller, or airless spray at manufacturer's recommended application rate.
  - a. Apply to exterior concrete surfaces that are exposed to view, excluding traffic-bearing surfaces.
- 18. Composite Structural Reinforcement Using Preimpregnated Fiber Sheet: Unless otherwise recommended by manufacturer, apply as follows:
  - a. Patch surface defects with epoxy mortar and allow to set before beginning reinforcement application.
  - b. Apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm) to prepared concrete surfaces in areas where composite structural reinforcement will be applied.
  - c. Clean preimpregnated fiber sheet with acetone or other suitable solvent, and apply epoxy adhesive to a thickness of 1/16 inch (1.6 mm).
  - d. Apply adhesive-coated fiber sheet to adhesive-coated concrete within open time of epoxy adhesive, and roll with a hard rubber roller until fiber sheet is fully embedded in adhesive, air pockets are removed, and adhesive is forced out from beneath fiber sheet at edges.
  - e. Apply additional layers as indicated using same procedure.
- 19. Composite Structural Reinforcement Using Fiber Tow Sheet and Saturant: Unless otherwise recommended by manufacturer, apply as follows:
  - a. Apply epoxy primer using brush or short nap roller to prepared concrete surfaces in areas where composite structural reinforcement will be applied.



- b. After primer has set, patch surface defects with epoxy filler and allow to set before beginning reinforcement application.
- c. Apply epoxy saturant to fiber tow sheet or primed and patched surface with 3/8-inch- (10-mm-) nap roller. Apply fiber tow sheet to primed and patched surface while saturant is still wet, using pressure roller to remove air pockets. Remove paper backing from fiber tow sheet and apply additional epoxy as needed to fully saturate tow sheet.
- d. Apply additional layers as indicated, fully saturating each with epoxy.
- e. After saturant has cured, apply protective topcoat by brush, roller or spray.

D. Field Quality Control

- 1. Testing Agency: Engage a qualified testing agency to sample materials and perform tests as follows:
  - a. Patching Mortar, Packaged Mixes: **<Insert number>** randomly selected samples tested according to ASTM C 928.
  - b. Patching Mortar, Field Mixed: **<Insert number>** randomly selected samples tested for compressive strength according to ASTM C 109/C 109M.
  - c. Concrete: As specified in Division 03 Section "Cast-in-place Concrete".
  - d. Shotcrete: As specified in Division 03 Section "Shotcrete".
  - e. Grouted Preplaced Aggregate: Tested for compressive strength of grout according to ASTM C 942.
    - 1) Testing Frequency: One sample for each 25 cu. yd. (19 cu. m) of grout or fraction thereof, but not less than one sample for each day's work.
  - f. Joint Filler: Core drilled samples to verify proper installation.
    - 1) Testing Frequency: One sample for each 100 feet (30 m) of joint filled.
    - 2) Where samples are taken, fill holes with joint filler.
  - g. Epoxy Crack Injection: Core drilled samples to verify proper installation.
    - 1) Testing Frequency: 3 samples from mockup and 1 sample for each 100 feet (30 m) of crack injected.
    - 2) Where samples are taken, fill holes with epoxy mortar.

END OF SECTION 03920



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Task	Specification	Specification Description
03920	01204	No Specification Required

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Task	Specification(s)
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01352	01204
01510	01510
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01590	01204
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02011	02011
02102	02102
02112	02112, 02112a, 01720
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