

DIVISION 02
SITE WORK

SECTION 02015

TEST PITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work of this Section includes the excavation of test pits where necessary to locate or examine utilities, subsurface structures, pipes, soils, groundwater, or any other obstacles or conditions.
- B. This work shall consist of the satisfactory removal of all materials including, but not limited to, sawcutting pavements, pavement removal, excavation, shoring and bracing, water removal from within pit, stockpiling, satisfactory disposal of surplus or unsuitable material, backfilling, compacting, pavement repair, etc.
- C. Test pits shall be dug as necessary for the Contractor to determine subsurface conditions as indicated on the Contract Drawings or as directed by the Owner's Representative.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials used for reconstruction of test pits shall be approved by the Owner's Representative.
- B. Unless otherwise shown or directed, replace excavated materials with equal or better materials.
- C. Unsuitable materials, as determined by the Owner's Representative shall be replaced with compacted granular fill.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate excavation of test pits with respective utility company, Town of Montville, or other owners having facilities in the vicinity. Check with "Call Before You Dig", 1/800/922-4455 before digging.
- B. Give sufficient notice and allow ample delay time for others to perform necessary work.

- C. Notify the Owner's Representative one-week in advance of digging each test pit.

3.2 CONSTRUCTION METHODS

- A. Perform all work in conformance with applicable safety codes.
- B. Sawcut pavement, curbs or other hard surface materials in neat and straight line. Excavate pits providing clean-cut vertical sides. Provide sheeting, bracing and dewatering wherever necessary.
- C. Dig test pits so as to ensure that underground utilities or structures are not damaged. It shall be the Contractor's sole responsibility for any damages incurred during excavation operations. Any damages shall be repaired or replaced by the Contractor to the satisfaction of the Owner/Responsible Agency/Owner's Representative at the Contractor's own expense.
- D. The Contractor shall measure and record the size, configuration, exact horizontal and vertical location of all utilities, pipes or other obstacles uncovered in the pits. Submit information in written or sketch form to the Owner's Representative and respective utility companies for review. Notify the Owner's Representative of any revealed conflicts which may require design revisions, relocations and/or adjustments as early as possible to avoid unnecessary delays. No work shall be started within areas of conflict until so authorized.
- E. Protect each pit with steel plates, other coverings, fences, barriers or other appropriate materials as deemed necessary.
- F. Do not backfill pits until authorized. Compact backfill materials to at least 95% of maximum density to the subgrade elevation or as otherwise directed.
- G. The surface of test pit areas shall be restored to a condition equal or better than original as approved by the Owner's Representative.

END OF SECTION

SECTION 02060
SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included: Perform selective demolition in accordance with the Contract Documents. The Work of this Section shall include but not be limited to the following:
 - 1. Selective demolition as required to accommodate new construction and as indicated; including in the Contract Drawings

1.2 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.

1.3 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, reinstalled, or otherwise indicated to remain the Owner's property, demolished materials shall become the contractor's property and shall be removed from the site, and disposed of in a legal.

1.4 SUBMITTALS

- A. Proposed schedule of operations, coordination for shutoff, capping, and continuation of utility services as required.
 - 1. Provide a detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
 - 2. Include proposed methods for both dust and noise control measures.
- B. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.

1.5 QUALITY ASSURANCE

- A. General: Engage an experienced firm that has successfully completed selective demolition Work similar to that indicated for this Project.

- B. Regulatory Requirements: comply with governing EPA notification regulations before starting selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
 - 1. All Demolition work shall comply with requirements of the building code of local governing authority having jurisdiction.
- C. The Contractor shall verify the location of all buried structures and remove same to the extent indicated and as required to complete all work under the contract.
- D. Contractor shall verify all conditions at site prior to the start of work.
- E. Contractor shall obtain all necessary permits required for the selective demolition of portions of the existing structures, prior to the commencement of any demolition work.
- F. Notify appropriate agencies of any hazardous materials found at the site. Do not proceed with removal of said substances until so instructed.
- G. Property adjacent to the Project Limit Line shall remain undisturbed and shall be protected by the Contractor.
- H. Coordinate selective demolition work with site earthwork operation.

1.6 JOB CONDITIONS

- A. Occupancy: Adjacent property Owners will occupy portions of the buildings immediately adjacent to areas of selective demolition. Conduct selective demolition work in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of demolition activities that will affect Owner's normal operations
 - 1. Condition of Structures: Owner assumes no responsibility for actual condition of structures to be demolished.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner insofar as practicable. However, variations within structure may occur by Owner's removal and salvage operations prior to start of demolition work.
- C. Items indicated to be removed but of salvageable value to contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed.
 - 1. Storage or sale of removed items will not be permitted on site.
- D. Explosives: Use of explosives will not be permitted.
- E. Traffic: conduct selective demolition operations and removal of debris to ensure minimum interference with roads, streets, walks and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other occupied or used facilities without permission from authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

- F. Protections: Ensure safe passage of persons around area of demolition. Conduct operation to prevent damage to adjacent buildings, structures and other facilities and injury to persons.
 - 1. Provide shoring, bracing or support to prevent movement, settlement, or collapse of structures to be demolished and adjacent facilities to remain.
- G. Damages: Promptly repair damages caused to adjacent facilities by demolition operations.
- H. Flame cutting: do not use cutting torches for removal of material to be salvaged. Do not use cutting torches for removal until work area is cleared of flammable materials. Maintain portable fire suppression devices during flame-cutting operations.
- I. Utility Services: Maintain existing utilities indicated to stay in service and protect against damage during demolition operations.
- J. Environmental Controls: Use temporary enclosures, water sprinkling, and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.
 - 1. Do not use water when it may create hazardous or objectionable conditions such as damage to finishes, flooding, and pollution.

PART 2 - PRODUCTS

2.1 REPAIR MATERIALS

- A. Use repair materials identical to existing materials.
 - 1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible; subject to the approval of the Owner's Representative.
 - 2. Use materials whose installed performance equals or surpasses that of existing materials. Contractor to submit supporting technical data as required for each material.
- B. 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. General: Prior to commencement of selective demolition operations, verify that existing utilities have been located, identified, disconnected and capped.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

- C. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- D. When unanticipated mechanical, electrical or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the Owner's Representative.
- E. Perform survey as the Work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

- A. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
 - 1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
 - a. Provide not less than 72 hours notice to Owner if shutdown of service is required during changeover.
- B. Utility Requirements: Refer to other Sections of the Specification for shutting off, disconnecting, removing, and sealing or capping utility services. Do not start selective demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.3 PREPARATION

- A. General: provide shoring, bracing, or support to prevent movement, settlement, or collapse of areas to be demolished and adjacent facilities to remain.
 - 1. Cease operations and notify Owner's Representative immediately if safety of structure appears to be endangered. Take precautions to support structure until determination is made for continuing operations. Maintain shoring and bracing throughout the term of this contract.
 - 2. Locate, identify, stub off and disconnect utility services that are not indicated to remain.
 - a. Provide bypass connections as necessary to maintain continuity of service to designated area of building. Provide minimum of 72 hours advance notice to Owner if shutdown of service is necessary during changeover.

3.4 SELECTIVE DEMOLITION

- A. Pollution Controls: Use water sprinkling, temporary enclosures and other suitable methods to limit dust and dirt rising and scattering in air. Comply with governing regulations pertaining to environmental protection.
 - 1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding and pollution.

- B. Clean adjacent structures and improvements of dust, dirt and debris caused by demolition operations. Return adjacent areas to condition existing prior to start of work.
- C. Demolition General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
 - 1. Proceed with selective demolition systematically, from higher to lower level, and in coordination with the overall project schedule. Complete selective demolition work above each tier before disturbing supporting members on lower levels.
 - 2. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
 - 3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 - 4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
 - 5. Maintain adequate ventilation when using cutting torches.
 - 6. Remove decayed, vermin-infested or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
 - 7. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
 - 8. Dispose of demolished items and materials promptly. On-site storage or sale or removed items is prohibited.
 - 9. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.
- D. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain, using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- E. If unanticipated mechanical electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to the Owner's Representative in written, accurate details. Pending receipt of directive from the Owner's Representative, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

3.5 CONCRETE PLACEMENT

- A. General: Remove daily from site accumulated debris, rubbish, and other materials resulting from demolition operations.
 - 1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws and ordinances concerning removal, handling and protection against exposure or environmental pollution.

- B. Removal: Transport materials removed from demolished structures and legally dispose off site.

3.6 CLEANUP AND REPAIR

- A. General: upon completion of demolition work, remove tools, equipment and demolished materials from site.
 - 1. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain to condition existing prior to start operations. Repair adjacent construction or surfaces soiled or damaged by demolition work.
 - 2. Clean adjacent areas, of all dust, dirt and debris caused by selective demolition, cutting, and patching operations. Daily and final clean up shall be satisfactory to the Owner's Representative.

END OF SECTION

SECTION 02100
SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. A. Work Included: This Section generally includes site clearing as indicated on drawings, including excavation and backfilling for the following:
1. Protection of existing trees.
 2. Removal of trees and other vegetation.
 3. Topsoil stripping.
 4. Clearing and grubbing.
 5. Removing above-grade improvements.
 6. Removing below-grade improvements.

1.2 PROJECT CONDITIONS

- A. Traffic: Conduct site clearing to ensure minimum interference with roads, streets, walks, and other adjacent properties. Do not close or obstruct streets, or other occupied without permission from authorities having jurisdiction.
- B. Protection of Existing Improvements: Provide protection necessary to prevent damage to existing improvements indicated to remain.
1. Protect improvements on adjoining properties and on Town property.
 2. Restore damaged improvements to their original condition, as acceptable to property owners.
- C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain, against unnecessary cutting, damage or smothering of trees by stockpiling within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation.
1. Water trees and other vegetation to remain within limits of contract work to maintain their health during construction.
 2. Protect roots over 1-1/2 inch diameter that are cut during construction. Coat cut faces with an emulsified asphalt, or other acceptable coating. Temporarily cover exposed roots with wet burlap to prevent roots from drying out; cover with earth as soon as possible.
 3. Repair or replace trees and vegetation indicated to remain which are damaged by construction operations, in a manner acceptable to the Town. Employ a licensed arborist to repair damages to trees and shrubs.
 4. Replace trees which cannot be repaired and restored to full growth status, as determined by the arborist.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SITE CLEARING

- A. General: Remove trees, shrubs, grass and other vegetation, improvements or obstructions as required to permit installation of new construction. "Removal" includes digging out and off-site disposing of stumps and roots.
 - 1. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct new construction.
- B. Topsoil: Topsoil is defined as friable organic clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over 2 inches in diameter, and without weeds, roots, and other objectionable material.
 - 1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
 - a. Remove heady growths of grass from areas before stripping.
 - b. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to protect root system.
 - 2. Stockpile topsoil in storage piles in areas indicated or directed. Construct storage piles to provide free drainage of surface water. Cover storage piles, if required, to prevent wind erosion.
 - 3. Dispose of unsuitable or excess topsoil same as specified for disposal of waste material.
- C. Clearing and Grubbing: Clear site of trees, shrubs and other vegetation, except for those indicated to be left standing.
 - 1. Completely remove stumps, roots, and other debris protruding through ground surface.
 - 2. Use only hand methods for grubbing inside drip line of trees indicated to remain.
 - 3. Fill depressions caused by clearing and grubbing with satisfactory soil, unless further earthwork is indicated.
 - a. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.
- D. Removal of Improvements: Remove existing above-grade and below-grade improvements as necessary for new construction.

3.2 DISPOSAL OF WASTE MATERIALS

- A. Removal: Transport non-combustible waste materials and unsuitable topsoil materials to designated State approved landfill site and dispose of legally.

END OF SECTION

SECTION 02118

SAW CUT EXISTING PAVEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work of this Section shall consist of saw cutting existing bituminous, concrete pavement and concrete retaining walls or other encountered pavements, as well as curbs, etc., as necessary for installation of the proposed work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. All pavement to be removed shall be cut uniformly along lines as shown on the Contract Drawings or as directed.
- B. Concrete pavements and/or bases shall be cut with an approved concrete saw through a minimum of one third of the depth of the pavement or base. The remaining depth may be removed carefully by approved methods.
- C. Bituminous pavements/base shall be saw cut or other methods if straight edge can be attained.
- D. Bituminous curbs shall be cut at the designated lines. Stones or concrete curbs shall be removed to the nearest joint or saw cut as directed.

END OF SECTION

SECTION 02150
SHEETING AND STAYBRACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The Contractor shall install sheeting or staybracing as necessary in order to comply with the applicable Safety Code; to accommodate traffic; to permit access to adjacent occupied properties; to protect adjacent buildings, pavements, structures, and all existing utilities; to provide an opening of proper depth and width in which to install the proposed pipes and other underground structures, and to protect his workmen, employees of the Town and Engineer, and the public, from death or injury from bank failure, earth collapse or earth movement of any nature whatsoever. In general, all trenches and excavations over 5 feet in depth shall be protected against the hazard of collapse.
- B. The Contractor shall be entirely and solely responsible for the adequacy and sufficiency of all supports and of all sheeting, bracing, shoring, underpinning, cofferdamming, etc. The Contractor shall assume the entire and sole responsibility for damages from injury to persons or damage to adjacent pavements and public and private property (including but not limited to, the work under construction, existing buildings, facilities, etc.) which injury or damage results directly from the Contractor's failure to install or to leave in place adequate and sufficient supports, sheeting, bracing, underpinning, cofferdamming, etc.
- C. The Contractor shall submit his proposed sheeting and/or shoring plans to the Engineer and to any others as required by law or as elsewhere specified prior to the installation of any sheeting and/or shoring. These plans should include, but not be limited to, the type of sheeting or shoring, sizes and dimensions, bracing, spacing, methods of installation and removal, etc.
- D. All sheeting shall be designed and sealed by a Professional Engineer licensed to practice in the State of Connecticut. He shall be known as the Contractor's Engineer.
- E. Sheeting, shoring, or other timbering may be left-in-place at the option of the Contractor when needed to protect other existing facilities or the work constructed or to be constructed under this Contract, unless shown/indicated on the Contract Plans to be removed.
- F. It is expressly understood and agreed that removing or leaving-in-place any sheeting or shoring, etc. as described above, shall not relieve the Contractor from any responsibility for any loss or damage due to omission of or failure of the sheeting, etc., failure to leave it in place, or the settling of the backfill, or any movement of the ground or any structure or object adjacent to any trench or excavation made by the Contractor. The Engineer will not order any sheeting, etc. left-in-place at the expense of the Owner in order to accommodate the convenience of the Contractor or to save him the cost of its removal.

- G. The Contractor may, with the approval of the Engineer, lay back slopes in accordance with the provisions of the applicable Safety Code in order to avoid the necessity for sheeting or limiting the quantity thereof. However, in the case of trenches, the toe of this slope will not be lower than one foot above the top of the pipe to be installed. A level bench of at least two (2) feet in width shall be maintained between the toe of the sloped section and vertical trench excavation for pipes with an outside diameter of six (6) feet or less. Where sloping is used as a substitute for sheeting or staybracing, or used in combination therewith, it shall be sloped a minimum of one horizontal to one vertical except where instability of the material requires a slope flatter than one to one.
- H. There shall be no obligation on the part of the Engineer to issue orders for sheeting, staybracing, or sheeting left-in-place and/or to pass upon sufficiency and adequacy of sheeting; nor shall the failure on the part of the Engineer to give such orders relieve the Contractor from liability for damages from injury to persons or damage to property occurring from or upon the work and occasioned by negligence, or otherwise growing out of the Contractor's failure to either install sufficient and adequate sheeting and/or staybracing or to leave in place in the excavation sufficient and adequate support to prevent the caving in or moving of the ground adjacent to the sides of the excavation during and after the backfilling operation.

1.3 SUBMITTALS

- A. Layout drawings for sheeting and staybracing and other related data prepared by the Contractor's Engineer. System design, locations and calculations shall be prepared in a manner and form acceptable to the Owner's Representative, the Engineer and local authorities having jurisdiction.

1.4 QUALITY ASSURANCE

- A. Engineer Qualifications: The Contractor's Engineer shall be authorized to practice in the State of Connecticut and shall be experienced in providing successful engineering services for sheeting and staybracing systems similar in extent required for this project.
- B. Supervision: Engage and assign supervision of sheeting and staybracing system to a qualified professional engineer foundation consultant.
- C. Regulations: Comply with codes and ordinances of governing authorities having jurisdiction.

1.5 JOB CONDITIONS

- A. Before starting work, verify governing dimensions and elevations. Verify condition of adjoining properties. Take photographs to record any existing settlement or cracking of structures, pavements, and other improvements. Prepare a list of such damages, verified by dated photographs, and signed by Contractor and other conducting investigation.
- B. Survey adjacent structures and improvements, employing a professional land surveyor, registered in the State of Connecticut, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

- C. During excavation, re-survey benchmarks weekly, maintaining accurate log of surveyed elevations for comparison with original elevations. Promptly notify the Owner's Representative if changes in elevations occur or if cracks, sags, or other damage is evident.

1.6 EXISTING UTILITIES

- A. Protect existing active sewer, water, gas, electric and other utility services and structures.
- B. Notify municipal agencies and service utility companies having jurisdiction. Comply with requirements of governing authorities and agencies for protection, relocation, removal, and disconnecting of services.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide adequate shoring and bracing materials which will support loads imposed. Materials need not to be new, but should be in serviceable condition.
- B. Structural Steel: ASTM A 36.
- C. Steel Sheet Piles: ASTM A 328.
- D. Timber Lagging: Any species, rough-cut, mixed hardwood, nominal 3 inches thick, unless otherwise indicated.
- E. Steel Pipe: ASTM A501.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Trench shields shall not be used unless requested by the Contractor and authorized by the Engineer. If authorized, they shall be used only when the protection of only workmen is involved, not for support for existing adjacent utilities, structures, embankments, etc. A trench protected by the use of a trench shield shall not be considered a sheeted trench.
- B. Unless expressly authorized by the Engineer, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting to facilitate driving, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside of the sheeting.
- C. All sheeting and staybracing shall be securely installed and properly braced in accordance with the applicable Safety Code.
- D. The depth of pilot cuts for trenches or structures shall not exceed five (5) feet in depth at any time. The Engineer may reduce the depth of the pilot cut should the soil and subsurface conditions

warrant such action. Sheet piling must be driven by drop hammer or other methods approved in by the Engineer below the area of the pilot cut. Driving of sheet piling above the pilot cut is subject to the directions of the Engineer. The Engineer may direct the Contractor to use other types of equipment, and to revise the procedure during the excavation of the pilot cut and the driving of the sheet piling should it be found necessary to do so.

- E. Vibratory driving hammers shall not be used unless specifically authorized by the Engineer.
- F. Where wooden sheet piling cannot be driven due to the nature of the material, then steel sheet piling may be driven and removed in lieu of wooden sheet piling providing the following procedures are followed:
 - 1. Backfilling of sheeted trenches or areas shall proceed by one of the following two (2) methods:
 - a. Simultaneously with the withdrawal of sheet piling and as each layer is compacted in accordance with Section "Trench Excavation, Backfilling and Compaction"; or
 - b. The trench/area will be backfilled to the surface. If the sheet piling is to be withdrawn, backfilling will proceed up to each set of rangers and braces; the rangers and braces will be removed; the backfilling will proceed up to the next set of rangers and braces, etc. - up to the top of the excavation. The backfill material shall be compacted to 98% of the maximum dry density as determined by AASHTO T 99, Method C. Alternate sections of sheet piling from the left side and right side of the trench/area shall be removed and the cavity remaining therefrom shall be jetted thoroughly by high pressure water, starting at the toe of the sheet piling and being drawn to the surface. Sand shall be inserted with the jetting process.
- G. Where the bottom of the excavation is not free draining material (some areas of organic material or miscellaneous fill) or where granular backfill is not available or ordered by the Engineer, the jetting shall be very carefully done with a minimum amount of water being expended. In such locations, the Contractor may request the approval of the Engineer for other compaction methods in the sheet piling cavity.
- H. The Contractor shall remove the sheet piling and/or staybracing from the excavation except where it is specifically indicated on the Contract Drawings "To Be Left-In-Place" or the Contractor may elect to leave the sheet piling and/or staybracing in place for his own convenience or to serve his own to protect existing facilities, the work constructed or to be constructed under this Contract, or for the safety of the public, etc., at no cost to the Owner. No sheet piling or bracing which is within three (3) feet of the existing or proposed finished grade may be left-in-place without the prior permission of the Engineer. This may require that the Contractor cut off sheet piling at this elevation at no additional cost to the Owner.
- I. Where sheet piling, regardless of the type of sheet piling used, is left in place, as specified or ordered or at the Contractor's convenience option, unless otherwise specifically permitted in writing by the Engineer, all elements such as rangers, braces, wales, etc. shall be left in place except as specified hereinbefore; and, except such temporary braces required to be removed to make way for the structure or utility. Where it is necessary to remove such temporary braces, the sheet piling shall be rebraced but in no case shall sheet piling be braced against the sides of the structure or utility to be constructed unless approved in writing by the Owner of the structure or utility. Where lagging and "soldier" beams are used, the "soldier" beams and all the braces shall also be left in place.

- J. Where wood sheeting has been driven below the excavation bottom to provide for a "toe-in", no wood sheeting below the top of pipe or structure shall be removed but cut off at this elevation and the remaining sheeting above this line removed as described herein.
- K. Sheeting shall be cut away and removed from in front of capped outlets or other branches or inlets set in the pipe for future connections.
- L. All sheeting, shoring, and bracing removed shall be carefully removed from the excavation in such a manner as not to endanger the completed work or any adjacent pavements, buildings, structures, utilities, property, etc. The sheeting shall be withdrawn to such an extent that it is just above the backfill material being compacted and all voids left or caused by the withdrawal of such sheeting, shall be immediately refilled with approved material and compacted at no additional cost to the Owner.
- M. Where the excavation is to be left open during non-working hours, the sheeting shall extend 42 inches above the open excavation.

END OF SECTION

SECTION 02205
DUST CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work of this Section consists of furnishing water equipment, water and/or calcium chloride for allaying dust conditions on the site. The Contractor shall furnish a pickup sweeper and accessory equipment and utilize it for the removal of earth and/or other dust producing materials from paved surfaces for the purpose of allaying dust conditions on the site. This work shall be done as directed by the Owner's Representative, at least once a week, and shall meet the referenced portions of "Form 818".

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Calcium Chloride: Articles 9.42.02 and 9.42.03 of "Form 818".
- B. Water: Article 9.43.03 of "Form 818".
- C. Water Equipment: Article 9.40.3 of "Form 818".
- D. Sweeping for Dust Control: Article 9.39.03 of "Form 818".

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Should the Contractor, after notice from the Owner's Representative, fail to provide Dust Control on the site, the Owner immediately and without further notice, may furnish dust control equipment/sweepers as necessary to rectify the situation. The cost of such shall be borne by the Contractor and may be deducted from any amounts due the Contractor.

END OF SECTION

SECTION 02215
PAVEMENT REMOVAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplemental Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The work under this Section shall consist of the satisfactory removal of all bituminous concrete and concrete pavements and/or bases which are not removed or to be removed under other Sections of work, the removal of which is required for trench, structure or test pit excavation and as directed by the Owner's Representative. "Pavement Removal" will not be classified by type or depth unless otherwise shown in the Bid Proposal. Work under this Section shall include the satisfactory removal and disposal of all temporary pavements subsequent to completion of final paving.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. All pavement and/or base to be removed under this Section shall be neatly removed within the limits shown on the Contract Drawings or as directed by the Owner's Representative. Care shall be exercised by the Contractor during breaking and removal of the pavement and base in order that the adjacent pavement and/or base outside the area of removal will not be damaged. Saw cut the perimeter of the area to be excavated prior to any removals.
- B. All excavated pavement and/or base shall be disposed of and removed from the site by the Contractor at a disposal area supplied by the Contractor at no additional cost to the Owner.
- C. No section or pieces of pavement and/or base shall be used for trench backfill and all such material shall be kept separate from other excavated materials.

END OF SECTION

SECTION NUMBER 02220

EXCAVATION BACKFILLING AND COMPACTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Documents, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.
- B. The requirements of Appendix 1 — "Geotechnical Investigation Proposed Headworks Building and Grit Chamber, Waste Water Treatment Plant Town of Montville, Connecticut" dated May 2012 apply to this Section of the Specifications.

1.2 SUMMARY

- A. Without limitations, the work of this Section includes the following:
 - 1. General site excavation for all improvements including pavement removal.
 - 2. Removal and satisfactory off-site disposal of unsuitable materials, excess materials or designated items.
 - 3. Rough grading.
 - 4. Backfill and compaction.
 - 5. Testing of materials to be used.
 - 6. Dewatering excavations.
- B. Classification: All excavations shall be "Unclassified", defined as removal of all materials regardless of its nature including rock and unsuitable material excavation. Excavation of rock or unsuitable material beyond the required contract limits, as authorized by the Owner's Representative, shall be "Classified" and costs are to be determined in accordance with provisions outlined in Division 1.
 - 1. Rock excavation shall include rock in definite ledge formation and boulders, or portions of boulders, three (3) cubic yards, or more, in volume.
 - 2. Unsuitable Material Excavation: Defined as any material, containing vegetation or organic matter, such as muck, peat, organic silt, sod, loose to very dense, brown to dark brown silty sand with gravel, trace brick, cobbles, asphalt and coal, or any other encountered material considered by the Engineer as having unsuitable in-site bearing properties (clay). All encountered unsuitable materials shall be removed and disposed of legally off the project, unless otherwise directed.
 - 3. Common Fill: Mineral soil, free of clay, organic soil, deleterious material, and particles larger than 10 in. in size, which can be spread and compacted.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:

1. AASHTO: Refers by number, letter, or both, to the latest specification or test method of the American Association of State Highway and Transportation Officials.
 2. ASTM: Refers by numbers, letter, or both, to the latest specification or test method of the American Society for Testing and Materials.
 3. References to "Form 818" mean the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2018", including the supplemental specifications.
- B. Field Quality Control: Compaction testing will be done by the Contractor.
- C. Testing Laboratory: The Contractor shall be responsible for compaction tests required under this Section.

1.4 SUBMITTALS

- A. The Contractor shall submit test reports and gradation analyses of all materials to be used which are from off-site and on-site sources to the Owner's Representative for approval.
- B. The Contractor shall submit compaction test reports as required under Section 3.10C and 3.10D to the Owner's Representative for approval.

1.5 PROTECTION

- A. Protect existing structures, fences, pavement, curb, etc.
- B. Protect above and below grade utilities which are to remain.
- C. Protect excavations by shoring, bracing, sheet piling, or other methods required to prevent cave-in or loose soil from falling into excavation.
- D. Notify the Owner's Representative of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- E. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- F. Grade excavation top perimeter to prevent surface water runoff into excavation.
- G. Repair damage at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill below the proposed pavement subbase elevation shall be compacted granular fill. Common fill material may be used for raising grades below pavement sections and in landscaped areas.
- B. Required fill under or around the various required site elements shall be compacted granular fill unless otherwise shown or directed (comply with Section 02234).

- C. Where unsuitable material is excavated and removed, backfill and/or refill shall be compacted granular fill meeting requirements of Section 02234.

2.2 ACCESSORIES

- A. 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 given in Section 2.2.C.
- B. Detectable Warning Tape: Acid and alkali resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of 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 given in Section 2.2.C.
- C. Underground Utility Warning Tape Color Codes:
 - 1. Red: Electric.
 - 2. Yellow: Gas, oil, steam, and dangerous materials.
 - 3. Green: Storm and sanitary sewers and drainage systems, including force mains.
 - 4. Blue: Water.
 - 5. Orange: Communication lines or cables.
- D. Filter Fabric: Mirafi Construction Products 140N, ConTech C26NW, SI Geosolutions Geotex 401 or approved equivalent.

PART 3 - EXECUTION

3.1 GENERAL

- A. Without limitations, comply with Sections of "Form 818" and as modified herein.
 - 1. Roadway Excavation, Formation of Embankment, Disposal of Surplus Materials and Channel Excavation Section 2.02.03
 - 2. Structure Excavation Section 2.03.03
 - 3. Ditch Excavation Section 2.06.03

3.2 PREPARATION

- A. Verify existing conditions and required lines, levels, contours and datum.
- B. Stake and flag existing, known above and below-ground utilities.
- C. Coordinate with respective utility companies or others doing work in the vicinity.
- D. Upon discovery of unknown utility or concealed conditions, discontinue affected work, notify the Owner's Representative.

3.3 PAVEMENT AND CURB REMOVAL

- A. The work for pavement removal shall consist of satisfactory removal of all existing bituminous, concrete or other pavements to the limits designated on the Drawings or directed as well as curbs, etc. as necessary for installation of the proposed work.
- B. All pavements to be removed shall be cut uniformly along the required lines. Concrete pavement or bases shall be cut with an approved concrete saw through a minimum of one-third of the pavement or base depth. The remainder may be removed by other methods. Bituminous pavements or bases may be cut with a saw, pneumatic spade edger or other method if straight edge can be attained.
- C. Concrete curbs shall be cut or removed to the nearest joint. Bituminous curbs shall be saw cut.
- D. Care shall be exercised during breaking and removal of the pavements and curbs in order that adjacent areas outside the curb lines will not be damaged.

3.4 GENERAL EXCAVATION

- A. Excavate all material required for proposed structures, pavement, mechanical, electrical and other work as indicated on the Drawings.
- B. Excavate to the working elevations indicated. Allow ample room for forming, inspection and other required work.
- C. Excavation shall not interfere with normal 33 degree bearing of any foundation.
- D. Temporary excavations above groundwater level shall have side slopes no steeper than 1.5H: 1 V.
- E. All excavations shall be performed in accordance with current OSHA regulations. Conformance to OSHA requirements is the sole responsibility of the contractor.
- F. Hand trim excavations and leave free of loose matter.
- G. Remove lumped subsoil boulders, loose rock and other debris from excavation.
- H. Correct unauthorized excavations at no cost to the Owner.
- I. Fill over-excavated areas or unsuitable material excavations with compacted granular fill as directed by the Owner's Representative.
- J. Remove excess excavated material from site for disposal in accordance with Section 02220 1.2 B.2.

3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures:
3. Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

3.6 ROCK EXCAVATION

- A. Construction methods, comply with Article 2.02.03 of "Form 818" and as amended or required herein.
 1. Rock excavation shall include the excavation, removal and disposal of all boulders and detached rock fragments 3 cubic yard or more in volume and all ledge rock, the removal of which, in the opinion of the Owner's Representative, can be accomplished only by drilling and splitting mechanically or by hand or by blasting. Boulders of less than 3 cubic yard in volume and all soft or disintegrated rock which can be removed without the manipulation noted above, shall be classified as "earth excavation".

3.7 UNSUITABLE MATERIAL EXCAVATION AND BACKFILL

- A. Excavate unsuitable materials to required limits as shown on the Drawings or as directed by the Owner's Representative. Backfill with compacted granular fill.

3.8 BACKFILLING AND EMBANKMENT

- A. Compacted granular fill used as structural fill below and adjacent to structures shall be placed in accordance with the requirements of Appendix 1 — "Geotechnical Investigation Proposed Headworks Building and Grit Chamber, Waste Water Treatment Plant Town of Montville, Connecticut" dated May 2012.
- B. Backfill systematically, as early as possible. Use unfrozen materials. Do not backfill over porous, wet spongy or frozen subgrade surfaces.
- C. Place compacted granular fill in continuous layers not exceeding nine (9) inches. Depths indicated refer to loose material measure.
- D. Use placement method that will not disturb or damage adjacent structures, utilities or other work.
- E. Maintain optimum moisture content of backfill materials to attain required compaction densities.
- F. Backfill uniformly against support foundation walls or structures. Backfill simultaneously on each side of unsupported walls or structures.
- G. Slope backfill grade away from building or structure.
- H. Make changes in grade gradual. Blend slopes into level areas.

- I. Remove surplus backfill materials from site.
- J. In the construction of embankments, layer placement shall begin in the deepest portion of the fill; as placement progresses, layers shall be constructed approximately parallel to the finished pavement grade line.

3.9 ROUGH GRADING

- A. Coordinate subgrade elevations with required depths for pavement cross-sections, slabs and footings, selected or imported fill and topsoil areas.
- B. Shape subgrade elevations, less required controlled fill depths, to within reasonably close conformity to the lines and elevations indicated on the Contract Drawings.
- C. All ruts or rough places that develop shall be smoothed and recompact.
- D. Provide uniform slopes and contoured subgrade surfaces to provide positive drainage. In areas where topsoil is to be spread, remove stones larger than two inch diameter and other debris.

3.10 COMPACTION REQUIREMENTS

- A. Compact all subgrade soils thoroughly prior to placing required controlled fills.
- B. Recommended compaction requirements are as follows:
 - 1. Beneath and around Footings, under slabs – 95%
 - 2. Parking, roadways, and sidewalks – 92% up to 3ft below finished grade and 95% in the upper 3ft.
 - 3. Landscaped Areas - 95
- C. Minimum compaction requirements refer to percentages of the maximum dry density determined in accordance with ASTM D1557 method C.

3.11 COMPACTION CONTROL TESTS

- A. This Specification shall govern the determination of the maximum density, field density, and percent compaction of those materials for which a minimum percent compaction is specified. It covers the basic procedures to be followed in performing the test for maximum density, field density, and percent compaction. In all cases, density shall be stated as the dry weight in pounds per cubic foot.
- B. Maximum density is defined as the maximum dry weight in pounds per cubic foot obtained when a material is mixed with different percentages of water and compacted in a standard manner. The percentages of water at which maximum density is obtained is termed the optimum moisture content.
- C. Laboratory Compaction Tests: The maximum density shall be determined by the appropriate method shown below: (Equivalent ASTM Tests may be substituted).

1. All particles passing a 3/4" sieve shall be tested in accordance with AASHTO T 180, Method D.
 2. Where the material contains particles larger than 3/4 inch, follow the replacement procedure given in the note under Method C of AASHTO T99 or 80.
- D. Field Density: Field density refers to the dry density expressed in pounds per cubic foot of a layer of compacted material in place at the site as determined by a sample representative of the compact layer. The field density shall be determined in accordance with AASHTO T 147, AASHTO T181, ASTM D1556, ASTM D2157, or other methods approved by the Owner's Representative.
1. The percent compaction is defined as the density of the compacted layer expressed as a percentage of the maximum density of the material when tested in accordance with these Specifications.
 2. The percentage of compaction is computed by the formula:
$$\text{Percent Compaction} = (\text{Field Density} / \text{Maximum Density}) \times 100$$
 3. The mold to be used for testing will be 6.11 inches high.
 4. Unless otherwise directed, one density test per lift for every 1,000 square feet of controlled fill under site pavement and for every 200 square feet of controlled fill under site structures shall be performed.
 5. If tests indicate work does not meet specified requirements, remove work and replace at no cost to the Owner.

3.12 DEWATERING

- A. The Contractor shall keep excavations free from water at all times as required. Excavations shall be dewatered to a sufficient depth below the bottom of excavation to allow compaction of the backfill to be accomplished as specified. Refer to Section 02240 for Dewatering.

3.13 SHORING, BRACING AND SHEETING

- A. Provide, install, maintain and remove all temporary and permanent sheeting and bracing, as required, in accordance with Section 02150, to permit the proper installation and construction of the work; to prevent injury to persons or damage to pavements, utilities or structures; to prevent injurious caving or erosion, or loss of ground; and to maintain at all times pedestrian and vehicular traffic.

3.14 SLABS-ON-GRADE

- A. Slabs-on-Grade shall be constructed in accordance with the requirements of Appendix 1 – "Geotechnical Investigation Proposed Headworks Building and Grit Chamber, Waste Water Treatment Plant Town of Montville, Connecticut" dated May 2012.
1. Slabs-on-Grade shall be supported on suitable densified, granular on-site soils or structural fill.

2. Prior to floor slab construction, all subgrades should be thoroughly proof-rolled with a smooth drum vibratory compactor that imparts a total applied force (static plus dynamic) of at least 500 pounds per lineal inch of drum width.
3. Any soft materials that cannot be densified by additional compaction should be removed and replaced with structural fill.
4. Any materials that were loosened by previous construction activity or weather conditions should be recompact to the requirements described above.
5. All floor slabs shall be constructed over a capillary break consisting of a 4-inch thick layer of compacted AASHTO No. 57 stone. After compaction, a 10-mil polyethylene vapor barrier shall be provided over the capillary break at bottom of slab.

END OF SECTION

SECTION 02221

TRENCH EXCAVATION, BACKFILLING, AND COMPACTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. Without limitations, the work of this Section includes:
1. Trench excavation, bedding, backfill and compaction for all underground piping such as storm drainage pipes, sewer, domestic water, fire protection, underdrain, service laterals, utility ducts, conduit or cable, etc.
 2. Disposal of all items to be removed, unsuitable soils or excess materials.
 3. Sheet piling and dewatering.
- B. Classification: All excavation for trenches shall be "Unclassified", defined as removal of all materials, including rock and unsuitable materials excavation. Excavation of rock in trench or unsuitable material beyond the required contract limits, as authorized by the Owner's Representative, shall be "Classified".
1. Rock excavation in trench shall include rock in definite ledge formation and boulders, or portions of the boulders, three (3) cubic yards or more in volume.
 2. Unsuitable Material Excavation: Defined as any material, containing vegetation or organic matter, such as muck, peat, organic silt, sod, loose to very dense, brown to dark brown silty sand with gravel, trace brick, cobbles, asphalt and coal, or any other encountered material considered by the Engineer as having unsuitable in-site bearing properties (clay). All encountered unsuitable materials shall be removed and disposed of legally off the project, unless otherwise directed.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill

1. Where unsuitable material is excavated and removed, backfill and/or refill shall be Compacted Granular Fill meeting requirements of Section 02234.
2. New material from off-site sources used for backfill under all pavements or structures, as shown on the details, shall be in accordance with the Contract Drawings or shall be Compacted Granular Fill meeting requirements of Section 02234.

B. Pipe Bedding

1. Bedding materials for storm drainage, water, sanitary sewer pipe and their appurtenances shall be 3/4 inch crushed stone, conforming to Article M..01.01 of "Form 818" unless otherwise shown on the Contract Drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

A. Comply with the following Articles of "Form 818"•

1. Trench Excavation – Article 2.05.03
2. Culverts – Article 6.51.03
3. Trenching and Backfilling – Article 10.01.03 (Conduits)

B. Trench backfill under pavements and structures shall be compacted granular fill.

C. Compact bedding and backfill a minimum of 95% of the dry density under all pavements or structures.

D. Refer to Section 02150 for sheeting and staybracing.

E. Refer to Section 02240 for dewatering.

F. Suitable excess trench excavation material shall be used as site fill under the required topsoil or as directed.

END OF SECTION

SECTION 02234
COMPACTED GRANULAR FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work under this Section consists of furnishing and placing compacted granular fill for replacement material for unsuitable materials where not specified elsewhere, as foundation for structures, as bedding material for riprap or other proposed improvements as indicated or detailed on the Drawings.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: provide borrow soil materials when sufficient satisfactory materials are not available from excavations.
- B. Compacted Granular Fill shall conform to the requirements of Structural Fill as outlined in Appendix 1 — "Geotechnical Investigation Proposed Headworks Building and Grit Chamber, Waste Water Treatment Plant Town of Montville, Connecticut" dated May 2012.
- C. Compacted Granular Fill shall consist of well-graded, predominately granular soils meeting the following requirements:
 - 1. Maximum particle size of 2 inches.
 - 2. No more than 12% finer than the No. 200 Sieve
 - 3. Plasticity index of not greater than 6 percent.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Comply with Appendix 1 — "Geotechnical Investigation Proposed Headworks Building and Grit Chamber, Waste Water Treatment Plant Town of Montville, Connecticut" dated May 2012.

END OF SECTION

SECTION 02235

PROCESSED AGGREGATE BASE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The base shall consist of a two-course foundation for bituminous concrete pavement constructed on a prepared subbase in accordance with the standard specifications and in conformity with the lines, grades, compacted thickness and typical details or cross sections indicated on the Contract Drawings.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

1.4 SUBMITTALS

- A. Submit certified test results from a testing laboratory to the Owner's Representative for approval. Test results must indicate characteristics of materials, including gradations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All materials for this work shall conform to the requirements of Article M.05.01 of "Form 818". The required depth shall be as indicated on the Contract Drawings. Coarse aggregate shall conform to Article M.05.01-2(a) or M.05.01-2(b).

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Comply with Article 3.04.03 of "Form 818".

END OF SECTION

SECTION 02240

DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. Division 2 Section "Sheeting and Staybracing".

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Work includes removing dewatering system when no longer needed.
 - 2. Maintain dewatering operations to ensure erosion is controlled, stability of excavations and constructed slopes is maintained, and flooding of excavation and damage to structures are prevented.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Accomplish dewatering without damaging existing buildings adjacent to excavation.

1.4 SUBMITTALS

- A. Shop Drawings: For all dewatering systems, show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.
 - 1. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.
 - 2. Include a written report outlining control procedures to be adopted if dewatering problems arise.
 - 3. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.

- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.
- D. Record drawings at Project closeout identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.
- E. Field Test Reports: Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform dewatering who has specialized in installing dewatering systems similar to those required for this Project and with a record of successful in-service performance.
- B. Professional Engineer Qualifications: A professional engineer who is legally registered to practice in the State of Connecticut and who is experienced in providing engineering services for designing dewatering systems that are similar to those indicated for this Project in material, design, and extent.
 - 1. Engineering Responsibility: Engage a qualified professional engineer to prepare or supervise the preparation of data for the dewatering system including drawings, testing program, test result interpretation, and comprehensive engineering analysis that shows the system's compliance with specified requirements.
- C. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by the Owner's Representative and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of the subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.
 - 1. Make additional test borings and conduct other exploratory operations as necessary.
 - 2. The geotechnical report is included elsewhere in the Project Manual.

- C. Survey adjacent structures and improvements, employing a qualified professional engineer or surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, resurvey benchmarks weekly, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Owner's Representative if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

3.2 DEWATERING

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
- B. Before excavation below ground-water level, place system into operation to lower water to specified levels and then operate it continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. 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.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level a minimum of 24 inches (600 mm) below surface of excavation.
- E. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on a 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.
 - 1. 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.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

- A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.
- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 - 1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

END OF SECTION

SECTION NUMBER 02260
FORMATION OF SUBGRADE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The area upon which pavements, concrete aprons, structures, site retaining walls, or any other proposed improvements are to be placed shall be known as the subgrade. This is the plane coincident with the bottom of the subbase, or compacted granular fill, as shown on the Contract Drawings or as directed. The work of this Section shall be performed at this plane.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Comply with Section 2.09.03 of "Form 818" and as modified herein.
- B. In areas where unsuitable material has been removed, the existing ground shall be compacted prior to the placement of compacted granular fill.
- C. After all grading has been substantially completed and all underground work complete, the subgrade material shall be brought to the required lines and grades.
- D. All soft and yielding material and other portions of the subgrade which will not compact readily shall be removed and replaced with approved Compacted Granular Fill.
- E. Compact subgrade with approved power roller vibratory roller or compactor. The dry density of all areas after compaction shall not be less than 95 percent. After compaction, the top surface of

the subgrade shall be fine graded to within 2 inches of the required elevation. Permit proper drainage.

- F. Protect the completed subgrade from damage until any foundation or surfacing materials is placed thereon.

END OF SECTION

SECTION 02275

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work of this Section consists of furnishing, placing, maintaining and removal of erosion and sedimentation control systems at the location and detail shown on the Contract Drawings or as directed by the Owner's Representative, and in conformity with the specifications.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.
 - 2. References to "Connecticut Guidelines for Soil Erosion and Sedimentation Control" (2002).
 - 3. State of Connecticut, Department of Transportation, Best Management Practices for the Protection of the Environment.

1.4 SUBMITTALS

- A. Submit erosion and sedimentation control plans in conformance with Article 2.10.01 of "Form 818".

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials for this work shall conform to the requirements of Article 2.10.02, 2.18.02 and 2.19.02 of "Form 818".

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Construction methods shall conform to the requirements of Article 2.10.03, 2.18.03 and 2.19.03 of "Form 818".

END OF SECTION

SECTION 02500

BITUMINOUS CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work under this Section shall consist of bituminous concrete placed upon a completed processed aggregate base course or upon the surface of an existing pavement. The work shall be installed in accordance with the line, grade, compacted thickness and details shown on the Contract Drawings.
- B. The work shall include, but not limited to the following:
 - 1. New pavement.
 - 2. Pavement overlay.
 - 3. Permanent pavement repair.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:
- B. Submit Material Certificates of Bituminous Mixture (Class) and Tack Coat signed by material producer and Contractor, certifying that each material item complies with or exceeds specified requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Bituminous Concrete Pavement:

1. Material for Bituminous Concrete Pavement and Bituminous Bases shall comply with Section M.04 of "Form 818".
2. The class of bituminous and compacted thickness shall be as indicated on the Drawings.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Bituminous Concrete for Pavement shall comply with Article 4.06.03 of "Form 818".

END OF SECTION

SECTION 02514
BITUMINOUS TACK COAT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work under this Section shall consist of preparing and treating an existing surface with a thin application of bituminous material in order to satisfactorily bond the old and new work in accordance with these specifications and as directed by the Owner's Representative.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Unless otherwise indicated on the Contract Drawings, the bituminous material for this work shall conform to the requirements of M.04.01 of Form 818 for Grade RS-I Emulsified Asphalt. Applications temperature shall be between a minimum of 75 °F and a maximum 140°F.
- B. The bituminous material shall be diluted with an equal amount of suitable emulsifier solution and thoroughly mixed into a homogeneous liquid.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Weather Limitations - The tack coat shall be applied only when the existing surface is dry, when the atmospheric temperature is above 60°F, and when the weather is not foggy or rainy. The temperature requirements may be waived, but only when approved by the Owner's Representative.

- B. Equipment - The equipment used by the Contractor shall include a self-powered pressure bituminous material distributor and equipment for heating bituminous material.
 - 1. The distributor shall have pneumatic tires and it shall be designed, equipped, and operated so that bituminous material at even heat may be applied uniformly on variable widths of surface at readily controlled rates from 0.05 to 2.0 gallons per square yard. The material shall be applied within a pressure range of 25 to 75 pounds per square inch and with an allowable variation from any specified rate not to exceed 5%. Distributor equipment shall include a tachometer, pressure gauges, volume-measuring devices, and a thermometer for reading temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. Distributors shall be equipped with an approved bituminous material sampling valve. When samples are taken through such valves, they shall be considered representative of all material in the tank.
 - 2. Smaller power spray units or hand spray equipment may be used in areas where the Owner's Representative determines that the use of a distributor is impractical.
- C. Preparation of Surface To Be Treated - The existing surface shall be patched and cleaned to provide a reasonably smooth and uniform surface to receive the treatment. Unstable corrugated areas shall be removed and replaced with patching materials, determined suitable by the Owner's Representative.
 - 1. The edges of existing pavements, which are to be adjacent to new pavements, shall be cleaned to permit the adhesion of bituminous materials.
- D. Application of Bituminous Material - The bituminous material shall be applied using approved pressure distribution equipment in a manner to provide a uniform spray covering. The rate of application shall furnish a uniform asphalt residue on the original surface from 0.05 to 0.07 gallon per square yard of bituminous material (0.10 to 0.15 gallon per square yard of diluted material) within the specified temperature range.
 - 1. All uncoated or lightly coated areas shall be satisfactorily corrected. All areas showing an excess of bituminous material shall be corrected with a covering of sufficient dry sand to effectively blot up or remove the excess tack coat material.
 - 2. Following the application, the surface shall be allowed to cure without being disturbed for such period of time as may be necessary to permit drying out and setting of the tack coat. This period shall be determined by the Owner's Representative.
 - 3. No more area shall be tack coated than can be properly cured and covered with the new surface within the same day.
- E. Protection of Treated Surfaces - The surface shall be maintained by the Contractor until the next course has been placed. Suitable precautions shall be taken by the Contractor to protect the surface against damage during this interval.

END OF SECTION

SECTION 02526

BITUMINOUS CONCRETE LIP CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplemental Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Bituminous concrete lip curbing shall consist of machine laid bituminous concrete, constructed on the pavement to the dimensions and details shown on the Plans, or as ordered, and in conformity with the Specifications.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

1.4 SUBMITTALS

- A. Submit certification of bituminous mixture (class) and tack coat to the Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials for this work, including tack coats, shall conform to the requirements of Section M.04.02-1, of "Form 818".

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

- A. Construction methods shall conform to the requirements of Article 8.15.03 of "Form 818".

END OF SECTION

SECTION 02831
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. The work under this Item shall consist of furnishing and installing chain link fence of the type specified herein, unless otherwise indicated on the Contract Drawings, and at the locations shown on the Contract Drawings in conformance with this Specification.

1.3 QUALITY ASSURANCE

- A. A.Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

1.4 SUBMITTALS

- A. Shop drawings: Layout of fences and gates with dimensions, details, and finishes of components, accessories, and post foundations.
- B. Product data: Manufacturer's catalog cuts indicating material compliance and specified options.
- C. Samples: Color selection for polyolefin finishes. Samples of materials (e.g., fabric, wires, and accessories).

1.5 MANUFACTURER

- A. Products from qualified manufacturers having a minimum of five years' experience manufacturing thermally fused chain link fencing will be acceptable by the architect as equal, if approved in writing, ten days prior to bidding, and if they meet the following specifications for design, size gauge of metal parts and fabrication.
- B. Obtain chain link fences and gates, including accessories, fittings, and fastenings, from a single source.

PART 2 - PRODUCTS

2.1 MATERIALS

2.2 CHAIN LINK FENCE FABRIC

- A. Polyolefin elastomer coating, 6 mil (0.15mm) to 10 mil (0.25mm) thickness, thermally fused to zinc-coated steel core wire: Per ASTM F668 Class 2b. Core wire tensile strength 75,000 psi (517 MPa).
- B. Size: Helically wound and woven to a height as indicated on drawings with 1 inch (25mm) diamond mesh, 11 gauge, with a core wire diameter of 0.120 inch (3.05mm) and a minimum breaking strength of 850 lbf (3780 N). Color Black ASTM F 934.
- C. Selvage of fabric knuckled at top and at knuckled at the bottom.

2.3 STEEL FENCE FRAMING

- A. Steel pipe - Type I: ASTM F 1083, standard weight schedule 40; minimum yield strength of 25,000 psi (170 MPa); sizes as indicated. Hot-dipped galvanized with minimum average 1.8 oz/ft² (550 g/m²) of coated surface area.
- B. Steel pipe - Type II: Cold formed and welded steel pipe complying with ASTM F 1043, Group IC, with minimum yield strength of 50,000 psi (344 MPa), sizes as indicated. Protective coating per ASTM F 1043, external coating Type B, zinc with organic overcoat, 0.9 oz/ft² (275 g/m²) minimum zinc coating with chromate conversion coating and verifiable polymer film. Internal coating Type B, minimum 0.9 oz/ft² (275 g/m²) zinc or Type D, zinc pigmented, 81 % nominal coating, minimum 3 mils (0.08 mm) thick.
- C. Formed steel ("C") sections: Roll formed steel shapes complying with ASTM F 1043, Group II, produced from 45,000 psi (310 MPa) yield strength steel; sizes as indicated. External coating per ASTM F 1043, Type A, minimum average 2.0 oz/ft² (610 g/m²) of zinc per ASTM A 123, or 4.0 oz/ft² (1220 g/m²) per ASTM A 525.
- D. Steel square sections: [ASTM A 500, Grade B] Steel having minimum yield strength of 40,000 psi (275 MPa); sizes as indicated. Hot-dipped galvanized with minimum 1.8 oz/ft² (550 g/m²) of coated surface area.
- E. Polyolefin Coated finish: In accordance with ASTM F 1043, apply supplemental color coating of minimum 10 mils (0.254mm) of thermally fused polyolefin in Black color to match fabric.
- F. For 6 ft to 8ft high fence,
 - 1. End and Corner Post 2.875 inches outside diameter (73.0 mm), 9.11 lbs/ft (13.6 kg/m)
 - 2. Line (intermediate) Post 2.375 inches outside diameter (60.3 mm), 3.65 lbs/ft (5.4 kg/m)
 - 3. Rail and Braces 1.66 inches outside diameter (42.2 mm), 2.27 lbs/ft (3.40 kg/m)
- G. Barbed wire top: Incorporate provisions for barbed extensions by extending vertical members 13" (380 mm) to accommodate three strands of barbed wire.

2.4 POLYOLEFIN COATED ACCESSORIES

- A. Chain link fence accessories: [ASTM F 626] Provide items required to complete fence system. Galvanize each ferrous metal item and finish to match framing.
- B. Post caps: Formed steel, cast malleable iron, or aluminum alloy weathertight closure cap for tubular posts. Provide one cap for each post. Cap to have provision for barbed wire when necessary. "C" shaped line post without top rail or barbed wire supporting arms do not require post caps. (Where top rail is used, provide tops to permit passage of top rail.)
- C. Top rail and brace rail ends: Pressed steel per ASTM F 626, for connection of rail and brace to terminal posts.
- D. Top rail sleeves: 7" (178 mm) expansion sleeve with spring, allowing for expansion and contraction of top rail.
- E. Wire ties: 9 gauge [0.148" (3.76 mm)] galvanized steel wire for attachment of fabric to line posts. Double wrap 13 gauge [0.092" (2.324 mm)] for rails and braces. Hogring ties of 12-1/2 gauge [0.0985" (2.502 mm)] for attachment of fabric to tension wire.
- F. Brace and tension (stretcher bar) bands: Pressed steel. At square post provide tension bar clips.
- G. Tension (stretcher) bars: One-piece lengths equal to 2 inches (50 mm) less than full height of fabric with a minimum cross-section of 3/16" x 3/4" (4.76 mm x 19 mm) or equivalent fiber glass rod. Provide tension (stretcher) bars where chain link fabric meets terminal posts.
- H. Tension wire: Thermally fused polyolefin applied to metallic coated steel wire: Per ASTM F 1664 Class 2 b, 6 gauge, [0.192" (4.88 mm)] diameter core wire with tensile strength of 75,000 psi (517 MPa).
- I. Truss rods & tightener: Steel rods with minimum diameter of 5/16" (7.9 mm). Capable of withstanding a tension of minimum 2,000 lbs.
- J. Barbed wire: Thermally fused polyolefin coated per ASTM F 1665 Class 2b steel wire double strand, 13-3/4 gauge, [0.083" (2.10 mm)] twisted line wire with galvanized steel, 4 point barbs (without polyolefin finish) spaced approximately 3" (76.2 mm) on center.
- K. Barbed wire supporting arms: Pressed steel arms with provisions for attaching 3 rows of barbed wire. Arms shall withstand 250 lb. (113.5 kg) downward pull at outermost end of arm without failure.
 - 1. Provide 45° 3 strands, single arm and 6 strands double "V" arms.
 - 2. Provide intermediate arms with hole for passage of top rail.
- L. L. Nuts and bolts are galvanized but not polyolefin coated. Cans of touch up paint are available to color coat nuts and bolts if desired. Standard —PDS (self-locking using horizontal bottom channel system) (see fence detail)

2.5 SETTING MATERIALS

- A. Concrete: Minimum 28 day compressive strength of 3,000 psi (20 MPa).

OR

- B. Drive Anchors: Galvanized angles, ASTM A 36 steel 1 " x 1" x 30" (25 mm x 25 mm x 762 mm) galvanized shoe clamps to secure angles to posts.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

3.2 EXAMINATION

- A. Verify areas to receive fencing are completed to final grades and elevations.
- B. Ensure property lines and legal boundaries of work are clearly established.

3.3 CHAIN LINK FENCE FRAMING INSTALLATION

- A. Install chain link fence in accordance with ASTM F 567 and manufacturer's instructions.
- B. Locate terminal post at each fence termination and change in horizontal or vertical direction of 30° or more.
- C. Space line posts uniformly at 8' (2438 mm) on center.
- D. Concrete set terminal posts: Drill holes in firm, undisturbed or compacted soil. Holes shall have diameter 4 times greater than outside dimension of post, and depths approximately 6" (152 mm) deeper than post bottom. Excavate deeper as required for adequate support in soft and loose soils, and for posts with heavy lateral loads. Set post bottom 36" (914 mm) below surface when in firm, undisturbed soil. Place concrete around posts in a continuous pour. Trowel finish around post. Slope to direct water away from posts.
- E. Drive Anchor line posts: With protective cap, drive post 36" (914 mm) into ground. Slightly below ground level install drive anchor shoe fitting. Install 2 diagonal drive anchors and tighten in the shoe.
- F. Check each post for vertical and top alignment and maintain in position during placement and finishing operations.
- G. Bracing: Install horizontal pipe brace at mid-height for fences 6' (1829 mm) and over, on each side of terminal posts. Firmly attach with fittings. Install diagonal truss rods at these points. Adjust truss rod, ensuring posts remain plumb.
- H. Tension wire: Provide tension wire at bottom of fabric and at top. Install tension wire before stretching fabric and attach to each post with ties. Secure tension wire to fabric with 12-1/2 gauge hog rings 24" (610 mm) oc.

- I. Top rail: Install lengths, 21 ' (6400 mm). Connect joints with sleeves for rigid connections for expansion/contraction.
- J. Center Rails (for fabric height 12' (3658 mm) and over). Install mid rails between posts with fittings and accessories.
- K. Bottom Rails: Install bottom rails between posts with fittings and accessories.

3.4 CHAIN LINK FABRIC INSTALLATION

- A. Fabric: Install fabric on security side and attach so that fabric remains in tension after pulling force is released. Leave approximately 2" (50 mm) between finish grade and bottom selvage. Attach fabric with wire ties to line posts at 15" (381 mm) on center and to rails, braces, and tension wire at 24" (600 mm) on center.
- B. Tension (stretcher) bars: Pull fabric taut; thread tension bar through fabric and attach to terminal posts with bands or clips spaced maximum of 15" (381 mm) on center.

3.5 ACCESSORIES

- A. Tie wires: Bend ends of wire to minimize hazard to persons and clothing.
- B. Fasteners: Install nuts on side offence opposite fabric side for added security.
- C. Barbed wire: Uniformly space parallel rows of barbed wire on security side of fence. Pull wire taut and attach in clips or slots of each extension.

3.6 CLEANING

- A. Clean up debris and unused material and remove from the site.

END OF SECTION

SECTION 02936
TURF ESTABLISHMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contract Drawings, General Conditions and Supplementary General Conditions apply to this Section of the Specifications.

1.2 SUMMARY

- A. Scarify all proposed topsoil/grass areas.
- B. Furnish and install 4" of topsoil and required soil supplements based on topsoil tests.
- C. Seeding by hydroseeding or sod placement (Contractor's option). All disturbed areas shall be seeded.
- D. Mulching and protection of all seeded areas.
- E. Maintaining seeded areas until acceptance by the Engineer.

1.3 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following, except otherwise indicated:
 - 1. References to "Form 818" means the State of Connecticut Department of Transportation "Standard Specification for Roads, Bridges and Incidental Construction, 2020", including any interim and supplemental specifications.

1.4 TESTS

- A. The Contractor shall take representative samples of the loam/ topsoil stripped and stockpiled for reuse. The topsoil samples shall be sent to an approved agricultural soil testing laboratory to determine PH rating, classification, humus and nutrient levels of the soil. Recommendations shall be made by the testing laboratory for required soil supplements in order to achieve agronomically acceptable nutrient levels for the type of lawn or crop to be established.
- B. The cost of the soil tests and installation of the recommended soil supplements are to be borne by the Contractor.

1.5 SUBMITTALS

- A. Submit certified loam testing reports to the Engineer for review and approval of required soil supplements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Comply with Article M.13 of "Form 818" and as modified herein.

2.2 SOIL SUPPLEMENTS

- A. Fertilizer shall be standard quality commercial type with 50 percent of the elements nitrogen (N), phosphorus (P) and potash (K), derived from organic sources.
- B. Agricultural ground dolomitic limestone used to raise the pH level shall conform to the Association of Official Agricultural Chemists and must comply with State and Federal Regulations. The minimum calcium carbonate equivalent shall be 90 percent.
- C. Aluminum sulfate shall be unadulterated commercial or flour sulphur. Add aluminum sulfate to a rate of 2-1/2 pounds per cubic yard of topsoil to lower the pH one full point unless otherwise recommended by manufacturer.
- D. Application rates of the Soil Supplements shall be per the recommendations of the soil testing laboratory.

2.3 SEED MIXTURE AND APPLICATION RATE

- A. Type 1 – Sunny Lawn Mixture (Fine Textured)

Name	% by Weight	Purity	Minimum Germination
Manhattan Perennial Ryegrass	25	95	90
Marion Kentucky Bluegrass	25	98	80
Penlawn Red Fescue	20	98	90
Chewings Red Fescue	20	95	90
Kentucky Bluegrass	10	90	80

Application rate shall be 5 pounds per 1000 square feet.

2.4 ACCESSORIES

- A. Mulching material for grass seed areas shall be oat or wheat straw or hay.
- B. Water shall be potable.
- C. The inoculant for treating leguminous seed shall be a standard commercial product consisting of a suitable carrier containing a culture of nitrogen fixing bacteria specific for the specific seed

variety to be inoculated. All containers must remain sealed until contents are used in their entirety. Inoculant shall not be used after the expiration date indicated on the container. Suitable storage in a moderate temperature shall be provided at all times. All inoculants shall be subject to approval of the Engineer.

PART 3 - EXECUTION

3.1 GENERAL

- A. Comply with Section 9.44.03 and 9.50.03 of "Form 818" and as modified herein.

3.2 SCARIFY AND PREPARATION OF SEEDBED

- A. After placement of topsoil to the depth shown on the Drawings, prepare the seedbed by discing or scarifying to a minimum depth of 4 inch.
- B. Apply recommended soil supplements required by the topsoil analysis and work into the top 2 inches.
- C. Rake, prepare the seedbed and fine grade to the limits and grades shown on the Drawings.

3.3 SEEDING SEASON

- A. The calendar dates for seeding shall be:
 - 1. Spring: March 15 to June 15
 - 2. Fall: August 15 to October 15

3.4 SEEDING METHODS

- A. The grass seed mixture shall be applied by an agronomically acceptable procedure.
- B. Roll seeded area with roller not exceeding 112 pounds.
- C. Apply water with fine spray immediately after each area has been sown.

3.5 SEED PROTECTION ON SLOPES

- A. Cover seeded drainage swales and slopes where grade is 3:1 or greater with straw or hay.

3.6 MAINTENANCE PERIOD

- A. Maintain seeded area until final acceptance, until the project is turned over to the Owner, and/or until such time as at least two mowings have been done on the fully established lawn/grass areas, whichever is greater.

3.7 MAINTENANCE REQUIRED UNTIL ACCEPTANCE

- A. Maintain surfaces and supply additional topsoil where necessary, including areas affected by erosion. Reapply mulch to protect restored areas.
- B. Water to ensure uniform seed germination and to keep surface of soil damp.
- C. Apply water slowly so that surface of soil will not puddle and crust.
- D. Rake up and remove all straw or hay mulch prior to first cutting.
- E. Cut grass first time when it reaches height of 2-1/2 inches (60 mm) and maintain to minimum height of 2 inches (50 mm). Do not cut more than 1/3 of blade at any one mowing. Remove clippings.
- F. After first mowing, water grass sufficient to moisten soil from 3 inches to 5 inches (76 to 127 mm) deep.
- G. Apply weed killer when weeds start developing, during calm weather when air temperature is above 50 degrees F (10 degrees C).
- H. Replant damaged grass areas showing root growth failure, deterioration, bare or thin spots, and eroded areas.

3.8 RESTORATION

- A. Restore all damaged areas as many times as necessary until turf is satisfactorily established.

3.9 ACCEPTANCE

- A. Seeded areas will be accepted at end of maintenance period when seeded areas are properly established and otherwise acceptable.

END OF SECTION

DIVISION 03
CONCRETE

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Aprons.
 - 5. Suspended slabs.
 - 6. Building walls.
- B. Related Sections:
 - 1. Division 2 Section "Excavation, Backfilling and Compaction" for drainage fill under slabs-on-grade.
 - 2. Division 2 Section "Compacted Granular Fill" for structural foundations.
 - 3. Division 9 Section "High Performance Coatings" for protection of concrete surfaces.

1.3 DEFINITIONS

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

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.

- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.
- E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
 - 1. Location of construction joints is subject to approval of the Engineer.
- F. Samples: For waterstops and vapor retarder

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
 - 1. Cementitious materials.
 - 2. Admixtures.
 - 3. Form materials and form-release agents.
 - 4. Steel reinforcement and accessories.
 - 5. Waterstops.
 - 6. Curing compounds.
 - 7. Floor and slab treatments.
 - 8. Bonding agents.
 - 9. Adhesives.
 - 10. Vapor retarders.
 - 11. Semirigid joint filler.
 - 12. Joint-filler strips.
 - 13. Repair materials.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- F. Field quality-control reports.

- G. Minutes of pre-installation conference.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities. "
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-I or an equivalent certification program.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- E. Welding Qualifications: Qualify procedures and personnel according to AWS DI.4/D 1.4M, "Structural Welding Code - Reinforcing Steel. "
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.
- H. Mockups: Cast concrete slab-on-grade panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.
 - 1. Build panel approximately 200 sq. ft. for slab-on-grade in the location indicated or, if not indicated, as directed by Architect.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- I. Pre-installation Conference: Conduct conference at Project site.
 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - e. Special concrete finish subcontractor.
 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 1. Plywood, metal, or other approved panel materials.
 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. High-density overlay, Class 1 or better.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

- E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.
- C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.4 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type 1/11, gray. Supplement with the following:
 - a. Fly Ash: ASTM C 618, Class F.
 - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

- B. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, Class 4S 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.
 - 1. Maximum Coarse-Aggregate Size: 1 inch (25 mm) nominal.
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
- C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.
 - 1. Products: Subject to compliance with requirements.
- D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
 - 1. Products: Subject to compliance with requirements

2.6 WATERSTOPS

- A. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.
 - 1. Products: Subject to compliance with requirements.
 - 2. Profile: Ribbed with center bulb
 - 3. Dimensions: 6 inches by 3/16 inch thick (150 mm by 4.75 mm thick)]; nontapered.

2.7 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E 1745, Class A, not less than ten mils thick. Include manufacturer's recommended adhesive or pressure-sensitive tape.
 - 1. Products: Subject to compliance with requirements.
- B. 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.

2.8 LIQUID FLOOR TREATMENTS

- A. VOC Content: Liquid floor treatments shall have a VOC content of 200 g/L OF less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. 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.
 - 1. Products: Subject to compliance with requirements.

2.9 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
 - 1. Products: Subject to compliance with requirements.
- B. 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.
- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type I, Class B, dissipating.
 - 1. Products: Subject to compliance with requirements.

2.10 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

- C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
 - 1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- D. Reglets: Fabricate reglets of not less than 0.022-inch- (0.55-mm-) thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- E. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch (0.85 mm) thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.11 REPAIR MATERIALS

- A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
 - 4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Screening Channel: Repair materials for vertical and horizontal concrete surfaces of screening channel and channel divider:
 - 1. See Section 03732: Concrete Repair.

2.12 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
 - 1. Fly Ash: 25 percent.
 - 2. Combined Fly Ash and Pozzolan: 25 percent.
 - 3. Ground Granulated Blast-Furnace Slag: 50 percent.

4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
 5. Silica Fume: 10 percent.
 6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
 7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use admixture in concrete, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
 3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
 4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
- E. 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.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.45 .
 3. Slump Limit: 4 inches (100 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for I-inch (25-mm) nominal maximum aggregate size.
- B. Foundation Walls and Building Walls: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.45 .
 3. Slump Limit: 4 inches (100 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch (25 mm).
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for I-inch (25-mm) nominal maximum aggregate size.
- C. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.

2. Minimum Cementitious Materials Content: 540 lb/cu. yd. (320 kg/cu. m).
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

D. Suspended Slabs: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
2. Minimum Cementitious Materials Content: 540 lb/cu. yd. (320 kg/cu. m).
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) nominal maximum aggregate size.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

2.14 FABRICATING REINFORCEMENT

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

2.15 CONCRETE MIXING

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

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
 2. Class B, 1/4 inch (6 mm) for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.

- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Install keyways, reglets, recesses, and the like, for easy removal.
 - 2. Do not use rust-stained steel form-facing material.
- F. 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.
- G. 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.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

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

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

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

3.5 VAPOR RETARDERS

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.
1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 3. 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.
 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. 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:
 1. 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.
 2. 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.
- D. 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.
 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
 2. 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 Section 079200 "Joint Sealants," are indicated.

3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. 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.

3.8 WATERSTOPS

- A. 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.

3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (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.
- D. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before staffing finishing operations.

- E. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
 - 1. 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.
 - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

- A. 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.
 - 1. Apply to concrete surfaces not exposed to public view.
- B. 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.
 - 1. Apply to concrete surfaces exposed to public view, to receive a rubbed finish.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 - 1. 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.
 - 2. 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, 111b surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
 - 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 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.

- D. 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.

3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302. IR recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bullfloated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in one direction.
 - 1. Apply scratch finish to surfaces indicated.
- C. 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.
 - 1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten 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.
 - 1. Apply a trowel finish to surfaces 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.
 - 2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
 - a. 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.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with a fine broom.
 - 1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

3.12 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-

place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

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

3.13 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (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.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
 - 2. 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.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - 3. 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.

4. 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.

3.14 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.
 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 2. Do not apply to concrete that is less than the number of days' old required by the manufacturer's instructions.
 3. 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.

3.15 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 1. Defer joint filling until concrete has aged at least [one] [six] month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one-part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension to solid concrete. Limit cut depth to 3/4 inch (19 mm). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar

- before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, 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.
1. 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.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to 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.
 5. 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.
 6. 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.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.
- G. Screening Channel: For additional requirements related to repair of vertical and horizontal concrete surfaces of screening channel and channel divider:
1. See Section 03732: Concrete Repair.

3.17 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
 - 1. Steel reinforcement placement.
 - 2. Steel reinforcement welding.
 - 3. Headed bolts and studs.
 - 4. Verification of use of required design mixture.
 - 5. Concrete placement, including conveying and depositing.
 - 6. Curing procedures and maintenance of curing temperature.
 - 7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
 - a. 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.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. 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.
 - 5. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
 - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
 - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
 - 7. 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.

8. 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).
 9. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
 10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
 11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
 12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
 13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

- A. 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

SECTION 03400
PRECAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Precast structural concrete.

B. Related Sections:

- 1. Division 3 Section "Cast-in-Place Concrete" for placing connection anchors in concrete.
- 2. Division 4 Section "Concrete Unit Masonry Assemblies" for inserts or anchorages required for precast concrete slab connections.
- 3. Division 5 Section "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.
- 4. Division 7 Section "Sheet Metal Flashing and Trim" for flashing receivers and reglets.

1.3 DEFINITION

- A. Design Reference Sample: Sample of approved precast structural concrete color, finish, and texture, preapproved by Architect.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.
 - 1. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318 (ACI 318M).

- a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of minus 18 to plus 120 deg F (minus 10 to plus 67 deg C).
2. Fire-Resistance Rating: Select material and minimum thicknesses to provide indicated fire rating.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each precast concrete mixture. Include compressive strength and water-absorption tests.
- C. 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.
 1. Indicate joints, reveals, and extent and location of each surface finish.
 2. Indicate separate face and backup mixture locations and thicknesses.
 3. Indicate welded connections by AWS standard symbols. Show size, length, and type of each weld.
 4. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
 5. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
 6. Include and locate openings larger than by 10 inches (250 mm).
 7. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
 8. Indicate relationship of precast structural concrete units to adjacent materials.
 9. Indicate shim sizes and grouting sequence.
 10. Design Modifications: If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.
- D. 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 registered in the State of Connecticut and responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator and testing agency.
- B. Welding certificates.
- C. Material Certificates: For the following, from manufacturer:
 1. Cementitious materials.

2. Reinforcing materials and prestressing tendons.
3. Admixtures.
4. Bearing pads.
5. Structural-steel shapes and hollow structural sections.

D. Material Test Reports: For aggregates.

E. Source quality-control reports.

F. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. 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.

1. Participates in PCI's Plant Certification program at time of bidding and is designated a PCI-certified plant as follows:

- a. Group C, Category C2 - Prestressed Hollowcore and Repetitively Produced Products.

B. Installer Qualifications: A precast concrete erector qualified at time of bidding, as evidenced by PCI's Certificate of Compliance, to erect Category SI - Simple Structural Systems.

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

D. 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.

E. 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. "

F. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4, "Structural Welding Code - Reinforcing Steel."

G. 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", and is acceptable to authorities having jurisdiction.

H. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Support units during shipment on non-staining shock-absorbing material in same position as during storage.
- B. 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.
 - 1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
 - 2. Place adequate dunnage of even thickness between each unit.
 - 3. Place stored units so identification marks are clearly visible, and units can be inspected.
- C. 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.
- D. Lift and support units only at designated points shown on Shop Drawings.

1.9 COORDINATION

- A. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Fabricators: Subject to compliance with requirements.

2.2 MOLD MATERIALS

- A. 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.
 - 1. 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.
- B. Form Liners: Units of face design, texture, arrangement, and configuration indicated. 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.

2.3 REINFORCING MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- E. 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.

2.4 PRESTRESSING TENDONS

- A. 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, low-relaxation strand.

2.5 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type III, gray, unless otherwise indicated.
 - 1. 1. For surfaces exposed to view in finished structure, mix gray with white cement, of same type, brand, and mill source.
- B. Supplementary Cementitious Materials:
 - 1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
 - 2. Silica Fume Admixture: ASTM C 1240, with optional chemical and physical requirement.
 - 3. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33, with coarse aggregates complying with Class SS. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
- D. Coloring Admixture: ASTM C 979, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- E. 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.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. 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.

1. Water-Reducing Admixtures: ASTM C 494/C 494M, Type A.
 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 4. Water-Reducing and Accelerating Admixture: ASTM C 494/C 494M, Type E.
 5. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 6. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 7. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M.
- H. 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.

2.6 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Shapes and Plates: ASTM A 36/A 36M.
- B. Carbon-steel-Headed Studs: ASTM A 108, AISI 1018 through AISI 1020, cold finished, AWS D1.1/DI.IM, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
- C. High-strength, Low-Alloy Structural Steel: ASTM A 572/A 572M.
- D. Deformed-Steel Wire or Bar Anchors: ASTM A 496 or ASTM A 706/A 706M.
- E. 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.
- F. Zinc-Coated Finish: For exterior steel items 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.
1. 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.
 2. 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.
- G. Welding Electrodes: Comply with AWS standards.
- H. Precast Accessories: Provide clips, hangers, plastic or steel shims, and other accessories required to install precast structural concrete units.

2.7 STAINLESS-STEEL CONNECTION MATERIALS

- A. Stainless-Steel Plate: ASTM A 666, Type 304, of grade suitable for application.
- B. 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 anti-seize thread lubricant during assembly.

- C. Stainless-Steel-Headed Studs: ASTM A 276, with minimum mechanical properties of PCI MNL 116.

2.8 BEARING PADS

- A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:
 - 1. 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.
 - 2. 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.
 - 3. 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-C882E.
 - 4. Frictionless Pads: Tetrafluoroethylene, glass-fiber reinforced, bonded to stainless- or mild-steel plate, of type required for in-service stress.
 - 5. High-Density Plastic: Multi-monomer, non-leaching, plastic strip.

2.9 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150, Type I, and clean, natural sand,
- B. 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.
- C. Nonmetallic, Non-shrink Grout: Premixed, nonmetallic, noncorrosive, non-staining 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.

2.10 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
 - 1. 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.
 - 2. 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; silica fume to 10 percent of portland cement by weight.

- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
- C. 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.
- D. Normal-Weight Concrete Mixtures: Proportion full-depth mixture 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:
 - 1. Compressive Strength (28 Days): 5000 psi (34.5 MPa).
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Water Absorption: 6 percent by weight or 14 percent by volume, tested according to PCI MNL 116.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI WINL 116.
- G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's instructions.
- H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

2.11 MOLD FABRICATION

- A. 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.
- B. Maintain molds to provide completed precast structural concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified.
 - 1. Edge and Corner Treatment: Uniformly chamfered.

2.12 FABRICATION

- A. 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 pre-casting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
 - 1. 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. "

- B. 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.
- C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
- D. Cast-in openings larger than 10 inches (250 mm) in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
 - 1. 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.
 - 2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
 - 3. 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.
 - 4. 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.
 - 5. 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.
- F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses.
- G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI/MNL 116.
 - 1. 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.
 - 2. 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.
 - 3. 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.
 - 4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

5. Protect strand ends and anchorages with a minimum of 1-inch- (25-mm-) thick, nonmetallic, non-shrink, grout mortar and sack rub surface. Coat or spray the inside surfaces of pocket with bonding agent before installing grout.
- H. 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.
- I. 1. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.
- J. 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.
 1. 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. "
- K. Comply with ACI 306.1 procedures for cold-weather concrete placement.
- L. Comply with PCI MNL 116 procedures for hot-weather concrete placement.
- M. 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.
- N. 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.
- O. 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 Architect's approval.

2.13 FABRICATION TOLERANCES

- A. 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.

2.14 COMMERCIAL FINISHES

- A. 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.

- B. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.

2.15 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.
 - 1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.
- B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.
 - 1. Test and inspect self-consolidating concrete according to PCI TR-6.
- C. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 (ACI 318M) requirements for concrete strength.
- D. 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.
 - 1. A minimum of three representative cores will be taken from units of suspect strength, from locations directed by Architect.
 - 2. 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.
 - 3. 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.
 - 4. Test results will be made in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports will include the following:
 - a. Project identification name and number.
 - b. Date when tests were performed.
 - c. Name of precast concrete fabricator.
 - d. Name of concrete testing agency.
 - e. 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.
- E. 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.

- F. 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 Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Do not install precast concrete units until supporting, cast-in-place, building structural framing has attained minimum allowable design compressive strength or until supporting steel or other structure is complete.

3.2 INSTALLATION

- A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
- B. 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.
 - 1. 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.
 - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
 - 3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
 - 4. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
- C. 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.
 - 1. Do not permit connections to disrupt continuity of roof flashing.
- D. Field cutting of precast units is not permitted without approval of the Architect.
- E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

- F. 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.
 - 1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
 - 2. 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.
 - 3. Remove, reweld, or repair incomplete and defective welds.
- G. 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.
 - 1. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
 - 2. Fill joints completely without seepage to other surfaces.
 - 3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
 - 4. Place grout end cap or dam in voids at ends of hollow-core slabs.
 - 5. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
 - 6. Keep grouted joints damp for not less than 24 hours after initial set.

3.3 ERECTION TOLERANCES

- A. Erect precast structural concrete units level, plumb, square, true, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
- B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Architect.

3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
 - 1. Erection of precast structural concrete members.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. 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.
- D. Testing agency will report test results promptly and in writing to Contractor and Architect.
- E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- G. Prepare test and inspection reports.

3.5 REPAIRS

- A. Repair precast structural concrete units if permitted by Architect.
 - 1. 1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units has not been impaired.
- B. 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).
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780.
- D. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Architect.

3.6 CLEANING

- A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
 - 1. 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.
 - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

SECTION 03401

PRE-CAST CONCRETE EXTERIOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Work Includes
 - 1. Precast concrete structures.

1.3 REFERENCES

- A. American Concrete Institute
 - 1. ACI 301 - Structural Concrete for Buildings.
 - 2. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - 3. ACI 350 R - Concrete Sanitary Engineering Structures.
- B. American Society for Testing Materials (ASTM International)
 - 1. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 2. ASTM A307 - Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners.
 - 3. ASTM A325 - Specification for High Strength Bolts for Structural Steel Joints, Including Suitable Nuts and Plain Hardened Washers.
 - 4. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 5. ASTM C33 - Concrete Aggregates.
 - 6. ASTM C150 - Portland Cement.
 - 7. ASTM C260 - Air Entraining Admixtures for Concrete.
 - 8. ASTM C330 - Lightweight Aggregates for Structure Concrete.
 - 9. ASTM C494 - Chemical Admixtures for Concrete.
- C. Precast/Prestressed Concrete Institute
 - 1. PCI MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
 - 2. PCI MNL-120 - Design Handbook - Precast and Prestressed Concrete.
 - 3. PCI MNL-123 - Manual on Design of Connections for Precast Prestressed Concrete.
 - 4. PCI MNL-127 - Manual on Recommended Practice for Erection of Precast Concrete.
- D. Concrete Reinforcing Steel Institute, "Manual of Standard Practice. "

- E. The most stringent code shall govern.

1.4 QUALITY ASSURANCE

- A. Testing:

- 1. Certification from independent testing agency supplied by the manufacturer.
 - 2. Cost of Testing: Borne by Contractor.

- B. Codes and Standards:

- 1. Except as modified by the requirements specified herein and/or the details shown on the Project Drawings, all work included in this section shall conform to the applicable provisions of the following codes and standards:
 - a. ACI 301
 - b. ACI 318
 - c. PCI MNL-116
 - d. PCI MNL-120
 - e. PCI MNL-123
 - f. Concrete Reinforcing Steel Institute, "Manual of Standard Practice"

1.5 STRUCTURAL DESIGN REQUIREMENTS

- A. Structural calculations are required for all precast concrete structures which address all anticipated loading conditions as indicated on the Drawings, as specified herein, and as required by local and state building codes. All load cases shall be considered, and the design shall be based on the governing case which produces the greatest stresses on the structure. Load cases to be addressed include: tanks empty with saturated soil outside, tanks full with saturated soil outside, tanks full with dry soils outside and tanks full with no soil pressure outside. .
- B. Maximum ground water elevation shall be assumed to be at finish grade level. Saturated soils shall be assumed to exert a minimum equivalent fluid pressure of 90 p.c.f. onto the structure.
- C. All structures shall be designed to resist buoyancy when empty and the ground saturated to the surface. The minimum safety factor against buoyancy shall be 1.25. Only the weight of the empty concrete structure and the weight of the soil directly above the anti-flotation collar shall be considered in calculating the forces to resist buoyancy. For buoyancy calculations, the density of the saturated soil shall be assumed at 37.6 lbs./cu.ft. The density of concrete shall be assumed to be 150 lbs./cu.ft.
- D. Effects on all vertical, horizontal and lifting loads anticipated on the finished structure shall be included in the analysis and design. Loading from piping and equipment, snow, and adjacent H-20 live load shall be included.
- E. Watertight pipe penetrations shall be provided for structures designed to retain liquids through the use of cast-in rubber or neoprene gaskets complying with ASTM C443 and C923 or wall pipes with intermediate wall collar.

- F. All structures designed to retain liquids shall be watertight and shall be tested for leaks before backfilling. Testing shall be performed for a minimum of 24 hours after presoaking. There shall be no visible leaks and loss of water shall be less than 0.1% of tank volume or less than h" drop whichever is more restrictive.
- G. Where conditions arise which are not specifically covered by these specifications, the current Standards of ACI 301, 304, 306, 311, 313, 315, 318, 350R, and ASTM C-94, C478, 090 and C913 shall govern.
- H. Design calculations for the above conditions shall be prepared, signed and sealed by a Professional Engineer, registered in the State of Connecticut, and submitted to the Engineer for review with detailed shop drawings of all structures.

1.6 SUBMITTALS

- A. Submit shop drawings under provisions of Section 01340.
- B. Submit design calculations and shop drawings indicating fabrication details, reinforcement, connection details, support items, member cross-sections and dimensions, gaskets, openings, manhole steps, size and type of reinforcement and lifting devices which shall be signed and sealed by a Professional Engineer licensed in the state where the Contract is performed.
- C. Indicate design loads, deflections, cambers, bearing requirements, and special conditions.
- D. Submit product data under provisions of Section 01340.
- E. Submit product data indicating standard component configurations, design loads, deflections, cambers, and bearing requirements.
- F. Submit data on proposed use of any admixture under provisions of Section 01340.
- G. Submit fabricator's installation instructions under provisions of Section 01340.
- H. Submit design data under provisions of Section 01340.
- I. Submit design data reports indicating calculations for loadings and stresses of fabricated, designed framing.

1.7 QUALIFICATIONS

- A. Fabricator: Company specializing in manufacturing the work of this Section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site at such times to assure continuity of installation.
- B. Handle precast members in position consistent with their shape and design. Lift and support only from support points.

- C. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage transportation, erection.
- D. Store and protect members to prevent staining, cracking, chipping, spalling, or other physical damage of concrete.
- E. Mark each member with date of production and final position in structure.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

- A. Water: Clean and free of organic materials, strong acids or alkalis, oils and salt. Potable.
- B. Portland Cement ASTM-C150, Type I or Type III American manufacture. One (1) brand used throughout project.
- C. Sand: (Fine aggregate) shall be clean, sharp, coarse, (minimum fines) hard, natural sand free from salt, loam, clay and other deleterious materials and shall conform to ASTM Specification C33 or C330.
- D. Coarse Aggregate: Shall be well graded, washed gravel or crushed stone and shall conform to ASTM Specification C33 for normal weight aggregate.
- E. Admixtures: Determined by precast fabricator as appropriate to design requirements and conforming to ASTM Specification C494.

2.2 REINFORCEMENT

- A. Reinforcing Steel: Reinforcing bars shall be deformed high strength bars conforming to ASTM M15, Grade 40 or 60.
- B. Welded Wire Fabric: Fabric shall conform to ASTM A1 85.

2.3 FORMWORK

- A. Forms: Wood, metal, plastic, or other acceptable material that will produce required finish surfaces and is non-reactive with concrete.
- B. Maintain formwork to provide completed precast concrete units of shapes, lines, and dimensions indicated, within fabrication tolerances specified in PCI MNL-116.
- C. Metal tie rods used to attach forms to concrete must be snapped off to 1-1/2 inch from the face of the concrete and patched with non-shrink grout.

2.4 ACCESSORIES

- A. Grout: Non-shrink, non-metallic, pre-mixed, non-corrosive, non-staining product containing selected silica sands, portland cement, shrinkage compensating agents, plasticizing and water reducing agents. Minimum yield strength of 10,000 psi at 28 days.
- B. High Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy bolts, and hardened washers complying with ASTM A325. Exposed units galvanized per ASTM A153; others painted with rust-inhibitive primer.
- C. Anchor Bolts, Nuts and Washers: Low-carbon steel bolts, regular hexagon nuts and carbon steel washers conforming to ASTM A307. Exposed units galvanized per ASTM A153; others painted with rust-inhibitive primer.
- D. Supports for Reinforcement: Provide bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing in accordance with CRSI and ACI recommendations.
- E. Gaskets: Pipe penetrations in precast structures shall be constructed with integrally cast rubber or neoprene gaskets unless otherwise indicated. Integrally cast gaskets shall be Dura Seal III, A-lok, Dual Seal or equal.
- F. Wall sleeves: Where indicated on the Drawings, precast structures shall have integrally cast mechanical joint wall sleeves. Integrally cast wall sleeves shall be cast iron Clow F-1429, Omni-Sleeve, or equal.
- G. Plastic coated steel steps equal to: manhole steps made by M.A. Industries, Inc. Peachtree City, GA.
- H. All steps shall be capable of resisting the following loads without loosening or damage.
 - 1. Minimum horizontal pull out load 400 lb.
 - 2. Minimum vertical load 800 lb.
- I. Joint Sealant: Watertight sealant shall be installed between all precast sections on both the interior and exterior edges of the joint. Ramsneck mastic tape or equal.

2.5 FABRICATION

- A. Fabrication procedure to conform to PCI MNL-116.
- B. Maintain plant records and quality control program during production of precast members. Make records available upon request.
- C. Reinforcing steel surface shall be free of rust, mill scale and any coating including ice that could destroy or reduce bond.
- D. Ensure reinforcing steel, anchors, inserts, plates, angles, and other cast-in items are embedded and located as indicated on shop drawings. Locate anchors where they do not affect position of main reinforcement or placing of concrete.
- E. Tension reinforcement tendons as required to achieve design load criteria.

- F. Cast-in required openings with a dimension larger than 6 inches or where indicated on Drawings.
- G. Concrete Strength: Minimum ultimate compressive strength of the concrete at age 28 days shall be 5000 psi. Slump shall not exceed 4 inches.

2.6 FINISHING

- A. Ensure exposed-to-view finish surfaces of precast concrete members are uniform in color and appearance.
- B. Cure members under identical conditions to develop required concrete quality, and minimize appearance blemishes such as non-uniformity, staining, or surface cracking.
- C. Interior and exterior above grade surfaces - Exposed-to-View Finish: Normal plant finish with fins and protrusions removed, ground edges and ends, and flat face surfaces.
- D. Exterior below grade surfaces - Normal plant finish; normal form joint marks, small surface holes caused by air bubbles, minor chips, and spalling at edges or ends, without major discoloration will be tolerated, but no major or unsightly imperfections, honeycomb or structural defects will be permitted.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that site conditions are ready to receive work and field measurements are as on Drawings.
- B. Ensure excavation is free of water and precast units will not be placed on frozen or soft ground.
- C. Beginning of installation means installer accepts existing conditions.

3.2 PREPARATION

- A. A. Prepare support equipment for the erection procedure, temporary shoring and bracing, and induced loads during erection.

3.3 INSTALLATION

- A. Install precast units according to manufacturer's recommendations and the Drawings without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- B. Align and maintain uniform horizontal and vertical joints, as erection progresses.
- C. Maintain temporary bracing in place until final support is provided. Protect members from staining.

- D. Grout open spaces at connections and joints. Provide forms or other acceptable method to retain grout in place until sufficiently hard to support itself. Pack spaces with stiff grout material, tamping until voids are completely filled. Place grout to finish smooth, plumb and level with adjacent concrete surfaces. Keep grouted joints damp for not less than 24 hours after initial set. Promptly remove grout material from exposed surfaces before it hardens.
- E. Do not use power-actuated fasteners for surface attachment of accessory items in precast, prestressed unit unless otherwise accepted by precast manufacturer.

3.4 ERECTION TOLERANCES

- A. Erect members level and plumb.
- B. Conform to PCI MNL-127.

END OF SECTION

SECTION 03500

LEAKAGE TESTS FOR CONCRETE STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. SCOPE OF WORK

1. All fluid retaining concrete structures are required to be watertight and shall be tested by the Contractor and witnessed by the Engineer. Structures shall be tested with water as specified.
2. All tests shall be conducted in a manner to minimize as much as possible any interference with the Contractor's work or progress.
3. The Contractor shall notify the Engineer when the work is ready for testing, and tests shall be made as soon thereafter as possible. Personnel for reading meters, gauges, or other measuring devices and all other labor, equipment, air, water, and materials, including meters, gauges, fuel, bulkheads, and accessory equipment, shall be furnished by the Contractor.

1.3 REFERENCES

- A. AWWA Journal "A Summary Report on Concrete Water-Holding Structures," AWWA Committee on Concrete Holding Structures
- B. ACI Manual of "Environmental Engineering Practice Concrete Structures," ACI Committee 350 R-89, Part 4, Detroit, MI

1.4 QUALITY ASSURANCE

- A. Leakage tests of chambers and tanks shall be made before backfilling by filling the structure with water to the operating level, and then allowing a 24 hour presoak period, refilling if necessary to the operating level, and then observing the water surface level for the following 24 hours. Inspection for leakage will be made of the exterior surface of the structure, especially in the area around construction joints.
- B. Each section of water-holding structure which can be isolated in actual operation shall be isolated and tested for leakage.

1.5 ALLOWABLE LIMITS

- A. Leakage within the allowable limits will be accepted for structures from which there are no visible leaks and loss of water is less than 0.1 % of the tank volume or the water surface water drops no more than 1/2 inch during the 24 hour test whichever is the most restrictive measurement method.
- B. If leakage exceeds the allowable limits, the structure shall be repaired by locating, removing and replacing the leaking portions of the structure, in accordance with the requirements of Section 03732 or by other means approved by the Engineer. Each structure shall be retested until leakage is within the specified limits.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 WATER

- A. Water for filling of the structures will be supplied by the Contractor. The Contractor shall supply all hoses, pumps, labor, and other material to fill the structures. Water for subsequent fillings, if required, shall be at the expense of the Contractor.

3.2 TEST RESULTS

- A. The test results shall be reported in writing to the Engineer on the same day that the tests are made.

3.3 ADDITIONAL TESTS

- A. Contractor shall perform additional tests, at no additional cost to the owner, as may be required to demonstrate concrete repairs are adequate and conform to the leakage criteria established herein.

END OF SECTION

SECTION 03732
CONCRETE REPAIR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. SECTION INCLUDES

- 1. Preparation of concrete and application of repair materials.
- 2. Rehabilitation of concrete surfaces.

1.3 REFERENCES

- A. ANSI/ASTM C404 - Aggregates for Masonry Grouts.
- B. ANSI/ASTM C882 - Bond Strength of Epoxy-Resin Systems Used with Concrete.
- C. ASTM C33 - Concrete Aggregates.
- D. ASTM C150 - Portland Cement.

1.4 SUBMITTALS

- A. Submit narrative on repair methods and product data under provisions of Section 01300.
- B. Submit product data indicating product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.
- C. Submit manufacturer's installation instructions under provisions of Section 01300.
- D. Accurately record actual locations of structural reinforcement repairs and type of repair. Submit information under section 01700.

1.5 QUALITY ASSURANCE

- A. Materials Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

- B. Applicator: Company specializing in concrete repair approved by materials manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01600.
B. Store and protect products under provisions of Section 01600.
C. Comply with instructions for storage, shelf life limitations, and handling.

PART 2 - PRODUCTS

2.1 PATCHING MATERIALS

- A. Epoxy adhesive: Two-part epoxy adhesive meeting the following minimum characteristics:

<u>Characteristic</u>	<u>Test Method</u>	<u>Results*</u>
Bond Strength	ANSI/ASTM C882	1,900 psi
Tensile Strength	ASTM D638	4,800 psi
Flexural Strength	ASTM D790	7,400 psi
Compressive Strength	ASTM D695	9,500 psi

* 14 day Test Results

Epoxy adhesive shall be Sikadur 32, Hi-Mod, as manufactured by Sika Corporation or approved equal.

- B. Repair Mortar: A one component, ready to use with water, high strength polymer modified cementitious patching mortar for horizontal, vertical and overhead repair of concrete. The repair mortar shall be Octocrete as manufactured by IPA Systems, Inc. or approved equal.
- C. Bonding Agent: Acrylic Bonding Agent shall be Octoblen, as manufactured by IPA Systems, Inc. or approved equal.
- D. Portland Cement: ASTM C150, Type 1; gray.
- E. Sand: ASTM C33; uniformly graded, clean.
- F. Water: Clean and potable.

- G. Cleaning Agent: Commercial muriatic acid of 10 percent strength.

2.2 MIXING EPOXY ADHESIVE

- A. Mix in accordance with manufacturer's instructions for purpose intended.
- B. Mix components in clean equipment or containers. Conform to pot life and workability limits.

2.3 MIXING CEMENTITIOUS REPAIR MORTAR

- A. Mix mortar in accordance with manufacturer's instructions for purpose intended.
- B. Include bonding agent as additive to mix as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means installer accepts existing surfaces.

3.2 PREPARATION

- A. Clean concrete surfaces of dirt, laitance, corrosion, or other contamination by water blasting, sand blasting, acid washing as required by the manufacturers instructions. Rinse surface and allow to dry.
- B. Flush out cracks and voids with water to remove laitance and dirt.
- C. Provide temporary entry ports spaced to accomplish movement of fluids between ports, no deeper than the depth of the crack to be filled. Limit port size diameter to be no greater than the thickness of the crack. Provide temporary seal at concrete surface to prevent leakage of adhesive.
- D. For areas to be patched, remove broken and soft concrete 1/4 inch deep. Remove corrosion from steel. Clean surfaces mechanically; wash with acid and rinse with water.

3.3 REPAIR WORK

- A. Repair exposed structural, shrinkage, and settlement cracks of concrete by the epoxy injection method.
- B. Repair holes and cavities with Repair Mortar.

3.4 INJECTION - EPOXY RESIN ADHESIVE

- A. Inject adhesive into prepared ports under pressure using equipment appropriate for particular application.
- B. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port. Continue from port to port until entire crack is filled.
- C. Remove temporary seal and excessive adhesive.
- D. Clean surfaces adjacent to repair and blend finish.

3.5 APPLICATION - REPAIR MORTAR

- A. Trowel apply mortar mix as recommended by the manufacturer. Tamp into place filling voids at spalled areas.
- B. For patching honeycomb, trowel mortar onto surface, working into honeycomb to bring surface flush with surrounding area. Finish trowel surface to match surrounding area.
- C. Cover exposed steel reinforcement with epoxy mortar; feather edges to flush surface.

END OF SECTION

DIVISION 4
MASONRY

SECTION 04816

CONCRETE UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Decorative concrete masonry units.
3. Mortar and grout.
4. Steel reinforcing bars.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Masonry-cell insulation.

B. Related Sections:

1. Section 033000 "Cast-in-Place Concrete" for dovetail slots for masonry anchors.
2. Section 071900 "Water Repellents" for water repellents applied to concrete unit masonry.
3. Section 076200 "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide structural unit masonry that develops a net-area compressive strength of 2,000 psi at 28 days.
 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
 - 1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
 - 1. Decorative CMUs, in the form of small-scale units.
 - 2. Colored mortar.
 - 3. Weep holes/vents.
- D. Samples for Verification: For each type and color of the following:
 - 1. Exposed Decorative CMUs.
 - 2. Colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
 - 3. Accessories embedded in masonry.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Material Certificates: For each type and size of the following:
 - 1. Masonry units.
 - a. Include data on material properties material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - 2. Cementitious materials. Include brand, type, and name of manufacturer.
 - 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 4. Grout mixes. Include description of type and proportions of ingredients.

5. Reinforcing bars.
 6. Joint reinforcement.
 7. Anchors, ties, and metal accessories.
- C. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
- D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.
1. Build sample panels for each type of exposed unit masonry construction in sizes approximately 48 inches (1200 mm) long by 48 inches (1200 mm) high by full thickness.
 2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
 3. Protect approved sample panels from the elements with weather-resistant membrane.
 4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

- a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination. "

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.
- C. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530. I/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Regional Materials: CMUs shall be manufactured within 500 miles (800 km) of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
 2. Provide square-edged units for outside corners unless otherwise indicated.
- C. Integral Water Repellent: Provide units made with integral water repellent for exposed units and where indicated.
 1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
 - a. Products: Subject to compliance with requirements.
- D. CMUs: ASTM C 90.
 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.3 MPa).
 2. Density Classification: Normal weight unless otherwise indicated.
 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
- E. Decorative CMUs: ASTM C 90.
 1. Density Classification: Normal weight.
 2. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
 3. Pattern and Texture:
 - a. Standard pattern, split-face finish
 4. Colors: As selected by Architect from manufacturer's full range.
 5. Special Aggregate: Provide units made with aggregate matching aggregate in Architect's sample.

2.3 MORTAR AND GROUT MATERIALS

- A. Regional Materials: Aggregate for mortar and grout, cement, and lime shall be extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- C. Hydrated Lime: ASTM C 207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Aggregate for Mortar: ASTM C 144.
 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- F. Aggregate for Grout: ASTM C 404.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
 1. Products: Subject to compliance with requirements.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs, containing integral water repellent by same manufacturer.
 1. Products: Subject to compliance with requirements.

- I. Water: Potable.

2.4 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
1. Interior Walls: Hot-dip galvanized, carbon steel.
 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 3. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
 4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 6. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.5 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
 3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch- (1.52-mm-) thick, steel sheet, galvanized after fabrication.
 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire
- C. Partition Top anchors: 0.105-inch- (2.66-mm-) thick metal plate with 3/8-inch- (9.5-mm-) diameter metal rod 6 inches (152 mm) long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- D. Rigid Anchors: Fabricate from steel bars 1-1/2 inches (38 mm) wide by 1/4 inch (6.35 mm) thick by 24 inches (610 mm) long, with ends turned up 2 inches (51 mm) or with cross pins unless otherwise indicated.
1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

2.6 MISCELLANEOUS ANCHORS

- A. Anchor Bolts: Headed steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

2.7 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.
2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
3. Fabricate through-wall metal flashing embedded in masonry from stainless steel, with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cheney Flashing Company; Cheney Flashing (Dovetail) or Cheney 3-Way Flashing (Sawtooth).
 - 2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.
 - 3) Sandell Manufacturing Co., Inc.; Mechanically Keyed Flashing.
4. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
5. Fabricate through-wall flashing with drip edge where indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
6. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
7. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
8. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
9. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

- B. Flexible Flashing: Use the following unless otherwise indicated:

1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.030 inch.
 - a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- 1) Advanced Building Products Inc.; Peel-N-Seal.
 - 2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
 - 3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier ThruWall Flashing.
 - 4) Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
 - 5) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
 - 6) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
 - 7) Hohmann & Barnard, Inc.; Textroflash.
 - 8) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
 - 9) Sandell Manufacturing Co., Inc.; Sando-Seal.
 - 10) Williams Products, Inc.; Everlastic MF-40.
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
2. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymers alloy.
 - a. Products: Subject to compliance with requirements, [available products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) DuPont; Thru-Wall Flashing.
 - 2) Hohmann & Barnard, Inc.; Flex-Flash.
 - 3) Hyload, Inc.; Hyload Cloaked Flashing System.
 - 4) Net USA, Ltd.; Total Flash.
 - b. Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch thick.
 - c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of adhesive.
 - d. Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch thick, with a 0.015-inch- thick coating of rubberized-asphalt adhesive. Where flashing extends to face of masonry, rubberized-asphalt coating is held back approximately 1-1/2 inches from edge.
 - 1) Color: Gray.
 - e. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- C. Application: Unless otherwise indicated, use the following:
 1. Where flashing is indicated to receive counterflashing, use metal flashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.
 4. Where flashing is fully concealed, use flexible flashing.

- D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.
 - 1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Mortar Net USA, Ltd.; Blok-Flash.
- E. Solder and Sealants for Sheet Metal Flashings: As specified in Section 07620 "Sheet Metal Flashing and Trim."
 - 1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
 - 2. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Pre-molded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-8050rPVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
 - 1. Products: Subject to compliance with requirements.

2.9 MASONRY-CELL INSULATION

- A. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

- B. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

2.10 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
 - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated.
 - 1. For reinforced masonry, use Type S.
- D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
 - 1. Mix to match Architect's sample.
 - 2. Application: Use colored aggregate mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
 - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530. I/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 - 2. Proportion grout in accordance with ASTM C 476, Table 1.
 - 3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Build chases and recesses to accommodate items specified in this and other Sections.
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
 - 2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
 - 3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
 - 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm).

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a Wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each Wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
2. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
3. At fire-rated partitions, treat joint between top of partition and underside of structure.

3.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to one story high, but not more than 20 feet (6 m).

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

3.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO CONCRETE

- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
 - 1. Provide an open space not less than 1/2 inch (13 mm) wide between masonry and concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c.. vertically and 36 inches (915 mm) o.c. horizontally.

3.9 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 - 1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
 - 2. Install preformed control-joint gaskets designed to fit standard sash block.
 - 3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
 - 4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

3.10 LINTELS

- A. Provide steel lintels at all wall openings.
- B. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.11 FLASHING

- A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
 5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
 6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
 7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

3.12 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530. I/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
1. Comply with requirements in ACI 530. I/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.13 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.
- B. Inspections: Level 2 special inspections according to the "International Building Code."
 - 1. Begin masonry construction only after inspectors have verified proportions of site prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

3.14 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
 - 3. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.15 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
 - 2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 02220 "Excavation, Backfilling and Compaction".
 - 3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

DIVISION 5
STEEL

SECTION 05100
STRUCTURAL STEEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Structural steel.
- 2. Grout.

- B. Related Sections:

- 1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
- 2. Division 05 Section "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other metal items not defined as structural steel.
- 3. Division 05 Section "Metal Stairs."
- 4. Division 09 painting Sections for surface-preparation and priming requirements.

1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges. "
- B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.
- C. Heavy Sections: Rolled and built-up sections as follows:
 - 1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.
 - 2. Welded built-up members with plates thicker than 2 inches.
 - 3. Column base plates thicker than 2 inches.
- D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

- E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.4 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering design by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
 - 1. Select and complete connections using schematic details indicated and AISC 360.
 - 2. Use LRFD; data are given at factored-load level.
- B. Moment Connections: Type FR, fully restrained.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
 - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
 - 2. Include embedment drawings.
 - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
 - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pre-tensioned and slip-critical high-strength bolted connections.
 - 5. Identify members and connections of the seismic-load-resisting system.
 - 6. Indicate locations and dimensions of protected zones.
 - 7. Identify demand critical welds.
 - 8. For structural-steel connections indicated to comply with design loads, include structural design data.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:
 - 1. Power source (constant current or constant voltage).
 - 2. Electrode manufacturer and trade name, for demand critical welds.
- D. Qualification Data: For qualified Installer, fabricator, testing agency.
- E. Welding certificates.
- F. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

- G. Mill test reports for structural steel, including chemical and physical properties.
- H. Product Test Reports: For the following:
 - 1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 2. Direct-tension indicators.
 - 3. Tension-control, high-strength bolt-nut-washer assemblies.
 - 4. Shop primers.
 - 5. Nonshrink grout.
- I. Source quality-control reports.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement PI or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators. "
- D. Welding Qualifications: Qualify procedures and personnel according to
- E. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 1. Welders and welding operators performing work on bottom-flange, demand critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.
- F. Comply with applicable provisions of the following specifications and documents:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts. "
- G. Pre-installation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.8 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 572/A 572M, Grade 50.
- B. Channels, Angles, S-Shapes: ASTM A 36/A 36M.
- C. Plate and Bar: ASTM A 36/A 36M.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
 - 1. Weight Class: Standard.
 - 2. Finish: Black except where indicated to be galvanized.
- F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type I, hardened carbon-steel washers; all with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

- B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers with plain finish.
 - 1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
 - 1. Finish: Hot-dip zinc coating.
 - 2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavyhex carbon-steel nuts, and hardened carbon-steel washers.
 - 1. Finish: Plain.
- E. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, coldfinished carbon steel; AWS DI. 1/1)1.1M, Type B.
- F. Unheaded Anchor Rods: ASTM A 36/A 36M.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436, Type 1, hardened carbon steel.
 - 5. Finish: Plain.
- G. Headed Anchor Rods: ASTM F 1554, Grade 36, straight.
 - 1. Nuts: ASTM A 563 hex carbon steel.
 - 2. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 3. Washers: ASTM F 436, Type 1, hardened carbon steel.
 - 4. Finish: Plain.
- H. Threaded Rods: ASTM A 36/A 36M.
 - 1. Nuts: ASTM A 563 hex carbon steel.
 - 2. Washers: ASTM A 36/A 36M carbon steel.
 - 3. Finish: Plain.
- I. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.
- J. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

2.3 PRIMER

- A. Primer: Comply with Division 09 painting Sections.
- B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- C. Galvanizing Repair Paint: ASTM A 780.

2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
 - 1. Camber structural-steel members where indicated.
 - 2. Fabricate beams with rolling camber up.
 - 3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
 - 4. Mark and match-mark materials for field assembly.
 - 5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
 - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
- H. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable

stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated.

- I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.
 - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
 - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
 - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
 - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
 - 2. Surfaces to be field welded.
 - 3. Surfaces to be high-strength bolted with slip-critical connections.
 - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 - 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
 - 1. SSPC-SP 2, "Hand Tool Cleaning. "
 - 2. SSPC-SP 3, "Power Tool Cleaning."
 - 3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning. "
 - 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
 - 5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning. "
 - 6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning. "
 - 7. SSPC-SP IONACE No. 2, "Near-White Blast Cleaning. "
 - 8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 - 9. SSPC-SP 8, "Pickling."

- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPCPS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
 - 1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
 - 2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.
 - 1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.
- C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts. "
- D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS DI. I/DI.IM and the following inspection procedures, at testing agency's option:
 - 1. Liquid Penetrant Inspection: ASTM E 165.
 - 2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - 3. Ultrasonic Inspection: ASTM E 164.
 - 4. Radiographic Inspection: ASTM E 94.
- E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS DI.I/DI.IM for stud welding and as follows:

1. Bend tests will be performed if visual inspections reveal either a less-than continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D 1. I/DI. 1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
 1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
 1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 2. Weld plate washers to top of baseplate.
 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's installation instructions for shrinkage-resistant grouts.
- C. c. Maintain erection tolerances of structural steel within AISCs "Code of Standard Practice for Steel Buildings and Bridges. "

- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS DI. I/DI. 1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS DI. I/DI. 1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
 - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS DI.1/D1.1M and AWS DI.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
 - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
 - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
 - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 PREFABRICATED BUILDING COLUMNS

- A. Install prefabricated building columns to comply with AISC 360, manufacturer's written recommendations, and requirements of testing and inspecting agency that apply to the fire-resistance rating indicated.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.
- B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts. "
- C. Welded Connections: Field welds will be visually inspected according to AWS DI.I/DI.IM.
 - 1. In addition to visual inspection, field welds will be tested and inspected according to AWS DI.I/DI.IM and the following inspection procedures, at testing agency's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS DI. I/DI. 1M for stud welding and as follows:
 - 1. Perform bend tests if visual inspections reveal either a less-than-continuous 360degree flash or welding repairs to any shear connector.
 - 2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D I. I/DI. 1M.
- E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.7 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 painting Sections.

END OF SECTION

SECTION 05510

MISCELLANEOUS ALUMINUM FABRICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. WORK INCLUDED

- 1. Custom fabricated aluminum items.

1.3 REFERENCE STANDARDS

- A. AA DAF-45 - Designation System for Aluminum Finishes
- B. AA SAA-46 - Standards for Anodized Architectural Aluminum
- C. ASTM B211- Aluminum-Alloy Bars, Rods, Wire.
- D. ASTM B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubing.
- E. ASTM B241 - Aluminum-Alloy Seamless Pipe and Seamless Extruded Tubes.
- F. ASTM B429 - Aluminum-Alloy Extruded Structural Pipe and Tube.
- G. AWS D1.1 - Structural Welding Code, and the Aluminum Association Standards; latest addition.
- H. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate.
- I. ASTM B210 - Aluminum and Aluminum Alloy Drawn Seamless Tubes.

1.4 SUBMITTALS

- A. Submit shop drawings of metal fabrications and product data on manufactured items in accordance with Section 01300.
- B. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners and accessories.
- C. Include erection drawings, elevations and details where applicable.

- D. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

1.5 QUALITY ASSURANCE

- A. Qualification of Installer: Use adequate numbers of skilled workman who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and methods needed for proper performance of the work of this section.
- B. Qualification of Manufacture: Products used in the work of this section shall be produced by manufacturers regularly engaged in the manufacture of similar items and with a history of successful production of these items.
- C. Requirements of Regulatory Agencies: All installations shall be in compliance with BOCA, Basic Building Code and Local Ordinances, and with the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Standards.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide and install items as indicated on the Drawings, complete in respect to function as intended.

2.2 MATERIALS

- A. Aluminum: Aluminum work shall be fabricated of plates and rolled or extruded shapes. All aluminum shall conform to the appropriate current ASTM Specifications and alloy listed in the following table:

<u>Application</u>	<u>Designator</u>	<u>ASTM</u> Alloy
Plate	B209	6061-T6
Bolts, Screws	B211	6061-T6
Nuts, 1/4" Tap and Under	B211	2024-T4
Nuts, 5/16" Tap and Over	B211	6061-T6
Rolled or Extruded Shapes	B308	6061-T6
Extruded Bar	B211	6061-T6
Drawn Tube	B210	6061-T6
Extruded Tube	B221	6061-T6
Pipe	B241	6061-T6
Shims	B209	1100-0

- B. Stainless Steel: Stainless steel work shall be fabricated of plates and rolled or cold drawn shapes. All stainless steel shall conform to the appropriate current ASTM Specifications and shall be Type 304L (extra low carbon).

2.3 FASTENERS & ANCHORAGE

- A. Anchorage shall be provided where necessary for fastening miscellaneous metal items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; toggle bolts for masonry; machine and carriage bolts for aluminum.
- B. ASTM A193 GRB8 stainless steel bolts with (2) stainless steel plate washers and ASTM A194 GRF8 nuts.

2.4 FABRICATION

- A. Verify dimensions on-site prior to shop fabrication.
- B. Fabricate items with joints neatly fitted and properly secured.
- C. Fit and shop assemble in largest particle sections for delivery to site.
- D. Grind exposed welds smooth and flush with adjacent finished surfaces.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts unobtrusively located consistent with design or structure, except where specifically noted otherwise.
- F. Make exposed joints flush butt type hair line joints where mechanically fastened.
- G. Supply components required for proper anchorage of metal fabrications. Fabricate anchorage and related components of same material and finish as metal fabrication, unless otherwise specified in schedule herein.

2.5 DISSIMILAR MATERIALS

- A. Where dissimilar metals are in contact, or where aluminum is in contact with concrete, mortar, masonry, wet or pressure-treated wood, or absorptive materials subject to wetting, the surfaces shall be protected with a coat of bituminous paint.

2.6 STAIRS

- A. All interior and exterior stairs shall be Aluminum per Section 2.2 Materials.
- B. Provide stair layout in accordance with the Drawings.
- C. Provide detailed shop drawings for the design and layout of all connections and individual members.

2.7 STOP GATES

- A. Stop gates shall be 114" thick 6061-T6 aluminum plate, reinforced as required to deflect no more than 1/30th of the span. Bottom edge shall be beveled for positive seating. Stop gate shall have 112" Ø bar handle.
- B. Stop gate frame shall be one piece 6061-T6 extruded aluminum frame mitered and welded continuously with one piece polymer guide. Frame shall be supplied with mounting flange to mount inside concrete channel.
- C. Stop gate and frame shall be Model 203 by Halliday Products, equal product by Washington Aluminum Company or approved equal.

PART 3 - EXECUTION

3.1 ERECTION

- A. Obtain Engineer's review prior to site cutting or making adjustments which are not part of scheduled work.
- B. Install items square and level, accurately fitted and free from distortion or defects.
- C. Make provision for erection stresses by temporary bracing. Keep work in alignment.
- D. Replace items damaged in course of installation.
- E. Perform field welding in accordance with AWS D1.1.
- F. After installation, touch-up field welds and scratched and damaged surfaces.
- G. Supply to appropriate sections, items requiring to be cast into concrete or embedded in masonry, complete with necessary setting templates.

END OF SECTION

SECTION 05511

METAL STAIRS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Industrial-type stairs with steel grating treads.

- B. Related Sections:

- 1. Division 03 Section "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
 - 2. Division 05 Section "Pipe and Tube Railings" for pipe and tube railings.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design metal stairs, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

- 1. Uniform Load: 100 lbf/sq. ft.
 - 2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to L/360.

- C. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

- 1. Handrails and Top Rails of Guards:

- a. Uniform load of 50 lbf/ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

- 2. Infill of Guards:

- a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..
 - b. Infill load and other loads need not be assumed to act concurrently.
- D. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. Component Importance Factor is 1.5.

1.4 SUBMITTALS

- A. Product Data: For metal stairs and the following:
 - 1. Prefilled metal-pan stair treads.
 - 2. Paint products.
 - 3. Grout.
- B. LEED Submittals:
 - 1. Product Data for Credit MR 4.1: Indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement indicating costs for each product having recycled content.
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- D. Samples for Initial Selection: For products involving selection of color, texture, or design.
- E. Samples for Verification: For the following products, in manufacturer's standard sizes:
 - 1. Precast concrete treads.
- F. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- G. Qualification Data: For qualified professional engineer.
- H. Welding certificates.
- I. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.
 - 1. Test railings according ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

- B. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
 - 1. Preassembled Stairs: Commercial Service class.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1. 1M, "Structural Welding Code - Steel."
 - 2. AWS D1. 3, "Structural Welding Code - Sheet Steel. "

1.6 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so that they will not encroach on required stair width and will be within the fire-resistance-rated stair enclosure.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

- A. Recycled Content of Steel Products: Provide products with average recycled content of steel products so postconsumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

- E. Steel Bars for Grating Treads: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
- F. Wire Rod for Grating Crossbars: ASTM A 510.
- G. Uncoated, Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, either commercial steel, Type B, or structural steel, Grade 25, unless another grade is required by design loads; exposed.
- H. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30, unless another grade is required by design loads.
- I. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating, either commercial steel, Type B, or structural steel, Grade 33, unless another grade is required by design loads.
- J. Woven-Wire Mesh: Intermediate-crimp, square pattern, 2-inch woven-wire mesh, made from 0.135-inch nominal diameter wire complying with ASTM A 510.
- K. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

2.3 NONFERROUS METALS

- A. Aluminum Extrusions: ASTM B 221 , Alloy 6063-T6.
- B. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.
- C. Bronze Extrusions: ASTM B 455, Alloy UNS No. C38500 (extruded architectural bronze).
- D. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. 04400 (leaded semi-red brass).
- E. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.4 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941, Class Fe/Zn 12 for exterior use, and Class Fe/Zn5 where built into exterior walls. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
 - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.
- D. Machine Screws: ASME B18.6.3.

- E. Lag Screws: ASMEB18.2.1.
- F. Plain Washers: Round, ASME B18.22.1.
- G. Lock Washers: Helical, spring type, ASME Bl 8.21.1.
- H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- C. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
- H. Welded Wire Fabric: ASTM A 185/A 185M, 6 by 6 inches, WI.4 by WI.4, unless otherwise indicated.

2.6 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, railings, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.

2. Use connections that maintain structural value of joined pieces.
- B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals. 2. Obtain fusion without undercut or overlap.
 2. Remove welding flux immediately.
 3. Weld exposed corners and seams continuously unless otherwise indicated.
 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 2 welds: completely sanded joint, some undercutting and pinholes okay.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.7 STEEL-FRAMED STAIRS

- A. Stair Framing:
 1. Fabricate stringers of steel channels.
 - a. Provide closures for exposed ends of channel stringers.
 2. Construct platforms of steel channel headers and miscellaneous framing members as needed to comply with performance requirements.
 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
 4. Where stairs are enclosed by gypsum board assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they will not encroach on required stair width and will be within the fire resistance-rated stair enclosure.
 5. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- B. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual. "

1. Fabricate treads and platforms from welded steel grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch (24 mm) o.c. and crossbars at 4 inches (100 mm) o.c.
2. Fabricate treads and platforms from welded or pressure-locked steel grating with openings in gratings no more than 5/16 inch (8 mm) in least dimension.
3. Surface: Serrated.
4. Finish: Galvanized.
5. Fabricate grating treads with rolled-steel floor plate or cast abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
6. Fabricate grating platforms with nosing matching that on grating treads. Provide toe plates at open-sided edges of grating platforms. Weld grating to platform framing.

2.8 STAIR RAILINGS

- A. Comply with applicable requirements in Division 05 Section "Pipe and Tube Railings." Delete or revise any of three subparagraphs below to suit type of railing required. Coordinate with Section that specifies railings.

2.9 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal stairs after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 2. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 1. Interior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Place and finish concrete fill for treads and platforms to comply with Division 03 Section "Cast-in-Place Concrete. "
 - 1. 1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.
- H. Install precast concrete treads with adhesive supplied by manufacturer.

3.2 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of baseplates.
- B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, If protruding, cut off flush with edge of bearing plate before packing with grout.
 - 1. Use nonmetallic, nonshrink grout unless otherwise indicated.
 - 2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.3 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

SECTION 05521
PIPE TUBE AND RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Aluminum pipe and tube railings

B. Related Sections:

- 1. Division 05 Section "Metal Stairs" for steel tube railings associated with metal stairs.
- 2. Division 06 Section "Rough Carpentry" for wood blocking for anchoring railings.
- 3. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.
- 4. Division 03 Section "Cast-in-Place Concrete" for hot dipped galvanized handrails and guard rails.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design railings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:

- 1. Steel: 72 percent of minimum yield strength.

- C. Structural Performance: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

- 1. Handrails and Top Rails of Guards:

- a. Uniform load of 50 lb/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

- 2. Infill of Guards:

- a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.

- b. Infill load and other loads need not be assumed to act concurrently.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- E. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
- D. Samples for Verification: For each type of exposed finish required.
 - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
 - 2. Fittings and brackets.
 - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
 - a. Show method of finishing and connecting members at intersections.
- E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For qualified professional engineer.
- G. Welding certificates.
- H. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

- B. Welding Qualifications: Qualify procedures and personnel according to AWS DI. 101.1M, "Structural Welding Code - Steel. "
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS DI. I/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS DI.2/D1.2M, "Structural Welding Code - Aluminum. "

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION AND SCHEDULING

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.2 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded bars and tubing: ASTM B 221, Alloy 6063-T6
- C. Extruded Structural Round Tubing: ASTM B 4291B 429M, Alloy 6063-T6.

- D. Drawn Seamless Tubing: ASTM B 210, Alloy 6063-T6.
- E. Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- F. Die and Hand Forgings: ASTM B 247, Alloy 6061-T6.
- G. Castings: ASTM B 261B 26M, Alloy A356.O-T6.

2.3 STAINLESS STEEL CHAIN

- A. 1/4" Stainless steel straight link chain with stainless steel safety snap hook and 1/4" stainless steel eye bolts.

2.4 FASTENERS

- A. General: Provide the following:
 - 1. Aluminum Railings: Type 304 stainless-steel fasteners.
- B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated Fasteners for Interconnecting Railing Components:
 - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
 - 2. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
 - 3. Provide tamper-resistant machine screws for exposed fasteners unless otherwise indicated.
- C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- E. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- F. Shop Primer for Galvanized Steel: Cementitious galvanized metal primer complying with MP1#26
- G. Intermediate Coats and Topcoats: Provide products that comply with Division 09 painting Sections.
- H. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- I. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- J. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.6 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
 3. Remove flux immediately.
 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Non-welded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
1. 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- J. Form changes in direction as follows:
1. As detailed.
- K. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- L. Close exposed ends of railing members with prefabricated end fittings.
- M. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- N. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- O. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.
- P. Perforated Steel Infill Panels: Fabricate infill panels from perforated plate panels Attached to stainless steel channel frames to existing stair stringers and upper handrail support with a minimum of exposed fasteners. Fabricate panel to fully integrate with existing stairway guard rails as indicated on drawings.
1. Perforated Panel: 16 gauge steel perforated panel with 63% open area airflow.
 2. Finish: Black polyester powder paint finish
- Q. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into I-by-1/2-by-1/8-inch metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.
1. Orient wire mesh with wires horizontal and vertical.
 2. Finish: Black polyester powder painted finish

- R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

2.8 ALUMINUM FINISHES

- A. Mechanical Finish: AA-MI 2 (Mechanical Finish: non-specular as fabricated).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
 - 1. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
 - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
 - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

- C. Corrosion Protection: Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- D. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Non-welded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.4 ANCHORING POSTS

- A. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
 - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.

3.5 ATTACHING RAILINGS

- A. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends
- B. Anchor railing ends to metal surfaces with flanges welded to railing ends.
- C. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
 - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- D. Secure wall brackets and railing end flanges to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

2. For hollow masonry anchorage, use toggle bolts.
3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into fire-retardant treated wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.6 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION

SECTION 05530

GRATING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal bar gratings.
2. Extruded-aluminum plank gratings.
3. Metal frames and supports for gratings.

B. Related Sections:

1. Division 05 Section "Structural Steel Framing" for structural-steel framing system components.
2. Division 05 Section "Metal Stairs" for grating treads and landings of steel-framed stairs.
3. Division 05 Section "Pipe and Tube Railings" for metal pipe and tube handrails and railings.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design gratings, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
 1. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft. (2.87 kN/sq. m) or concentrated load of 1200 lbf, whichever produces the greater stress.
 2. Limit deflection to L/360 or 1/4 inch (6.4 mm), whichever is less.
- C. Seismic Performance: Provide gratings capable of withstanding the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:

1. Metal bar gratings.
2. Extruded-aluminum plank gratings.
3. Clips and anchorage devices for gratings.

- B. Shop Drawings: Include plans, sections, details, and attachments to other work.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified professional engineer.
- B. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
- C. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum. "

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with gratings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

- B. Steel Bars for Bar Gratings: ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.
- C. Wire Rod for Bar Grating Crossbars: ASTM A 510 (ASTM A 510M).
- D. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 33 (Grade 230), with G90 (Z275) coating.

2.2 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer for type of use indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- B. Extruded Bars and Shapes: ASTM B 221 (ASTM B 221M), alloys as follows:
 - 1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
 - 2. 6061-TI, for grating crossbars.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners for interior and exterior use. Select fasteners for type, grade, and class required.
 - 1. Provide stainless-steel fasteners for fastening aluminum.
- B. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts, and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 2 (A4).
- C. Anchor Bolts: Stainless-steel bolts, nuts, and flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts.
- D. Plain Washers: Round, ASME B18.22.1 (ASME 1318.22M).
- E. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME 1318.21.2M).
- F. Post-Installed Anchors: Chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Interior and Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 2 (A4) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy that is welded.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.5 FABRICATION

- A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch material cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.
- D. Fit exposed connections accurately together to form hairline joints.
- E. Welding: Comply with AWS recommendations and the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
- F. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space the anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
 - 1. Fabricate toeplates for attaching in the field.
 - 2. Toeplate Height: 4 inches (100 mm) unless otherwise indicated.

2.6 METAL BAR GRATINGS

- A. Manufacturers: Subject to compliance with requirements. :
- B. Welded Steel Grating MBG-I :
 - 1. Bearing Bar Spacing: 11/16 inch (17 mm) o.c.
 - 2. Bearing Bar Depth: 2 inches (51 mm) and as required to comply with structural performance requirements.
 - 3. Bearing Bar Thickness: 3/16 inch (4.8 mm) and as required to comply with structural performance requirements.
 - 4. Crossbar Spacing: 2 inches (51 mm) o.c.

5. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz./sq. ft. (550 g/sq. m) of coated surface.
- C. Removable Grating Sections: Fabricate with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
 1. Provide no fewer than four weld lugs for each grating section composed of rectangular bearing bars 3/16 inch (4.8 mm) or less in thickness and spaced less than 15/16 inch (24 mm) o.c., with each lug shop welded to three or more bearing bars. Interrupt intermediate bearing bars as necessary for fasteners securing grating to supports.
 2. Furnish galvanized malleable-iron flange clamp with galvanized bolt for securing grating to supports. Furnish as a system designed to be installed from above grating by one person.
 - 1) Products: Subject to compliance with requirements.
- D. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
 1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.
- E. Do not notch bearing bars at supports to maintain elevation.

2.7 EXTRUDED-ALUMINUM PLANK GRATINGS

- A. Manufacturers: Subject to compliance with requirements.
- B. Provide extruded-aluminum plank gratings in type, size, and finish indicated or, if not indicated, as recommended by manufacturer for indicated applications and as needed to support indicated loads.
 1. Type: Extruded-aluminum planks approximately 6 inches (152 mm) wide with multiple flanges approximately 1.2 inches (30 mm) o.c., acting as bearing bars connected by a web that serves as a walking surface. Top surface has raised ribs to increase slip resistance.
 2. Depth: 2 inches (51 mm) and as required to comply with structural performance requirements.
 3. Perforations: Rectangular, 19/32 by 3 inches (15 by 76 mm), with adjacent rows staggered.
 4. Finish: Mill finish, as fabricated.
- C. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.

2.8 GRATING FRAMES AND SUPPORTS

- A. Frames and Supports for Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

1. Unless otherwise indicated, fabricate from same basic metal as gratings.
 2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches (600 mm) o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches (32 mm) wide by 1/4 inch (6 mm) thick by 8 inches (200 mm) long.
- B. Galvanize steel frames and supports in the following locations:
1. Exterior.

2.9 STEEL FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish gratings, frames, and supports after assembly.
- C. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- D. Fit exposed connections accurately together to form hairline joints.
 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- E. Attach toeplates to gratings by welding at locations indicated.
- F. Field Welding: Comply with the following requirements:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.

1. Remove welding flux immediately.

- G. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

3.2 INSTALLING METAL BAR GRATINGS

- A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.
- C. Attach nonremovable units to supporting members by welding where both materials are same; otherwise, fasten by bolting as indicated above.

3.3 INSTALLING METAL PLANK GRATINGS

- A. General: Comply with manufacturer's written instructions for installing gratings. Use manufacturer's standard anchor clips and hold-down devices for bolted connections.
- B. Attach aluminum units to steel or aluminum supporting members by bolting at side channels at every point of contact and by bolting intermediate planks at each end on alternate sides. Bolt adjacent planks together at midspan.

3.4 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION

DIVISION 11
EQUIPMENT

SECTION 11310
PLANT WATER BOOSTER PUMPS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The Contractor shall furnish and install skid mounted packaged booster pump system with pumps, control panel and accessories as indicated on the Drawings and specified herein.
 - 1. Supply one (1) packaged plant water system as described herein. Packaged plant water system shall include pumps, motor's, VFD's, piping, valves, and control panel.
- B. The supplier of the booster pump system shall be responsible for the proper performance of the system. All equipment shall perform as specified and the completed installation shall operate in accordance with the requirements of the Drawings and Specifications for this project.
- C. The booster pump system with controls and appurtenances shall be provided by the same supplier.

1.2 REFERENCE STANDARDS

- A. The work in this section is subject to the requirements of applicable portions of the following standards:
 - 1. Hydraulic Institute
 - 2. ANSI – American National Standards Institute
 - 3. ASTM – American Society for Testing and Materials
 - 4. IEEE – Institute of Electrical and Electronics Engineers
 - 5. NEMA – National Electrical Manufacturers Association
 - 6. NEC – National Electrical Code
 - 7. ISO – International Standards Organization
 - 8. UL – Underwriters Laboratories, Inc.

1.3 SUBMITTALS

- A. Submit manufacturer's shop drawings, product data, operation and maintenance manuals, and installation instructions under the provisions of Section of 01300.
- B. Shop Drawings: Provide dimensioned drawings which indicate in large scale detail, fabricated project specific equipment showing construction methods, and component assembly and location in plan and cross section, mounting requirements and clearances, and utility requirements as to types, sizes, and locations. For electrical and signal requirements, indicate service connections, characteristics, and wiring diagrams.
- C. Product Data: Provide pump performance curves, electrical motor data, equipment description, pump controller characteristics, dimensions and construction, equipment capacities, characteristics and limitations, materials, finishes, utility requirements and locations. Provide a

performance chart showing curves for torque, current, power factor, input/output KW, efficiency and data on starting and no load characteristics.

- D. Manufacturer's Installation Instructions: Indicate installation requirements and special procedures.
- E. Operation and Maintenance Manuals: Submit under the provisions of Sections 01300 and 01700.

1.4 SCHEDULING AND COORDINATION

- A. Schedule Work under the provisions of Section 01310.
- B. Coordinate the delivery and installation of the Work of this Section with the Work of other Sections.

1.5 . QUALITY ASSURANCE

- A. Perform work in accordance with Section 01400.
- B. Materials and installation shall conform to manufacturer's specifications and instructions.
- C. The booster pump system, controls and accessories shall be from the same supplier in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.
- D. Provide services of an authorized manufacturer's representative for on-site assistance and instruction during installation and start-up.
- E. Contractor shall verify dimensions in the field before ordering equipment.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle equipment according to manufacturer's instructions and the provisions of Sections 01600 and 01610.
- B. Coordinate the delivery and installation of the work of this section with the work of other sections.

1.7 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Sections 01300 and 01700.
- B. The manufacturer shall provide a detailed manual that includes specific instructions for receiving and handling, assembly, wiring, installation, operation, repair and service, storage, troubleshooting, detailed exploded drawings of the unit, and a full parts list.
- C. The manual shall include periodic maintenance requirements and schedules.

1.8 WARRANTY

- A. The Contractor shall provide a one year warranty which begins at Final Completion for defects in materials and workmanship in accordance with Sections 01700 and 01740.
- B. The manufacturer shall provide a warranty against any defect or malfunction in materials and workmanship for a period of one year which begins when the equipment is put into service in accordance with Sections 01700 and 01740.
- C. A written manufacturer's warranty shall be supplied.
 - 1. The warranty period shall be a non-prorated period of 24 months from date of installation, not to exceed 30 months from date of manufacture.

1.9 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Sections 01700 and 01720.
- B. Record actual locations of pipes, utilities, equipment and accessories.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. To provide single source responsibility, the booster pump system including pumps, controls, piping and appurtenances for this project shall be provided by the same manufacturer.
- B. Subject to Compliance with requirements provide products by one of the following
 - 1. HPIC-3656 Water pressure booster system, by Hayes Pump Inc.
 - 2. Equal product, subject to compliance with requirements.

2.2 VARIABLE SPEED PACKAGED MANUFACTURED BOOSTER PUMP SYSTEM

- A. Furnish and install a pre-fabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure. System shall include;
 - 1. Three (3) Goulds Close Coupled End Suction Pumps, Model 22BF
 - 2. Three (3) 5 Horsepower, 3500 RPM, 230/460 Volt, 3 Phase, 60 Hertz TEFC Electric Motors
 - 3. Three (3) Allen-Bradley 5 Horsepower 460 Volt Variable Frequency Drive (VFD) with NEMA 1 Disconnects.
 - 4. One (1) 30 Amp Single Point NEMA 4 Disconnect.
 - 5. One (1) Custom Booster Pump NEMA 4 Controller.
 - 6. Fabricated Steel
- B. System shall be capable of automatically providing a minimum system pressure of 70 psig while at a flow rate of from 40 gpm to 100 gpm with a suction pressure of 0 psig minimum, 10 psig

maximum. Booster system shall consist of three end suction centrifugal pumps with a rated flow of 50 gpm at 162 feet of head (70 psi). Two pumps shall operate at any time with the third acting as a spare.

- C. The packaged pump system shall be a standard product of a single pump manufacturer. The entire pump system including pumps and pump logic controller, shall be designed and built by the same manufacturer.
- D. The complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. standards.

2.3 PUMPS

- A. The pump units shall be of one manufacturer and provide complete including electric motor drive. Production performance testing conducted by manufacturer on each pump unit using motor. Head shut off and a minimum of two operating points will be measured at operating speed to verify performance.
- B. Pumps shall be Goulds 3656 S Group, Model 22BF single stage horizontal close-coupled end suction centrifugal pumps or approved equal.
- C. Pump casing shall be a spiral volute type with back pull out design with a tangentially oriented discharge nozzle and casing drain with a steel or brass pipe plug.
- D. The suction/discharge connections shall be up to 2-1/2" size with NPT threaded connections.
- E. A replaceable suction wear ring shall be provided and held securely by means of an interference fit in the casing suction.
- F. Pump impeller shall be of enclosed design and key driven. A stainless-steel cap screw and washer shall provide positive attachment of the impeller to the motor shaft.
- G. Seal housing shall hold the stationary seat of the mechanical shaft seal. The seal housing shall be held in place in a machined fit on the pump casing to maintain component alignment and 'O-ring'
- H. A rigid motor adaptor of ASTM A48 CL20 cast iron construction shall support the pump liquid end and maintain pump to motor alignment. A bottom port shall be provided to allow condensation or seal leakage to drain and not be retained within the adaptor. The power frame adapter shall be an integral 1-piece design with the seal housing.
- I. Pump shaft seal shall be a John Crane Type 21 constructed of the following materials
 - 1. Stationary Face: Ceramic
 - 2. Rotating Face: Carbon
 - 3. Elastomers: Buna N
 - 4. Mechanical Seal: 316 Stainless Steel
- J. Pump Construction:
 - 1. Casing: Cast iron, ASTM A48 Class 20B
 - 2. Casing Wear Ring: Bismuth Brass

- | | | |
|----|---------------|-----------------------------------|
| 3. | Seal Housing: | Cast Iron ASTM A48 Class 30 |
| 4. | Adapter: | Cast Iron ASTM A48 Class 30 |
| 5. | Impeller: | Silicon Bronze, ASTM B584, C87500 |
| 6. | Shaft | AISI 1045 Steel |
| 7. | Shaft Sleeve | AISI Type 303 Stainless Steel |

- K. Motor maximum HP rating shall be 5 HP. Motor shall be rated for operation on 460 volt, 3 phase service at 3500 RPM. See Part 2.4 for requirements for the variable frequency drive motors.
- L. Electric drive motor shall be non-overloading of NEMA standard design with JM shaft extension and C-Face mounting suitable for close coupled pump mounting. Motor shall be Totally enclosed, fan cooled (TEFC) with Class F insulation with a temperature rise no higher than Class B.
- M. Motor service factor shall be 1.15 and maintain High Efficiency

2.4 VARIABLE FREQUENCY DRIVE MOTORS

- A. The VFD shall be of the PWM (Pulse Width Modulation) design using current IGBT (Insulated Gate Bipolar Transistor) technology.
- B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of motor. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate the need for motor de-rating.
- C. The VFD shall utilize an energy optimization algorithm to minimize energy consumption. The output voltage shall be adjusted in response to the load, independent of speed.
- D. The VFD shall automatically reduce the switching frequency and/or the output voltage and frequency to the motor during periods of sustained ambient temperatures that are higher than the normal operating range. The switching frequency shall be reduced before motor speed is reduced.
- E. An integral RFI filter shall be standard in the VFD.
- F. The VFD shall have a minimum of two skip frequency bands which can be field adjustable.
- G. The VFD shall have internal solid-state overload protection designed to trip within the range of 125-150% of rated current.
- H. The VFD shall have, as a minimum, the following input/output capabilities:
 - 1. Speed Reference Signal: 0-10 VDC, 4-20 mA
 - 2. Digital remote on/off
 - 3. Fault Signal Relay (NC or NO)
 - 4. Fieldbus communication port (RS485)
- I. The cooling design of the VFD shall be such that a Class B motor temperature rise is not exceeded at full rated load and speed at a minimum switching frequency of 9.0 kHz.

2.5 CONTROL PANEL AND PUMP SYSTEM CONTROLLER

- A. The pump system controller shall be a standard product developed and supported by the pump manufacturer. The custom controller by Hayes Pump or approved equal.
- B. The pump system control panel enclosure shall be NEMA 4. Incoming power shall be 460 volt, 3 phase.
- C. Pump controller to have Internal Webserver and Communication with External RJ45 to allow end users to view all alarms and setting through a standard internet connection without special software. Allows end user to determine an IP address to view any screen from a standard internet connection
- D. HMI touch screen Controller
 - 1. Shall be UL listed 5.7" color touch screen controller to control all pump starts and stops and indicate alarm and or fault conditions.
 - 2. Shall have enclosure dimensions of 16"h x 12"w x 8"d
- E. The controller shall have the following features:
 - 1. Selectable pump sequencing on same controller
 - 2. Non-volatile internal memory to prevent program loss due to power failure
 - 3. Power Off/On Switch
 - 4. Auto Detect – specialized internal software to automatically and continually determine the optimal start and stop speed of each pump to ensure lowest possible kW and water usage. Feature will eliminate pump cycling automatically
 - 5. Auto Commission- specialized internal software to automatically calibrate the booster to meet the buildings demand profile, obey customer selected operating conditions. Software will also determine no flow without use of separate sensor. Feature will eliminate specialized start-up personal and ensure booster is operating at best efficiency to meet customers set points
 - 6. External Fault and Alarm inputs, (4) - User selectable
 - 7. Relay Outputs (6 amp, form 'C') fault and alarm, (4) - User selectable
 - 8. Complete preventative maintenance notification based upon life expectancy of pump, motor, VFD, PLC and transducers
 - 9. Control power light, pulsating audiovisual alarm system
 - 10. Complete VFD access on controller HMI to allow operator to run pumps in manual at desired frequency
 - 11. User selectable reaction to specific alarm
 - a. Transducer failure or loss of signal = shutdown or maintain a selectable max speed for all pumps
 - b. Alarms can be set to shut down after a determined number of faults within "X" hrs
 - c. Help buttons available on touchscreen to provide the customer additional support
- F. Electrical
 - 1. Pump controller to be UL Listed.
 - 2. Conduit between motors and VFD to be liquid-tight flexible metallic type.
 - 3. Conduit between VFD and Single Point Disconnect to be liquid-tight flexible metallic type.

4. Single Point Disconnect enclosure and base pan shall be Nema 4 and shall house all main disconnect with external operating handle and include control power transformer and other necessary controls.
5. All of the electrical components shall be factory wired and tested by the pump system manufacturer in accordance with the provisions of the National Electrical Code. All control wires shall be individually numbered and each component shall be labeled accordingly. All internal wiring shall be copper stranded, A.W.G. with a minimum insulation of 90o C. Manufacturer shall certify the complete power and control assembly with the UL mark for Industrial Control panels.

2.6 SEQUENCE OF OPERATION

- A. The system controller shall operate equal capacity variable speed pumps to maintain a constant discharge pressure (system set-point). The system controller shall receive an analog signal [4-20mA] from the factory installed pressure transducer on the discharge manifold, indicating the actual system pressure. As flow demand increases the pump speed shall be increased to maintain the system set-point pressure. When the operating pump(s) reach 96% of full speed (adjustable), an additional pump will be started and will increase speed until the system set-point is achieved. When the system pressure is equal to the system set-point all pumps in operation shall reach equal operating speeds. As flow demand decreases the pump speed shall be reduced while system set-point pressure is maintained. When all pumps in operation are running at low speed the system controller shall switch off pumps when fewer pumps are able to maintain system demand.
- B. The system controller shall be capable of switching pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.
- C. All pumps in the system shall alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), the system controller shall have the capability to alternate the pumps every 24 hours, every 48 hours or once per week. The interval and actual time of the pump change-over shall be field adjustable.

2.7 SYSTEM CONSTRUCTION

- A. Centrifugal pumps shall be manifolded together in suction and discharge manifolds with 4" diameter headers and 2" pump branch lines. Manifold connection sizes shall be 4" grooved.
- B. Branch isolation valves shall be provided on the suction and discharge of each pump. Isolation valve sizes shall be full port ball valves.
- C. A spring-loaded non-slam type check valve shall be installed on the discharge of each pump. The valve shall be a wafer style type fitted between two flanges. Check valves shall have a POM composite body and poppet, a stainless steel spring with EPDM or NBR seats.
- D. Connection for diaphragm tank shall be 2.0" NPT.
- E. A pressure transducer shall be factory installed on the discharge manifold. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be +/- 1.0% full scale with hysteresis and repeatability of no greater than 0.1% full scale. The output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

- F. A water shortage protection device shall be included on the suction manifold to prevent the pumps from running dry.
- G. A bourdon tube pressure gauge, 2.5 inch diameter, shall be placed on the suction and discharge manifolds. The gauge shall be liquid filled and have copper alloy internal parts in a stainless steel case. Gauge accuracy shall be 2 1/2 %. The gauge shall be capable of a pressure of 30% above its maximum span without requiring recalibration.
 - 1. Suction Gauge Pressure Range: 0 - 150PSI
 - 2. Discharge Gauge Pressure Range: 0 - 300 PSI
- H. The base frame shall be constructed of fabricated carbon steel. Structural members shall be painted in acrylic enamel with a minimum thickness of 3 mils.
- I. Rubber vibration dampers shall be fitted between each pumps and base frame to minimize vibration.
- J. Standard production equipment valves, and fittings shall have factory finish. Bolts to be zinc plated.

2.8 HYDROPNEUMATIC TANK

- A. Tank shall be an ASME rated full acceptance bladder type steel pressure tank. Tanks volume shall be up to 158 gallons. Tank shall be rated for a working pressure capacity of 150 psig.
- B. Tank shall be standard with a heavy-duty butyl replaceable bladder with a minimum thickness of 0.1 inch.
- C. Tank bottom shall have a 2 inch malleable iron NPTF connection fitting.

2.9 TESTING

- A. The entire pump station shall be factory performance tested as a complete unit prior to shipment. Job-site programming shall be entered into the controller prior to shipment (details of installation requirements shall be communicated to the pump system manufacturer).
- B. System shall be performance tested for project specific conditions. A verified performance test report shall be provided by the manufacturer.
- C. The system shall undergo a hydrostatic test prior to shipment. System to be tested at 200 Psi for 5 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate the work of this section with the work of other sections.

- B. Verify that site conditions are ready to receive the work of this section.
- C. Verify that required utilities are available and in correct locations.
- D. Verify dimensions and clearances in the field prior to installation to ensure proper fitting and operation of equipment.

3.2 INSTALLATION

- A. Contractor shall perform all field wiring and other utility connections as required by manufacturer to provide a complete working system.
- B. Install all submersible pumps and appurtenances in accordance with Drawings, manufacturer's instructions and Sections 01400 and 01610.
- C. Furnish all accessories and components as required to provide a complete working system in accordance with manufacturer's recommendations.
- D. The manufacturer shall provide assistance and inspection of installed equipment for proper operation as described in Sections 01400 and 01610.
- E. Manufacturer's representative shall make all final adjustments for proper operation in accordance with Section 01610.

3.3 INITIALSTART-UP

- A. After the installation is complete, a qualified factory representative shall place the pumps, controls and accessories in operation, conduct a complete function check, and make all necessary adjustments for regular service in accordance with Sections 01400 and 01610.
- B. Manufacturer's representative shall certify in writing that equipment is installed and operating as specified and in accordance with the manufacturer's recommendations.

3.4 TESTING AND DEMONSTRATION

- A. Start-up, test and demonstrate equipment in accordance with Sections 01400 and 01610. Contractor shall provide water for testing and demonstration.
- B. After the pumps have been completely installed and wired, the manufacturers' representative shall perform the following:
 - 1. Megger stator and power cables.
 - 2. Check seal lubrication.
 - 3. Check for proper rotation.
 - 4. Check power supply voltage.
 - 5. Measure motor operating load and no load current.
 - 6. Check level control operation and sequence.
- C. Provide instruction to Owner in accordance with Section 01610.

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PLANT WATER BOOSTER PUMPS
CONTRACT 2021-5

END OF SECTION

SECTION 11342
GRIT REMOVAL EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Work described in this section includes furnishing all labor, equipment, materials, tools and incidentals required for a complete and operable installation of the grit removal system as shown on the drawings and specified herein. The manufacturer shall supply the equipment and the general contractor shall install the equipment.

1.2 DESIGN REQUIREMENTS

- A. The Grit Removal and Dewatering System shall:
 - 1. Remove 90% to 95% of all grit particles with specific gravity of 2.65 greater than or equal to 150 micron at a total peak design flow of 14.0 mgd.
 - 2. Remove 90% to 95% of all grit particles with specific gravity of 2.65 greater than or equal to 106 micron at the average design flow of 4.75 mgd.
- B. The Grit Removal System shall be comprised of the following components:
 - 1. Grit Separator
 - 2. Grit Pump
 - 3. Grit Classifier
 - 4. Control Panel
- C. The Grit Separator shall consist of internal components installed into a concrete tank to receive the incoming screened flow. The Grit Separator shall remove the specified grit particles from the specified peak flow and collect them in a sump at the bottom of the unit. The de-gritted effluent from the Grit Separator shall be discharged via an overflow channel as shown on the drawings.
- D. The Grit Separator shall be all-hydraulic, self-activating and shall not require instrumentation, internal moving parts or external power.
- E. The Grit Separator shall be self-cleaning and consist of corrosion resistant components.
- F. The Grit Pump shall convey the concentrated grit slurry from the underflow of the Grit Separator to the Grit Classifier.
- G. The Grit Removal System and all appurtenances shall be supplied by a single supplier. Piping to/from the Grit Pump and Grit Classifier shall be provided by the Contractor.

- H. The system to be furnished hereunder shall be made by a manufacturer regularly engaged in such work and who has furnished similar installations and had them in successful and continuous operation for a minimum period of ten years.
- I. Data on performance testing, service history and operation of existing installations using the submitted equipment shall be made available to the Engineer, upon request, for use in determining that the Grit Removal System offered meets the intent of the contract, performance requirements and criteria stated in these specifications.
- J. The Grit Separator technology shall be designed utilizing Computational Fluid Dynamics (CFD) and field data to verify its flow regime, headloss and grit removal characteristics. Upon request, data on the computation methods used and generic simulation results shall be made available to the engineer.
- K. Grasshoppers, reciprocating rakes and similar type of units shall not be accepted.
- L. Units without an internal dip plate with annulus baffle plate to modify the flow pattern shall not be accepted.
- M. Units using Apex valves shall not be accepted.
- N. Equipment using paddles or air to supplement or induce a vortex shall not be accepted.

1.3 SUBMITTALS AND OPERATION AND MAINTENANCE MANUALS

- A. Submittals shall be provided in accordance with Section 01300 and shall include at a minimum the following:
 - 1. Manufacturer's catalog data and descriptive literature including equipment weights and performance data.
 - 2. General arrangement and dimensional drawings of the grit removal system.
 - 3. Written recommended procedures for job site storage, handling, and installation of the equipment.
- B. Operation and maintenance manuals shall be provided in accordance with the Sections 01300 and 01700. The manuals shall at a minimum include the following data:
 - 1. Alignment, adjustment, and repair instructions.
 - 2. MANUFACTURER'S installation instructions
 - 3. Assembly diagrams.
 - 4. Troubleshooting guide.
 - 5. Lubrication instructions.
 - 6. Recommended spare parts lists and predicted life of parts subjected to wear.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with Section 01400.
- B. Materials and installation shall conform to manufacturer's specifications and instructions.

- C. The grit system components and accessories shall be from the same supplier in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.
- D. Provide services of an authorized manufacturer's representative for on-site assistance and instruction during installation and start-up.
- E. Contractor shall verify dimensions in the field before ordering equipment.
- F. The system shall be furnished by a MANUFACTURER who complies with the requirements of the ISO 9001 Quality.
- G. MANUFACTURER shall be successful in the experience of manufacture, operation, and servicing of Grit Removal Systems of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years. The MANUFACTURER shall submit evidence of experience having supplied a minimum of ten (10) installations in North America of similar size to the proposed system.
- H. If equipment other than that shown on the Drawings is submitted to the Engineer for consideration as an equal, it shall be the responsibility of the MANUFACTURER requesting approval to submit with the request a revised design and layout of the mechanical equipment acceptable to the ENGINEER. Revised drawings shall show the proposed location of the alternate unit, and area required for withdrawal space of replacement or serviceable components. This drawing shall also show clearances of adjacent equipment and service area required by that equipment. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the MANUFACTURER and not the OWNER.
- I. Approved equal MANUFACTURERS shall furnish performance test results documenting that the System has achieved the specified performance requirement. Performance test reports must clearly show the performance of the entire grit removal system, including grit washing and/or dewatering units.

1.5 SCHEDULING AND COORDINATION

- A. Schedule Work under the provisions of Section 01310.
- B. Coordinate the delivery and installation of the Work of this Section with the Work of other Sections.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle equipment according to manufacturer's instructions and the provisions of Sections 01600 and 01610.
- B. Coordinate the delivery and installation of the work of this section with the work of other sections.

1.7 WARRANTY

- A. The Contractor shall provide a one-year warranty for defects in materials and workmanship in accordance with Sections 01700 and 01740.
- B. The manufacturer shall provide a one-year warranty against any defect or malfunction due to workmanship in the equipment and materials in accordance with Sections 01700 and 01740.
- C. A written manufacturer's warranty shall be supplied.
- D. Certificate of Compliance - The MANUFACTURER shall warrant that the Grit Removal System which was supplied was manufactured in strict compliance with the Contract Specifications.

1.8 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01720.
- B. Record actual locations of pipes, utilities, equipment and accessories

PART 2 - PRODUCTS

2.1 GRIT SEPARATOR

- A. Design Data
 - 1. Number of units: 1
 - 2. Size: 20' Diameter
 - 3. Configuration: In Situ
 - 4. Performance (Peak Flow): 95% Removal of all grit (specific gravity 2.65) $\geq$ 150 Microns at peak flow.
 - 5. Performance (Average Flow): 95% Removal of all grit (specific gravity 2.65) $\geq$ 106 Microns at average flow.
 - 6. Performance (Average Flow): 95% Removal of all grit (specific gravity 2.65) $\geq$ 75 Microns at daily flow.
 - 7. Daily Flow/Unit: 2.5 M.G.D. with nor more than 1" headloss
 - 8. Average Flow/Unit: 4.75 MGD with no more than 1" headloss
 - 9. Peak Flow/Unit: 14.0 MGD with 8" headloss
 - 10. Depth of flow Peak/Average/Daily: 13"/7"/5"
 - 11. Underflow Rate: 400 GPM
 - 12. Influent Connection: 30" Flanged Pipe
 - 13. Effluent Connection: 60" wide channel
 - 14. Underflow Layout: Submersible Pump
 - 15. NPW Connection: 2" NPT
 - 16. Internal Component Material: 304SS
 - 17. Support Frame Material: Galvanized Mild Steel
- B. Operation

1. The Grit Separator shall be designed to separate grit and sand from screened raw wastewater using hydrodynamic separation and boundary layer effects to aid gravitational forces.
2. All flow passages shall be self-cleaning and free of sharp projections or fittings that may snag stringy or fibrous materials.
3. The Grit Separator shall be characterized by a predetermined flow path caused by the vessel geometry and flow modifying components to maximize the concentration and removal of settleable solids.
4. The Grit Separator shall include a fluidizing system to prevent the collected grit from compacting in the collection area, release entrapped organics, and aid in transporting the accumulated grit to the Grit Dewatering Unit.

C. Construction

1. The Grit Separator shall consist of a circular concrete chamber constructed by the CONTRACTOR. The base of the chamber shall be sloped towards the grit collection area located in the chamber sump.
2. The tangential inlet pipe shall be cast into the chamber as shown on the contract
3. drawings.
4. The internal components of the Grit Separator shall consist of a dip plate with annulus baffle plate and overflow channel and a center shaft and cone fabricated from stainless steel.
5. The center shaft and cone shall be mounted so that its edge is clear of the sloping base
6. of the vessel. It shall be removable from the top of the unit.
7. All suspended components shall be attached to a support frame anchored to the concrete chamber walls.
8. A stainless steel fluidizing ring shall be mounted to the floor of the grit collection
9. under the cone.
10. All flanges shall conform to ANSI B16.1 bolt patterns.

D. Valves and Accessories

1. The Grit Separator shall be supplied with the following valves:
 - a. One (1) 2" NEMA 4X bronze solenoid valve to automate the fluidizing water supply.
 - b. One (1) 2" brass pressure regulator to adjust the fluidizing water pressure.
 - c. Two (2) 2" bronze ball valves to shut off the fluidizing water and isolate the solenoid valve.
2. One (1) 0-100 psig pressure gauge shall be provided for the grit removal system to monitor the fluidizing water delivery pressure.

2.2 GRIT PUMP

- A. Provide a submersible wet pit vortex-type slurry pump capable of delivering 400 gpm at 41' Total Dynamic Head (TDH). The pump shall be 4xll Model CLCESR with 10.5 inch impeller as manufactured by WEMCO, equal pump by Hayward Gordon, or approved equal.
- B. The pump shall be of a design and manufacture that has been used in at least five installations in which identically sized equipment has provided satisfactory performance for a minimum of five

(5) years in a similar application. The pump manufacturer shall comply with the requirements of the ISO 9001 Quality and ISO 14001.

- C. The pump complete with submersible motor, fastout, Hi-Chrome iron base elbow and lifting yoke, and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to insure compatibility and integrity of the individual components, and provide the specified warranty for all components
- D. The pump shall be designed for continuous operation with a fully recessed impeller mounted completely out of the flow path between the pump inlet and discharge connections so that solids are not required to flow through the impeller. All flow path clearances within the pump shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.
- E. The untrimmed impeller shall be of the cup-type design such that blade ends are surrounded by an integral rim which shall direct the flow to the center of the volute, minimizing particle impact and reducing wear.
 - 1. The impeller shall be specifically designed to pump grit slurries and shall have no less than 10 vanes, each of minimum of 5/16 inches of the specified material and be trimmed to meet the condition points as specified. Pump-out vanes on the rear shroud of the impeller are not acceptable.
 - 2. The hydraulic design shall be such that the length of the impeller vane increases as wear occurs to the rim, allowing as new or better pumping performance throughout the wear cycle of the impeller.
- F. The single piece casing thickness shall be a minimum of 3/4" with normal casting tolerances, and of centerline discharge to ensure that the pump and motor will be centered on and provide maximum clamping force to the base elbow installed in the wet-well. Pumps shall be equipped with slotted raised-face flanges to receive 125 lb. standard bolting, and special case slots shall be cast in to retain bolts and fasten the motor adapter for easy case removal. A removable wearplate of Hi-Chrome iron shall be provided back of the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing.
- G. The parts exposed to abrasive wear - case, impeller and wearplate - shall be of all Hi-Chrome iron material conforming to ASTM Designation A532-75 Class III, Type A, and be a minimum of 700 Brinell hardness for maximum wear resistance.
- H. The pump manufacturer shall provide a means to remove and reinstall the pump into the wet pit without entering the pit or disconnecting piping using a cast, base elbow, constructed of Hi-chrome iron ASTM A532, with a minimum Brinell hardness of 650 and wall thickness of 3/4", which shall be permanently mounted in the grit separator as shown by the plans. The fast-out/base-elbow casting shall include a base elbow to which vertical discharge piping can be connected and provide mounts for two stainless steel Schedule 40 rails which will guide the pump into position.
- I. The pump motor shall be suitable for completely submerged service rated 15 HP, 3 phase, 60 cycle, 460-volt, 1200 RPM, and shall be mounted on the pump with the impeller attached to the motor shaft by suitable means. The motor shall be squirrel-cage induction premium quality suited for sewage wet well applications defined by the National Electric Code as Class 1; Division 1, hazardous locations section 501-8(a) requiring explosion proof construction. The motor shall

conform to the latest applicable requirements of NEMA, IEEE, ANSI and NEC standards. The motors shall be furnished with Class F rated insulation materials and shall be rated as Class F, 1.15 service factor, Class 1, Groups C&D. The motor shall be manufactured in the United States of America. The ability to provide any/all replacement parts, engineering design support, complete dynamometer testing, and U/L rerate capability shall be provided domestically.

- J. The motor bearings shall be ball, single row, deep groove, Conrad type, and shall have a Class 2 internal fit conforming to AFBMA Std. 20 with a minimum L10 rating life of 17,500 hours. The motor shall be greased by the manufacturer with premium moisture resistant polyurea thickened grease containing rust inhibitors and suitable for operation over a temperature range of 25° C to +120° C.
- K. Two independently mounted mechanical face type shaft seals shall be provided. The inner and outer seals shall be separated by an oil filled chamber. The oil chamber shall act as a barrier to trap moisture and provide sufficient time for a planned shutdown. The oil shall also provide lubrication to the internal seal. Standard John Crane Type 21, Sealol type 43, or Sealol type 42, U/L approved seals shall be provided. The inner seal shall be provided with carbon rotating face and ceramic stationary face. The outer seal shall be provided with a solid tungsten carbide rotating face and a silicon carbide or tungsten carbide stationary face and shall be designed for easy replacement. The outer seal assembly will be designed to allow solids and particles to be thrown away from the seal face. In compliance with U/L Standards for explosion proof motors, a flame path shall be provided by a labyrinth slinger in the bottom flange in order to prevent the ignition of ambient gases. Under such conditions the seal design shall allow for pressure relief across either seal face. Dual moisture sensing probes shall be provided that extend into the oil chamber to detect the presence of moisture should the outer seal fail.
- L. The moisture protection system shall also be designed to detect water in the motor chamber and provide a warning signal prior to water levels reaching the bearing or wound stator assemblies.
- M. The power cable and cap assembly shall be designed to prevent moisture from wicking through the cable assembly even when the cable jacket has been punctured.
- N. The motor enclosure including: frame, end brackets, flange and cap assembly shall be cast iron, ASTM type A-48, Class 25 or better. The motor shaft shall be 416 stainless steel. 303, 304, 410 stainless steel 1704 PH, Carpenter 20, all types of Monel or Nitronic 50 stainless steel may be specified as options. All external hardware including the motor nameplate shall be made of stainless steel. Motor rotor construction shall be die cast aluminum or fabricated copper or their respective alloys. All exposed motor parts including frame, brackets, flange, and cap assembly shall receive an alkyd primer and epoxy ester finish coat of high-grade paint to resist rust and corrosion.
- O. The motor shall successfully operate under power supply variations per NEMA MG1-14.30 and shall be designed to limit the maximum surface temperature to NEC specifications for Division 1: Class 1, Group D, or Class 1, Group C&D for hazardous locations. The motor shall be NEMA Design B or A with torque and starting current in accordance with NEMA MG1-12.
- P. All motors to include 2 normally closed automatic reset thermostats connected in series and embedded in adjoining phases as required by Underwriters Laboratories for motors of 1 HP or higher.

2.3 GRIT CLASSIFIER

A. Design Data

1. Number of Units: 1
2. Design Flow Rate: 400 gpm
3. Maximum Grit Load (at +/- 2 rpm): 0.93 cu. yard./hr
4. Performance: 95% removal of all grit (specific gravity of 2.65)
5. Tank Capacity Volume: 355 gal
6. Clarifier Surface Area: 43 Sq. Ft.
7. Spiral Diameter: 12"
8. Maximum Spiral Speed: +/- 2 rpm
9. Inlet Connection: 8" Flanged Pipe
10. Overflow Connection: 10" Flanged Pipe
11. Motor: 2.0 hp
12. Body Material: 304SS with PE Liner
13. Spiral Material: Carbon steel.

B. Operation

1. The Grit Classifier shall be designed to capture and dewater concentrated grit slurry from the Grit Separator.
2. Units requiring cyclone separators as the first stage primary separation shall not be acceptable

C. Construction

1. The Grit Classifier shall include but not be limited to the following:
 - a. Specially designed tank with internal flow redirecting inlet baffle
 - b. Conveying screw
 - c. Tank covers
 - d. Tank support assemblies
2. The receiving tank and screw trough shall be constructed of stainless steel and shall be supplied with a replaceable polyurethane wear liner. The inclined screw conveyor discharge trough shall be furnished with a 304 stainless steel support assembly for the discharge end of the unit. The trough support assembly shall be shipped as one finished assembly for ease of field installation. An external trough support assembly at the lower end shall be specifically designed to support the lower end of the tank assembly.
3. The conveying screw shall be shaft-less, a minimum 3/4 inch thick, 1/2 pitch, and inclined at 25 degrees from the horizontal and require no intermediate or lower bearings.
4. Units containing lower bearing assemblies for the screw auger shall not be acceptable.
5. Units utilizing shafted screws and/or intermediate hanger bearings internal to the unit shall not be acceptable.
6. The receiving tank and screw discharge trough assembly shall be fully covered. All covers shall be stainless steel of a minimum 11 gauge thickness. All covers shall be of bolted construction with gasketing. The inlet pipe support cover shall include a welded inlet pipe with spinning flange connection. All assembly hardware shall be stainless steel.
7. All flanges shall be a minimum of 1/2 inch thick, drilled to match ANSI 150 lb. pipe flanges.

D. Drive Unit

1. The discharge trough mounted screw conveyor drive assembly shall be an integral unit with a maximum output speed of approximately 5 RPM.
2. The motor shall be 3 phase, 460 VAC, 60 Hz
3. The gear reducer shall have an oil tight housing and be bolted directly to the screw trough.

E. Valves and Accessories

1. The Grit Classifier unit shall be supplied with one (1) 2" brass ball valve to open/close the drain pipe.

F. Grit Dumpster

1. The grit dumpster shall be of adequate capacity and dimensions to be suitable for this application and shall adhere to the following specifications:
 - a. Material: Heavy duty 7 gauge steel body
 - b. Casters: semi-steel, phenolic, rubber mold-on or polyurethane (two swivel and two rigid)
 - c. Drain plug shall be provided
 - d. Finish: primer and finish coat of high-grade paint to resist rust and corrosion.

2.4 CONTROLS AND INSTRUMENTATION

A. Control Panel

1. One (1) control panel shall be furnished, completely pre-wired and tested .
2. The control panel shall adhere to the following specifications:
 - a. Enclosure rating: NEMA4X
 - b. Material: 304SS
 - c. Voltage: 480 Volt
 - d. Phase: 3 Phase
 - e. Frequency: 60 Hz
 - f. Load: 21 Amp
 - g. Logic: Relay
3. The Control panel shall contain all timers, starters, switches, indicator lights, and other components necessary to operate the following equipment:
 - a. One (1) Grit Separator
 - b. One (1) Grit Pump
 - c. One (1) Grit Classifier
4. The control panel shall be supplied with a Transformer with 480 volt primary winding and 120 volt secondary winding with fused secondary.
5. The control panel shall be supplied with applicable control relays and time delay relays with a minimum one extra normally closed and one extra normally opened contact is provided for each relay.

6. Where remote monitoring is required, the panel shall be provided with all dry contacts necessary.
7. The panel door layout shall include the following items:
 - a. Front panel mounted combination main disconnect switch and circuit breaker
 - b. Back lit Power Maintained 2-way switch
 - c. System three position HOA switch
 - d. System Emergency Stop push button
 - e. System Alarm Reset push button
 - f. Grit Removal Cycle Start push button
 - g. Grit Separator fluidizing water solenoid Open/Close switch
 - h. Grit Separator fluidizing water valve OPEN indicating light
 - i. Grit Pump running light
 - j. Grit Pump three position HOA switch
 - k. Grit Pump fail indicating light
 - l. Grit Pump manual START push button
 - m. Grit Pump manual STOP push button
 - n. Grit Classifier running light
 - o. Grit Classifier fail indicating light
 - p. Grit Classifier three position HOA switch
 - q. Grit Classifier manual START push button
 - r. Grit Classifier manual STOP push button

2.5 SEQUENCE OF OPERATION

- A. The system shall be controlled to provide automatic or manual operation, manual starting and stopping and system shut down when a fault is detected.
- B. Grit Separator
 1. Screened raw wastewater shall be gravity fed into the Grit Separator continuously.
 2. A time clock (TC) shall initiate when grit discharge cycles occur. The time clock shall be adjustable to initiate cycles up to every 20 minutes.
 3. When the time clock initiates a cycle, the Grit Classifier shall operate for an adjustable time period.
 4. Concurrently, the control panel shall send a signal to open the solenoid valve
 5. located on the fluidizing line for an adjustable time period (typically 60 seconds).
 6. After the fluidizing time runs out and the solenoid valve closes, the grit pump shall operate for an adjustable period of time.

2.6 UTILITY REQUIREMENTS

- A. WATER
 1. The Grit Separator shall require an intermittent supply of minimum 50 gpm clarified non-potable water at 50 psig supplied to the grit fluidizing pipe via a NPT connection.
- B. ELECTRICAL

1. The system shall require one (1) 480 VAC, three phase electrical service connection

2.7 MATERIALS AND FINISHES

A. MATERIALS

1. All stainless steel used for the fabrication of the equipment shall conform to the following standards:
 - a. Plate and Sheet: ASTM A167/A240
 - b. Bar: ASTM A276/A479
 - c. Tube: ASTM A312

B. EXTERIOR SURFACES FINISHES

1. All surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.
2. All stainless steel surfaces shall be acid washed.

2.8 MANUFACTURER

- A. The Grit Removal System shall be manufactured by Hydro International, Hillsboro, OR approved equal. Being named or bidding as an approved equal does not relieve the manufacturer of meeting these specifications.
- B. Alternate manufacturers shall require the engineer's written approval during the bidding period in accordance with bidding requirements.

PART 3 - EXECUTION

3.1 DELIVERY AND INSTALLATION

- A. The equipment and material shall be shipped complete except where partial disassembly is required by transportation regulations or for protection of components.
- B. Spare parts shall be packed in containers bearing packing lists clearly designating contents and pieces of equipment for which they are intended.
- C. The CONTRACTOR shall inspect equipment prior to unloading and notify the MANUFACTURER of any damage to equipment to effect proper remedial action. Failure to notify the MANUFACTURER of damage to equipment prior to unloading shall void all warranties pertaining to subject equipment.
- D. The CONTRACTOR shall unload, store and safeguard equipment, materials, and spare parts in accordance with MANUFACTURER'S recommendations.

3.2 EXAMINATION

- A. Coordinate the work of this section with the work of other sections.
- B. Verify that site conditions are ready to receive the work of this section.
- C. Verify that required utilities are available and in correct locations.
- D. Verify dimensions and clearances in the field prior to installation to ensure proper fitting and operation of equipment.

3.3 INSTALLATION

- A. Contractor shall perform all field wiring and other utility connections as required by manufacturer to provide a complete working system.
- B. Install all equipment and components in accordance with Drawings, manufacturer's instructions and Sections 01400, 01600 and 01610.
- C. Furnish all accessories and components as required to provide a complete working system in accordance with manufacturer's recommendations.
- D. Prior to startup, the manufacturer shall provide assistance and inspection of installed equipment for proper alignment, operation and connections as described in Sections 01400, 01600 and 01610.
- E. Manufacturer's representative shall make all final adjustments for proper operation in accordance with Sections 01600 and 01610.

3.4 DEMONSTRATION

- A. Satisfactory operation shall be demonstrated in accordance with Section 01610.

3.5 MANUFACTURER'S CERTIFICATE(S)

- A. Provide MANUFACTURER'S certificate of installation and commissioning following functional testing and startup in accordance with Section 01700.

3.6 START-UP, TRAINING AND MANUFACTURER'S SERVICES

- A. A factory trained representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for a maximum of four (4) 8-hour man-days (two (2) visits) for installation inspection, plant startup, functional testing, and operator instructions; travel time excluded in accordance with Section 01610.

END OF SECTION

DIVISION 14
CONVEYING EQUIPMENT

SECTION 14600
HOISTS AND CRANES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. WORK INCLUDED

- 1. Furnish and install two electric chain hoist/trolley assembly mounted on an I beam with accessories as shown on the Drawings and described in this specification.

1.3 SUBMITTALS

- A. Submit Product Data, Shop Drawings and installation instructions under the provisions of Section 01300.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Sections 01300 and 01700.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle equipment according to the provisions of Sections 01600 and 01610.

1.6 QUALITY ASSURANCE

- A. The appurtenances for equipment provided under this specification shall be from the same equipment manufacturer in order to achieve standardization of operation, maintenance, spare parts, manufacturer's service and warranty.

1.7 WARRANTY

- A. Provide a one year warranty which begins when the equipment is accepted by the Owner in accordance with Sections 01700 and 01740.

1.8 MANUFACTURER'S REPRESENTATIVE

- A. Furnish the services of a qualified equipment manufacturer's representative in accordance with Sections 01400, 01600 and 01610 if required during installation or start-up.

PART 2 - PRODUCTS

2.1 TROLLEY HOIST FOR GRIT PUMP

- A. Provide a one ton US Army type trolley hoist with lug suspension and hand geared trolley with 8 foot lift. Trolley hoist shall be integrally built trolley and chain block combination.
- B. The hoist frame shall be impact resistant, lightweight, heat treated, permanent mold cast aluminum alloy. The frame shall be heavily proportioned, designed for rigidity to hold the gears and bearings in close alignment. The frame and covers shall enclose all operating parts protecting them from dirt and weather.
- C. The chain wheel shall be formed to receive the links of the hand chain, and an overload device calibrated for the capacity of the hoist.
- D. The gearing shall be a straight spur for good efficiency, with gears and pinions generously proportioned and precision cut from alloy steel and heat treated for maximum strength and durability. Gears shall be grease packed in a grease tight gear case.
- E. An automatic, screw actuated, Weston-type load brake shall hold the load under all conditions and permit fine smooth control in lowering. The brake shall be self-adjusting with long wearing friction washers.
- F. The load sprocket and sprocket gear shall be machined from a one-piece steel forging. The chain guide shall be heat-treated, spring steel, flexible guide which provides heat treated smooth surfaces that flex in the frame, controlling the load without binding.
- G. The load chain shall be formed from closely calibrated chain links of heat treated steel alloy. The links shall be accurately formed to fit the pockets of the load sprocket. Sufficient length of chain shall be provided to allow hoisted equipment to be lowered to finished grade level.
- H. The hand chain shall be zinc plated welded steel links accurately formed to fit the pockets of the chain wheel for gag-resistant operation in the chain wheel and guide arrangement.
- I. The hooks shall be drop forged steel which will open noticeably when subjected to excessive overload. They shall be full swiveling and equipped with a spring type hook latch.
- J. Provide a hand geared one ton rigid mount trolley linked to the hoist via a lug suspension.
- K. Trolley shall have geared wheel flanges on one side that mesh with a pinion.
- L. The wheels shall be steel with hardened treads and ball bearings which operate on flat I beam flanges of the size shown on the Drawings.

- M. Movement of hand geared trolley shall be accomplished by pulling on an endless hand chain. Trolley wheel gears and pinions shall have machine cut gear teeth.
- N. Trolley hoist shall be Budgit Model 8322 by Columbus McKinnon Corporation or approved equal.

2.2 CHAIN CONTAINER

- A. Provide a chain container to accommodate the length of chain supplied with the hoist.
- B. Chain container shall be Budgit Model 902631 by Columbus McKinnon Corporation or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install specified equipment in accordance with manufacturers instructions, Drawings, and Section 01600 and 01610.
- B. Coordinate placement of hoist and trolley with installation of beams and equipment to be lifted.
- C. Installation shall include furnishing and applying initial supply of grease and oil if recommended by manufacturer.
- D. Check and align equipment to ensure smooth, accurate operation.

3.2 TESTING

- A. After installation is complete, start-up, test and demonstrate equipment in accordance with Sections 01400, 01600 and 01610.
- B. Provide instruction to Owner in accordance with Section 01600 and 01610.

END OF SECTION

DIVISION 15
MECHANICAL

SECTION 15000
PIPING AND VALVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes

- 1. Furnish and install piping, valving, and miscellaneous appurtenances as indicated on the Drawings and specified herein.

B. Related Sections

- 1. Division 15 Section 15140 – “Supports and Anchors”

1.3 REFERENCES

A. American National Standards Institute/American Water Works Association

- 1. ANSI/AWWA C104/A21.4 - Cement - Mortar Lining for Ductile Iron Pipe and Fittings for Water.
- 2. ANSI/AWWA C110/A21.10 - Ductile Iron and Gray Iron Fittings.
- 3. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- 4. ANSI/AWWA C15/A21.15 - Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
- 5. ANSI/AWWA C150/A21.50 - Thickness Design of Ductile Iron Pipe.
- 6. ANSI/AWWA C151/A21.51 - Ductile Iron Pipe Centrifugally Cast for Water.
- 7. ANSI/AWWA C153/A21.10-87 - Ductile Iron Compact Fittings, 3 in. through 16 in. for Water Service.
- 8. ANSI/AWWA C561 — Fabricated Stainless Steel Slide Gates
- 9. ANSI/AWWA C600 - Installation of Ductile Iron Water Mains and their Appurtenances.

B. ASTM International (American Society for Testing and Materials)

- 1. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
- 2. ASTM A1248 - HDPE Pipe.
- 3. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) compounds.

4. ASTM DI 785 - Specifications for Poly (Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80, and 120.
5. ASTM D2241 - Standard Specification for Polyvinyl Chloride (PVC) Pressure Rated Pipe (SDR Series)
6. ASTM D2321 Standard Specification for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity - Flow Applications.
7. ASTM D2467 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 80.
8. ASTM D2564 - Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
9. ASTM D2855 - Making Solvent - Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
10. ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping.
11. ASTM D3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
12. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipe Using Flexible Elastomeric Seals.
13. ASTM D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
14. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
15. ASTM A312, A409 for SS pipe and tubing.
16. ASTM A403, A182 and A296 for SS fittings, forgings and casting.
17. ASTM A-193 for bolting materials.

C. American Water Works Association

1. AWWA C-900, PVC Pressure Pipe & Fabricated Fittings, 4 inch through 12 inch.
2. AWWA C-905, PVC Pressure Pipe & Fabricated Fittings, 14 inch through 48 inch.

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Submit manufacturer's technical Product Data, installation instructions, and directions for adjustment for all Products required to complete Work of this Section.
- C. Submit Shop Drawings: Indicate pipe materials and fittings used, valves, joining methods, all equipment of this Section, installation and piping connections for all piping systems to be installed under this section.

1.5 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Sections 01300 and 01700.
- B. Maintenance Instructions: Include maintenance instructions and procedures, and spare parts lists.

1.6 QUALITY ASSURANCE

- A. Valves: To bear AWWA or UL label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle Products to site under provisions of Sections 01600 and 01610.
- B. Deliver and store valves in shipping containers, with labeling in place.
- C. Provide temporary protective coating on valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

PART 2 - PRODUCTS

2.1 DUCTILE IRON PIPE (DIP)

- A. Ductile iron pipe shall conform to AWWA C150 and AWWA C151 and shall have an ANSI Class 52 thickness unless otherwise specified.
- B. All buried pipe shall receive an outside bituminous seal coat and cement interior lining in accordance with AWWA C104. Above ground or exposed piping shall be uncoated and suitable for painting.
- C. Above ground or exposed ductile iron pipe shall be flanged in accordance with ANSI A21.15. Buried ductile iron pipe shall have push-on joints, mechanical joints, or flexible joints where indicated on the Contract Drawings. Rubber gaskets shall conform to ANSI A21.11 for mechanical and push-on joints. All buried joints shall be restrained type similar to Mega-lug series 1100 manufactured by EBAA Iron or equal. Concrete restraint is also required as shown on the drawings.
- D. Ductile iron fittings shall conform with AWWA C110 or C153.
- E. All gaskets between flanged connections and fittings shall be non-asbestos composition minimum thickness of 1/8" and shall be coated with thread lubricant prior to making up joints. Flange bolts, nuts and washers shall be of mild steel with sound, well-fitted threads, the nuts shall be cold-punched, hexagonal, trimmed, and chamfered. Heads, nuts and threads shall be United States standard sizes. Bolts shall be of such length as to project one-quarter inch beyond the nut when the flanged joint with gasket is assembled.
- F. Ductile iron pipe shall be manufactured by U.S. Pipe and Foundry Company, Inc., American Cast Iron Pipe Company, or approved equal.

2.2 STAINLESS STEEL PIPE

- A. Stainless steel pipe carrying liquids shall be Schedule 10 or Schedule 40 as shown on the drawings. All pipe shown as "SS" less than 4" in diameter shall be 304L Schedule 40 with screwed fittings. All pipe and fittings shown as "SS" 4" and greater shall be 304L Schedule 10 150 lb. rated with flanged connections (Vanstone or equal) or welded.
- B. Stainless steel air pipe above grade shall be Schedule 5 and be joined by welding.
- C. Pipe and fittings shall meet the requirements of ASTM312 and A403 respectively, seamless, Grade TP304L, with dimensions conforming to ASME B36.19M. Stainless steel tubing joints shall be shop welded full penetration butt joints or Van Stone joints using angle face rings with backing flanges drilled in accordance with ASME B16.5, Class 150.

2.3 PVC GRAVITY PIPE

- A. PVC compound shall conform to ASTM D 1784.
- B. PVC pipe eight inches and larger shall conform to ASTM D3034, SDR 35, Type PSM, with integral bells meeting requirements of ASTM D3212. Rubber gaskets shall conform to ASTM F477.
- C. Fittings for PVC pipe eight inches and larger shall conform to ASTM D3034, SDR 35, Type PSM. Joints shall meet requirements of ASTM D3212 and gaskets shall conform to ASTM F477.
- D. Pipe and fittings shall be manufactured by CertainTeed Corporation; J-M Manufacturing Company, Inc., or equal.

2.4 PVC PRESSURE PIPE

- A. Pipe and Fittings Less Than 4 inch Diameter
 - 1. Pipe shall meet requirements of ASTM DI 785, Schedule 40, Schedule 80, or SDR 21 where indicated. All SDR 21 pipe and fittings shall be bell and spigot type.
 - 2. Pipe shall be manufactured of Type I, Grade I PVC materials conforming to ASTM DI 784, minimum cell classification 12454; PVC pressure pipe for plumbing systems, if required, is specified in other sections.
 - 3. Schedule 40 or Schedule 80 piping systems shall be joined by socket-weld connections except where connecting to unions, valves, and equipment with threaded connections that may require future disassembly. Connections at those points shall be threaded and back-welded.
 - 4. The schedule rating for the fittings shall not be less than that for the associated pipe. Fittings shall be ASTM DI 784, minimum cell classification 12454, PVC conforming to the requirements of ASTM D2467, socket type.
 - 5. PVC Solvent Cement: Socket connections shall be joined with PVC solvent cement conforming to ASTM D2564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility. Joints shall be prepared with primers conforming to ASTM F656 prior to cementing and assembly.
- B. Pipe and Fittings 4 inch Diameter to 24 inch

1. Pipe shall conform to AWWA C900 or C905 and shall be plain end or gasket bell end, Pressure Class 150 (DR 18), with cast-iron-pipe-equivalent OD.
 2. Joints for pipe shall be push-on joints as specified in ASTM D3139.
 3. Joints between pipe and fittings shall be compression-type joints/mechanical-joints as respectively specified in ASTM D3139 and AWWAC111/A21.11.
 4. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F477. Gaskets for compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in AWWA C111/A21.11. All buried joints shall be restrained with Mega-Lug or equal. Concrete restraint is also required as shown on the drawings.
 5. Fittings shall be ductile iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53. Fittings shall have pressure rating at least equivalent to that of the pipe. Fittings shall have mechanical joint connections. Fittings shall have an epoxy coating on the interior and exterior surfaces in accordance with AWWA C116/A21.16 or cement-mortar lining in accordance with AWWA C104/A21.4, standard thickness. Buried fittings not having an epoxy coating shall receive a bituminous seal coat on the exterior surfaces in accordance with AWWA C151/A21.51.
 6. Pipe and fittings shall be manufactured by CertainTeed Corporation, J.M. Manufacturing Company, Inc., or equal.
- C. Push-on buried joints shall be restrained with Bell Restraint Series 2800 (for C905 pipes) and Series 1500 (for C900 pipes) manufactured by EBAA Iron or equal. Concrete restraint is also required as shown on the drawings. Mechanical joints shall be restrained with Mega-Lug Series 2000PV by EBAA Iron or equal.

2.5 GATE VALVES - RESILIENT WEDGE

A. Valves 12" or smaller

1. Gate valves shall be furnished and installed where indicated on the Drawings. Each gate valve shall conform to AWWA Standard C509 or C515 for resilient wedge gate valves. The cast iron gate valves shall be epoxy coated inside and out. The valve stem shall be constructed of manganese bronze and shall be equipped with a wedge nut to provide low operating torque. Stem sealing shall be accomplished by dual O-rings allowing replacement of O-rings seals while the valve is open and under pressure. Buried valves shall be equipped with an extension stem. Valves shall be Mueller, Clow Corporation, M&H Valve, A.P. Smith Company, American R/D, Kennedy, or equal.

B. Valves 14" or Larger

1. Gate valves shall be furnished and installed where indicated on the Drawings. Each gate valve shall conform to AWWA Standard C500, as applicable to double discs, and handwheels shall be cast iron. Valve bodies used with PVC pipe shall be PVC pipe end connections or mechanical joint connections with PVC adapters. Where flanged piping is called for, valve bodies shall be furnished with ASA B 16.1 125E flange ends. Accurately machined bronze seating rings shall be secured in the valve bodies. Valves shall be provided with bronze seatings rings, machined and scraped, if necessary, to seat truly flat against body seating rings. All gate valves shall be supplied with non-rising stems unless

otherwise noted as the Drawings. Valve stems shall rotate freely in the valve bonnet recess and shall close by and clockwise rotation. Where rising stems are specified, the stem collars shall be designed to seat tightly against the bonnet bushing with the valve in the open position, permitting repacking of the stuffing box under line pressure. Stuffing box glands shall be bronze: gland followers shall be cast iron. Buried valves shall be equipped with an extension stem. Gate valves shall be as manufactured by Clow Corporation, M&H Valve Fitting Company, A.P. Smith Company, American R/D, Kennedy Valve or equal.

2.6 VALVE BOXES

- A. All buried gate valves shall be furnished with a suitable cast iron valve box. Valve boxes shall be two or three piece, screw or slide type installed over the bonnet and operating nut of the valve and be of sufficient length to reach the surface of the ground but not to extend above the ground surface. Valve box covers shall be marked "sewage". Valve box shall be as manufactured by Tyler Pipe or approved equal.
- B. Installation shall be such that when setting a valve box in place, the base should rest two or more inches above the flanged joint of the cover. The top of the operating nut should be no higher than the hub or upper part of the valve box base where it connects to the center section. This location for the valve box will leave ample space all around the valve, prevent the box from touching the valve in any way, and permit free access to the operating nut with a valve wrench or operating stem.
- C. Provide "valve box aligner" to keep box centered over operating nut, USA Blue Book #75181.

2.7 VALVE KEY

- A. The Contractor shall furnish two 4 foot long valve operating wrenches, Mueller A24610, or approved equal if buried valves are utilized in the project.

2.8 AIR RELEASE VALVES

- A. Air release valves used to vent pressure lines shall be short body valve, size 2" NPT inlet and 3/16" orifice.
- B. Body and cover shall be ASTM A 126 Class B Cast Iron. The internal parts shall be stainless steel.
- C. Air release valves shall be model 34-WWS manufactured by Cla-Val Co or approved equal.

2.9 WALL SLEEVES AND WALL PIPES

- A. All pipe passing through water retaining walls, floors or other structural members shall utilize wall pipes unless otherwise stated on the drawing.
- B. Wall pipes shall be mechanical joint type ductile iron with intermediate waterstop flange as manufactured by Clow Corporation Model F- 1429.

- C. Ductile iron wall pipes shall be flush to the wall as indicated on the drawing. MJ flange side of the wall pipe shall be tapped for studs.

2.10 SLUICE GATE

- A. Sluice gates shall be open frame, wall mounted with embedded bottom frame, furnished and installed complete with operating stem, gate lift operator and other appurtenances as specified or needed to make a complete and operable installation. All components subject to submergence shall be constructed of stainless steel.
- B. Gates shall be heavy duty and meet requirements of AWWA Specifications C-561 (latest version). All mating and sliding parts shall be fully machined. The sluice gates shall be shop tested for leakage and proper operation before shipping.
- C. Sluice gates shall be substantially watertight under the design head conditions. Leakage shall not exceed 0.05 U.S. gallon per minute per foot of seating perimeter. Testing shall show minimum deterioration after 25,000 cycles of operation. Gates shall be sized to cover open area and wall thickness of pipe it is to seal.
- D. The frame shall be made of wrought stainless steel of the specified commercial grade or from commercially available structural shapes. The minimum material thickness of all members except seal retainers shall be $\frac{1}{4}$ - inch. (6.4 mm). The gate frame shall be constructed of structural members or formed plate welded to form a rigid one-piece frame with a flanged back design. The frame shall be of the flange back design suitable for mounting on a concrete wall. The guide slot shall be made of UHMWPE (ultra high molecular weight polyethylene). A rigid stainless steel invert member shall be provided across the bottom of the opening. The invert member shall be of the flush bottom type. A rigid stainless steel top seal member shall be provided across the top of the opening.
- E. The slide and reinforcing stiffeners shall be constructed of stainless steel plate. All structural components shall have a minimum thickness of $\frac{1}{4}$ -inch (6.4 mm). The slide shall be designed for the minimum safety factor of 4 with regard to ultimate tensile, compressive, and shear strength, and a minimum safety factor of 2 with regard to the tensile, compressive, and shear yield strength. The slide shall consist of a flat plate reinforced with formed plates or structural members to limit its deflection to $\frac{1}{720}$ of the gate's span under the design head.
- F. Self-adjusting seal systems utilizing UHMWPE seals and resilient compression cord shall restrict leakage to that specified herein. The self-adjusting seals shall be designed with a continuous compression cord to ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate. The guides shall be made of virgin UHMWPE (ultra high molecular weight polyethylene) to restrict leakage, prevent metal-to-metal contact between the frame and the slide, and provide long-term maintenance free operation. The guides/seals shall extend to accommodate minimum $1\frac{2}{3}$ x the height of the slide. The top seal shall be the self-adjusting type, utilizing a cup shaped UHMWPE seal with twin contact surfaces and compression cord. The cup shaped seal with twin contact surfaces shall be designed with the outer seal acting as a wiper to remove debris from the slide when raising the gate thereby protecting the primary seal. A resilient seal made of neoprene shall be set into the bottom frame member to seal the bottom portion of the gate and form a flushbottom. All UHMWPE seals must be bolted or

otherwise mechanically fastened to the frame. Gates that utilize rubber "J" seals or "P" seals are not acceptable.

- G. The operating stem shall be constructed of stainless steel of the specified grade designed to transmit in compression at least 2 times the rated output of the operating manual mechanism with a 40 lbs. (178 N) effort on the crank or handwheel. The stem shall have a slenderness ratio (L/r) less than 200. The threaded portion of the stem shall have machined cut threads. The couplings shall be grooved and keyed and shall be of greater strength than the stem.
- H. Stem guides shall be furnished when necessary to ensure that the L/r ratio shall not be greater than 200. Stem guides shall be fabricated from type 304L (or 316L) stainless steel. The guide shall be equipped with an UHMWPE bushing. Stem guides shall be mounted on stainless steel brackets and attached to the wall by stainless steel anchor bolts provided by the manufacturer. Brackets shall be sufficient strength to prevent twisting or sagging under load. Guides shall be adjustable in two directions and spaced in accordance with the manufacturer's recommendation.
- I. Rising stem gates shall be provided with a clear PVC stem cover. The stem cover shall have a cap and condensation vents and a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.
- J. Sluice gates shall be manually operated by handwheel operated pedestal floor stand. The manual actuator shall have a direct-drive handwheel without reduction gearing. The actuator shall be sized to permit slide operation with an effort of not more than 40-1b (178-N) pull on the handwheel—handcrank. Maximum pull or torque to start the slide in motion must not exceed one and one-half times this amount. Components of the actuator shall be designed to withstand these input efforts or torques with a minimum safety factor of 5 with regard to ultimate tensile, compressive, and shear strength.
- K. The manual actuator shall have a bronze lift nut threaded to fit the operating stem. Lift nuts shall be of high strength bronze having a minimum tensile of 65 ksi, and a minimum hardness of 94 BHN. Threads shall be Acme type and shall have a PV (pressure velocity) factor not exceeding 50,000 (pressure velocity factor is surface feet per minute times contact pressure in PSI [SFPM x PSI]) for open/close service and 30,000 for modulating service with lubrication as specified by the manufacturer. Maximum pressure on the projected area of thread contact shall not exceed 2,000 psi at normal maximum operating load. Roller, needle or ball bearings shall be provided above and below the flange on the lift nut to take the thrust developed during gate operation. Bearings shall be enclosed in a cast iron, ductile iron, or cast aluminum housing with oil seals and O-rings used to seal the unit. Fittings shall be provided so that bearings can be periodically lubricated. The actuator shall be supplied with a pedestal, torque tube, or baseplate, machined and drilled for mounting the lift housing.
- L. The crank shall be removable and fitted with a corrosion-resistant rotating handle. The maximum handwheel diameter shall be 30 inches and the handwheel shall be approximately 36 inches from the operating floor unless otherwise shown. The direction of wheel or crank rotation to open the gate shall be indicated on the actuator.
- M. Sluice gates and equipment shall be stored and installed in accordance with the installation manual furnished by the gate manufacturer. After installation, the completely assembled gate, stem, guides and lift shall be operated through one full cycle to demonstrate satisfactory operation. Such adjustments as necessary will be made until operation is approved by the Engineer.

- N. Sluice gates shall be Series 20 stainless steel flow control gates as manufactured by Fontaine Industries LTD or approved equal.

2.11 DRESSER COUPLINGS

- A. Where indicated on the Drawings, Contractor shall supply Dresser type couplings. Dresser couplings shall consist of one cylindrical steel middle ring, two steel follower rings, two resilient gaskets and a set of steel track head bolts. The couplings shall provide a flexible, leak-proof seal. Couplings shall be manufactured for joining two plain-end pipes of sizes shown on the Drawings. Glands and gaskets of appropriate type to fit pipe O.D. shall be supplied. Couplings shall be Style 38, 62, 138, 153, or 162 as appropriate by Dresser Industries, Inc., equivalent coupling by Smith Blair, Clow, or approved equal.

2.12 CHECK VALVES

- A. Check valves shall be furnished and installed where indicated on the Drawings. Each valve shall conform to AWWA C508. Each check valve shall be of the iron body, bronze-mounted swing type. Valve body, bonnet and disc shall be ASTM A126 cast iron. Body shall be furnished with ASA B16.1 125E flanges. Bonnet shall be sufficiently large to permit cleaning and maintenance of inner works without removing the valve body from the line. Disc and valve body shall be provided with machine-face bronze seating rings. Valve disc shall be securely bolted to malleable iron hinges; hinges shall be secured to bronze hinge pins, supported by bronze bearings mounted in the valve body. Hinge pins shall extend through the valve bearings mounted in the valve body. Hinge pins extend through the valve body and shall be suitable for attachment of outside weight and lever assembly. They shall be as manufactured by Wheatly-Dresser, Zy-Tech Fairbanks, Clow, GA Industries, Apco Industries, or approved equal.

2.13 COPPER PIPE

- A. Above ground copper pipe shall be Type L conforming to ASTM B88-96 and ASTM B-280.
- B. Underground copper pipe shall be Type K conforming to ASTM B88-96 and ASTM B-280.
- C. Copper fittings shall be wrought copper, ASME B16.22, compressive type.
- D. Joints: Tubing shall be joined using solder fittings except where connections to unions, valves, and equipment with threaded connects that may require future disassembly. Solder joint fittings shall conform to ASME B 16.22 and ASME B16.18. Dielectric fittings or isolation joints shall be provided between all dissimilar metals; as manufactured by EPCO or equal.
- E. Solder Joint Material: Alloy Grade 95-5 (95% tin — 5% silver) in wire or rod conforming to ASTM B32 with flux as recommended by manufacturer applied to fitting and pipe.

2.14 UNDERGROUND WARNING TAPE

- A. Contractor shall provide and install underground detectable warning tapes for all underground pipeline installations. Tape shall be polyethylene plastic, acid-and alkali-resistant, manufactured

specifically for warning and identification of buried utility lines. Tape shall be metallic core or metallic-faced enabling detection by a metal detector when tape is buried up to 3 feet deep. Tape shall be manufactured by Seton Nameplate Corporation or equal.

2.15 BRONZE BALL VALVES

- A. Provide bronze ball valves of the size indicated on the Drawings. Ball valves shall be fully ported with TFE seats and seals, and stainless steel ball, stem and handle nut. Ball valves shall be manufactured by Nibco Inc., T-595-Y-66 and T-560-BRY-66, or approved equal.

2.16 PVC BALL VALVES

- A. Provide PVC True Union Ball Valves with Viton/PTFE or ethylene propylene diene monomer (EPDM) O-ring stem seals, polyvinyl chloride (PVC) bodies, balls, and stems. Thermoplastic shall conform to ASTM DI 784, minimum cell classification 12454. Valves shall be end entry, with solvent-weld socket end connections, and ethylene propylene diene monomer (EPDM) seat. Valves shall be rated for 150 psig service at 120 degrees F and have hand lever operators.

2.17 STAINLESS STEEL BALL VALVES

- A. Provide stainless steel valves of the size indicated on the drawings. Valves shall conform to ASTM A 351/A 351M Grade CF8M stainless steel body, full port, with ASME B 16.5 flanged end connections. Valves shall have polytetrafluoroethylene (PTFE) seats, TP316 stainless steel stem, stem seal and bearing and stainless steel ball. Valves shall be rated for 200 psig service, and have hand lever operator. Manufactured by Nibco, Neles-Jamesbury or equal.

2.18 PIPE TAPS

- A. Provide taps where shown or required for small pipe or instrument connections. Where the pipe or fitting wall thickness is insufficient to provide required number of threads, a SS boss or SS tapping saddle shall be installed or pipe class shall be increased. Threads shall be protected with temporary plugs. Saddles shall be Ford SS saddles Style FS303 for C900 PVC or approved equal.

2.19 CORPORATION STOPS

- A. Corporation stops with coupling nuts and main shall be Mueller Models H-15008, H-15009 and H-15013, Ford Meter Box or approved equal.

2.20 SERVICE CLAMPS

- A. Service clamps shall be Mueller Model H-16126, H-16130 and H-16134, Ford Meter Box or approved equal.

2.21 SERVICE FITTINGS

- A. Service fittings shall be compression type, manufactured by Mueller, Ford meter Box or approved equal.

2.22 FROSTPROOF WALL HYDRANT

- A. Anti-siphon frostproof wall hydrant with 3/4" hose connection, 3/4 inch male pipe thread on inlet, and copper body tube in length suitable for wall depth. Hydrant shall consist of bronze body, nitrile seat and metal handwheel; ASSE 1019-A Compliant, CSA Approved, IAPMO Listed. A copper, brass or bronze operating rod shall be provided within a copper casing of sufficient length to extend through the wall so that the valve is inside the building, and the portion of the hydrant between the outlet and valve is self-draining. A brass or bronze valve with coupling and union elbow having metal-to-metal seat shall be provided. Valve rod and seat washer shall be removable through the face of the hydrant. NIBCO Fig, 90 or equal.

2.23 PRESSURE GAUGE

- A. Pressure gauges shall be supplied with 1/4" stainless steel ball valves with black, drawn steel cases and 4-1/2" dials. Pressure gauges shall be Model 1279 4-1/2" and 1/4" NPT as manufactured by Ashcroft or approved equal. Pressure ranges shall be selected by the Engineer.

2.24 BUTTERFLY VALVES (LIQUID)

- A. Butterfly valves shall be furnished with a 10 position lever or wheel operator as shown on the drawings. Each valve shall be of cast iron construction. Valves shall have molded EPDM rubber seats and shall be bubble tight under all pressure conditions. Valve shaft shall be 316 stainless steel. Valve operator, whether position lever or geared, shall be designed to hold the valve in any intermediate position between full open and fully closed without creeping or fluttering. Disc shall be 316 stainless steel. Valves shall meet requirements of AWWA C504.
- B. Valves shall be BRS Resilient Seated by DeZurik, Miliken, Kennedy, Val-Matic American, or equal.

2.25 PLUG VALVES

- A. Eccentric plug valves shall be furnished and installed where indicated on the drawings. Each eccentric plug valve shall conform to AWWA C504 and MSS SP108 for eccentric, non-lubricated plug valves. Buried valves shall be equipped with a two inch square operating nut. Valves shall be DeZurik, Val-Matic, or equal.
- B. All valves above ground or in vaults shall be flanged valves unless otherwise noted.
- C. All buried valves shall have mechanical joint connections. Valve bodies used with PVC pipe shall be PVC pipe end connection or mechanical joint connections with PVC adapters.

2.26 DRAINS

- A. Floor Drains (FD) shall be cast iron body and flashing collar with nickel bronze adjustable round strainer head, secured grate vandal proof top and sediment bucket. Provide with "P" trap. J.R. Smith series 2110-W Josam, Watts.
- B. Floor Area and Indirect Waste Drain shall be suitable for large volume drainage and indirect waste applications. Drain shall be 12" x 12" x 8" deep cast iron body with loose set ³/₄ grate to allow grit classifier drain pipe to discharge through opening in grate. Grate and frame shall be cast iron or stainless steel, medium or heavy duty for foot traffic. Provide an anti-splash aluminum dome strainer and 4" outlet pipe. MIFAB Model FS 1730, equivalent by J.R. Smith, or equal.

2.27 QUICK DISCONNECT COUPLING

- A. Quick Disconnect Coupling shall be hot dipped galvanized, high tensile strength, abrasion resistant steel fabricated to allow watertight connection to Godwin pump suction or discharge as manufactured by Bauer or equal. Contractor shall coordinate with Owner to select end type, size and coupling configuration to match Owner's portable pump. Assembly shall be rated for pump discharge pressure. Provide compatible corrosion resistant dust cap.

2.28 WATER HAMMER ARRESTOR

- A. Water Hammer Arrestor shall consist of a pre-charged air chamber that is rechargeable, an air-tight sealing cap, standard tire valve connection for easy charging, stainless steel top, sealed-in diaphragm and stainless-steel chamber. Maximum Working Pressure: 150 psi, Maximum Shock Pressure: 200 psi, Maximum Velocity: 10 F.P.S. Water Hammer Arrestor shall be Watts Series 150A or equal.

2.29 FLOOR BOXES

- A. Floor boxes shall be cast in precast concrete vault tops where indicated on Drawings. Floor boxes shall provide support for extension stems and provide cover for operation nut.
- B. Floor boxes shall be bushing type F-5695 by Clow Corporation or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examine all pipe, fittings, valves and other appurtenances for damage or defects immediately before installation.
- B. Mark and hold for inspection by Owner any defective Products.
- C. Verify dimensions of all pipes, valves, fittings and appurtenances to ensure all Work of this Section will fit together properly and conform to Drawings.

- D. Verify lines, grades, slopes and elevations to ensure that the installed work of this section will meet the requirements shown on the Drawings.
- E. Verify that trench excavations meet alignment, depth, width and elevation requirements shown on the Drawings.
- F. Verify that trench bottoms to receive Work of this Section are smooth and free of water, frozen materials, large stones or dirt clods.
- G. Beginning of Work of this Section means acceptance of existing conditions.
- H. Pipe and equipment openings shall be closed with caps or plugs prior to installation. Equipment shall be protected from dirt, water, and chemical or mechanical damage.
- I. Repair damaged coating areas in the field with material equal to the original coating. Do not install damaged piping materials.

3.2 BELOW GRADE PIPE INSTALLATION FOR LIQUIDS

A. General Requirements

- 1. No pipework is to be started until all materials, layout, schedules, stakeout, and cut sheets have been approved by the Engineer in writing. Samples of all materials to be incorporated in the Work shall be submitted for the approval of the Engineer sufficiently in advance of Work commencement to allow time for specified testing.
- 2. Do not lay water lines in the same trench with gas lines or electric wiring.
- 3. Proper and suitable tools and equipment for the safe and convenient handling and laying of the pipe and fittings shall be used in accordance with manufacturer's standards. Pipe and fittings shall be carefully handled and lowered into the trench.
- 4. Whenever a pipe requires cutting to fit in the line or to bring it to the required location, the Work shall be done without extra compensation, in a satisfactory manner so as to leave a smooth end perpendicular to the long axis of the pipe.
- 5. Before any joints are actually made in the trench, the Contractor shall demonstrate to the Engineer, by making a sample joint, that the methods he will employ conform to specifications and will secure a watertight joint, and that the workmen whom he intends to use in this Work are familiar with the requirements of this Specification Section.
- 6. The excavation in which pipe is being laid shall be kept free from water, and no joint shall be made under water. Care shall be used to secure watertightness and to prevent damage to, or the disturbing of, the joints during the backfilling process or at any other time. After pipes have been laid and the joints have been made, there shall be no walking on or working over them except as may be necessary in tamping until there is a covering at least two (2) feet in depth over their top. After joint materials, which require it, have received their set, backfilling of the trench may proceed.
- 7. Before joints are made, each pipe shall be well bedded on a solid foundation and no pipe shall be brought into position until the proceeding length has
- 8. been thoroughly embedded and secured in place. No pipe shall be laid in wet trench conditions that preclude proper bedding, or on a frozen trench bottom, or when in the opinion of the Engineer, the trench or weather conditions are unsuitable for proper installation. Any defects due to settlement shall be corrected by the Contractor at his own

- expense. Bell holes or coupling holes shall be dug sufficiently large to insure making of proper joints. In no case will pipe be closer than four (4) inches from bedrock.
9. In laying pipe, special care shall be taken to insure that each length shall abut against the next in such a manner that there shall be no shoulder or unevenness of any kind along the inside of the pipe line.
 10. No wedging or blocking will be permitted in laying pipe unless by written order from the Engineer.
 11. Pipes and fittings shall be thoroughly cleaned before they are laid and shall be kept clean until the acceptance of the completed Work. The open end shall be kept closed with a stopper until the next length is laid. At the close of work each day, the end of the pipe line shall be tightly closed with an expansion stopper so that no dirt or other foreign substances may enter the line, and this stopper shall be kept in place until pipe laying is again resumed.
 12. All open ends of pipelines to be abandoned, exposed during construction operations, shall have their openings plugged with a two (2) foot minimum thickness of concrete.
 13. All dead-ends of pipelines, and fittings, shall be provided with standard plugs and caps either temporarily or permanently as directed by the Engineer. A concrete or other approved thrust blocking shall be provided at all dead ends. Where plugged or capped outlets are to be tied to fittings with clamps and tie rods, as indicated on the Contract Documents, the minimum number and size of rods and other pertinent details shall be as shown and/or specified.
 14. Anchorages, buttresses, and thrust blocks shall be used to secure all caps, plugs, horizontal and vertical bends, branches, tees, and dead ends. They shall be constructed in accordance with the Drawing details, unless otherwise specified, and shall bear against solid, undisturbed earth.
 15. Place underground warning tape in the trench above all underground pipeline installations.

B. Ductile Iron Pipe and Fittings

1. Unless otherwise specified, install pipe and fittings in accordance with
2. paragraph entitled "General Requirements" and with the requirements of AWWA C600 for pipe installation, joint assembly, valve-and-fitting installation, and thrust restraint.
3. Make push-on joints with the gaskets and lubricant specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.
4. Make mechanical joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWAC111/A21.11.
5. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer.
6. The maximum allowable deflection shall be as given in AWWA C600. If the alignment requires deflection in excess of the above limitations, special bends or a sufficient number of shorter lengths of pipe shall be furnished to provide angular deflections within the limit set forth.
7. Provide concrete thrust blocks for pipe anchorage in accordance with the requirements of AWWA C600 for thrust restraint, except that size and positioning of thrust blocks shall be as indicated.

C. Copper Pipe and Fittings

1. Copper tubing shall not be installed in the same trench with ferrous piping materials. Where copper tubing crosses any ferrous piping, provide a minimum vertical separation of 12 inches between pipes.
2. Install pipe and fittings in accordance with paragraph entitled "General Requirements" and with the applicable requirements of AWWA C600 for pipe installation, unless otherwise specified.
3. Cut copper tubing with square ends; remove fins and burrs.
4. Handle tubing carefully; replace dented, gouged, or otherwise damaged tubing with undamaged tubing.
5. Make solder joints using specified ASTM B32 solder. Solder and flux shall contain not more than 0.2 percent lead. Before making joint, clean ends of tubing and inside of fitting or coupling with wire brush or abrasive. Apply a rosin flux to the tubing end and on recess inside of fitting or coupling. Insert tubing end into fitting or coupling for the full depth of the recess and solder.

D. PVC Pressure Pipe and Fittings

1. Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements with the requirements of UBPPA UNI-B-3 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23.
2. Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble pushon joints for pipe-to-pipe joint connections in accordance with the requirements of UBPPA UNI-B-3 for laying the pipe and the recommendations in AWWA M23 for pipe joint assembly.
3. Make mechanical joints with the gaskets, glands, bolts, nuts, and internal stiffeners previously specified for this type joint; assemble in accordance with the requirements of UBPPA UNI-B-3 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C11/A21.11. Cut off spigot end of pipe for mechanical-joint connections and do not re-bevel.
4. Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer using internal stiffeners as previously specified for compression-type joints.
5. Maximum offset in alignment between adjacent pipe joints shall be as recommended by the manufacturer and approved by the Engineer, but shall not exceed 5 degrees.
6. Provide concrete thrust blocks for pipe anchorage in accordance with the requirements of UBPPA UNI-B-3 for reaction or thrust blocking and plugging of dead ends, except that size and positioning of thrust blocks shall be as indicated. Thrust blocks shall be constructed in accordance with Article BUTTRESSES AND THRUST BLOCKS FITTINGS.
7. Fittings shall be installed in accordance with AWWA C605.

E. PVC Gravity Pipe and Fittings

1. Install pipe and fittings in accordance with paragraph entitled "General Requirements" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings.
2. Gravity pipe alignment shall be maintained through the use of laser alignment equipment.
3. Lay non-pressure pipe with the bell ends in the upgrade direction.
4. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints.
5. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

F. Installation of Valves

1. Install gate valves, AWWA C509, in accordance with the requirements of AWWA C600 for valve-and-fitting installation and with the recommendations of the Appendix ("Installation, Operation, and Maintenance of Gate Valves") to AWWA C509.
2. Install gate valves on PVC water mains in accordance with the recommendations for appurtenance installation in AWWA M23.
3. Make and assemble joints to gate valves as specified for making and assembling the same type joints between pipe and fittings.

3.3 ABOVE GROUND OR EXPOSED PIPING FOR LIQUIDS

A. General Requirements

1. Exposed piping shall be run as straight as practical along the alignment shown on the contract drawings and with a minimum of joints.
2. Piping and appurtenances shall be installed in conformance with reviewed shop drawings, manufacturer's instructions and ASME B31.3.
3. Piping shall be installed without springing or forcing the pipe.
4. Pipe, fittings, valves and appurtenances shall be handled with proper equipment and care according to manufacturer's recommendations and ASME B31.3 for pressure pipe. Remove protective coatings prior to installation according to manufacturer's recommendation.
5. All pipe and fittings shall be cleaned before installation and kept clean and dry. Foreign material shall be prevented from entering the pipe by using caps, plugs or covers.
6. Gaskets shall be wiped clean prior to installation. Flexible couplings and flanged coupling adapter gaskets shall be lubricated with the manufacturer's standard lubricant before installation on the pipe ends. Couplings, service saddles, and anchor studs shall be installed in accordance with manufacturer's instructions.
7. Adjoining pipe, valves and/or equipment to be joined by flanges shall be blocked and shimmed to true elevation with bolt holes in perfect alignment before bolts are inserted and tightened. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Torque-limiting wrenches shall be used to tighten bolts. Drawing skewed joints into alignment by tightening flange bolts will not be permitted.
8. Whenever a pipe requires cutting to fit in the line to bring it to the required location, the Work shall be done without extra compensation, in a satisfactory manner so as to leave a smooth end perpendicular to the axis of the pipe.

9. Before any joints are actually made, demonstrate to the Engineer, by making a sample joint, that the methods employed conform to specifications and will secure a watertight joint.
10. Group piping whenever practical at common elevations.
11. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
12. Provide all pipe supports independent of equipment.

B. PVC Pipe and Fittings

1. All plastic pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations.
2. Schedule 80 threaded nipples shall be used where necessary to connect to threaded valves or fittings. Strap wrenches shall be used for tightening threaded plastic joints, and care shall be taken not to over tighten these fittings.
3. Adequate ventilation shall be provided when working with pipe joint solvent cement and the handling of solvent cements, primers and cleaners shall be in accordance with ASTM F402.
4. Provide and install supports and hangers as specified and shown on the contract drawings.
5. Where plastic pipe is subjected to severe temperature fluctuations, provisions for expansion and contraction must be provided. This shall be accomplished with the use of expansion joints and offset piping arrangements.
6. Solvent-cemented joints shall be constructed in accordance with ASTM D2855.

C. Installation of Valves

1. Valves shall be located in accordance with the contract drawings where actuators are shown. Where actuators are not shown, valves shall be located and oriented to permit easy access to the valve operator, and to avoid interferences.
2. Flanged valve bolt holes shall be installed so as to straddle the vertical centerline of pipe.
3. Flanged faces shall be cleaned prior to inserting the gasket and bolts, and then the nuts shall be tightened progressively and uniformly.
4. Threaded ends shall have the threads cleaned by wire brushing or swabbing prior to installation.
5. The operating stem of a manual valve shall be installed in a vertical position when the valve is installed in horizontal runs of pipe having centerline elevations 4.5 feet or less above finished floor, unless otherwise shown on contract drawings. The operating stem of a manual valve shall be installed in a horizontal position in horizontal runs of pipe having centerline elevations between 4.5 feet and 6.75 feet above finish floor, unless otherwise shown on contract drawings.
6. Automatic valves shall be installed in accordance with the manufacturer's instructions and approved drawings.
7. Orientation of butterfly valves shall take into account changes in pipe direction. Valve shafts shall be oriented so that unbalanced flows caused by pipe direction changes or other disturbances are equally divided to each half of the disc.
8. If a plug valve seat position is not shown in the contract drawings, locate the seat position as follows: for horizontal flow, the flow shall produce an "unseating" pressure, and the plug shall open into the top half of valve; and for vertical flow, the seat shall be installed in the highest portion of the valve.

9. A line size ball valve and union shall be installed upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flow meters, for isolation during maintenance.
 10. Where the depth of the valve is such that its centerline is more than 3 feet below grade, an operator extension stem shall be furnished with a 2 inch operating nut to bring the operating nut to a point 5.9 inches below the surface of the ground and/or box cover. The operating nut shall be located in a floor box.
 11. Chain wheel and guide assemblies or chain lever assemblies shall be installed on manually operated valves located over 6.73 feet above finished floor elevation. Where chains hang in normally traveled areas, appropriate tie-back anchors shall be used.
- D. Backflow preventers shall be installed with nameplate and test cocks accessible from front of unit, and with a minimum clearance of 12.2 inches between the port and grade. The assemblies shall be installed in accordance with local codes and shall discharge to an open drain with an air gap; vertical installation is prohibited.

3.4 AIR PIPE

A. Installation

1. Install according to manufacturer recommendations.
2. Use hangers no greater than 24" apart.
3. Welds at job site shall follow manufacturer's recommendations.
4. Remove heat stains at welds.
5. Do not use flange bolts to draw pipe together that is misaligned.

3.5 TESTING

- A. All testing for defects and for leakage shall be performed in the presence of the Engineer. All defects in workmanship rejected by the Engineer shall be promptly corrected by the Contractor and defective material removed from the Project site.
- B. Testing Gravity Flow Pipe
1. 1. The Contractor shall furnish all labor, tools, materials including water and equipment including mirrors, flashlights or other artificial lighting, weirs, pump, compressors, stopwatch, gauges, and meters, subject to the approval of the Engineer for testing in accordance with these Specifications.
 - a. All branch fittings and ends of lateral stubs shall be securely plugged to withstand the internal test pressures. The section of line being tested shall also be securely plugged at each manhole. All stoppers shall be adequately braced when received.
 - b. Air shall be slowly supplied to the plugged pipeline until the internal air pressure reaches 8.0 pounds per square inch. At least two minutes shall be allowed for temperature stabilization before proceeding further with the test.
 - c. The rate of air loss shall then be determined by measuring the time interval required for the internal pressure to decrease by 1.0 pound per square inch (psi).

- d. The line shall be considered acceptable if the time required for the 1.0 psi pressure drop is not less than 10 minutes.

C. Testing Air Pipe

1. Air pipe shall be tested the same as gravity flow pipe except the test pressure shall be 12 psi.

D. Testing Full Flow Pipe

1. The Contractor shall furnish all labor, tools, materials, water and equipment for testing in accordance with these specifications.
2. Notify Engineer in advance of all tests.
3. All pipe, materials and equipment necessary for tests shall be adequately braced and supported during the test to prevent movement, displacement, or damage during application of test pressure.
4. Allow cement thrust blocks to set before testing.
5. Cap and brace test ends of piping as required to withstand test pressure and
6. Allow adequate drying time based on manufacturer's recommendation for solvent welded joints prior to testing.
7. Pressure Pipe (Greater Than 6 psi Working Pressure)

- a. All pressure pipe shall be tested in accordance with AWWA C600, Installation of Ductile Iron Water Mains and their Appurtenances.
- b. Pressure pipe shall be tested at a minimum pressure of 100 psi.
- c. No pipe installation shall be accepted if the leakage is greater than the value calculated for allowable leakage.

Allowable leakage per 1,000 ft. of pipeline*

Nominal Pipe Diameter (in)	<u>Allowable leakage at 100 psi</u> <u>(gph)/1000 ft</u>
1-1/4	0.09
3	0.23
4	0.30
6	0.45
8	0.60
10	0.75
12	0.90
14	1.05
16	1.20

If the pipeline contains sections of various diameters, the allowable leakage will be the sum of computed leakage for each size.

*Taken from AWWA C600-87.

3.6 BUTTRESSES AND THRUST BLOCKS

- A. Buttresses or thrust blocks shall be installed on in accordance with the requirements of AWWA C600 on all below grade pipe lines at all valves, bends, tees, caps, plugs, dead ends and at reducers

or other fittings where changes in direction or pipe size occur unless otherwise indicated on Drawings. The buttresses and thrust blocks shall be sized as shown on the Drawing details.

- B. Cold weather protection shall be provided, during freezing weather, for all masonry, mortar and concrete construction connection with the piping by maintaining a temperature of not less than 60 degrees F for a period of three (3) days.

3.7 PROTECTION OF INSTALLED WORK

- A. Protect installed pipe, joints, fittings and appurtenances from damage or displacement during the backfilling process or other construction activities.
- B. Keep pipe interior free from debris. Stopper open ends of pipe each day and until next length of pipe is laid.

3.8 ADJUSTING

- A. Adjust Work in accordance with Section 01700 and manufacturer's instructions.

END OF SECTION

SECTION 15140
SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes
 - 1. Hangers, supports, brackets and anchors.
- B. Related Sections
 - 1. Division 15 Section 15000 – “Supports and Anchors”

1.3 REFERENCES

- A. American Society of Mechanical Engineers (ASME) B31.3 Process Piping.
- B. ASTM International (ASTM) A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- C. Manufacturers' Standardization Society (MSS) SP-58 Pipe Hangers and Supports - Materials, Design and Manufacture.
- D. Manufacturers' Standardization Society (MSS) SP-69 Pipe Hangers and Supports - Selection and Application.
- E. Manufacturers' Standardization Society (MSS) SP-89 Pipe Hangers and Supports — Fabrication and Installation Practices.

1.4 DESIGN REQUIREMENTS

- A. Support systems shall be selected and designed in accordance with ASME B31.3, MSS SP-58, and MSS SP-69 within the specified spans and component requirements.
- B. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing supports throughout project.
- C. Where pipe supports contact bare piping or in-line devices, provide supports of compatible material so that neither shall have a deteriorating action on the other.

- D. Establish maximum load ratings with consideration for allowable stresses prescribed by ASME B33 or MSS SP-58.
- E. Ensure that supports, guides and anchors do not transmit excessive quantities of heat to building structure.
- F. Utilize hangers and supports to support systems under all conditions of operation, to allow free expansion and contraction, and to prevent excessive stresses from being introduced into pipework or connected equipment.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data:
 - 1. Include data on materials, fittings and accessories.
 - 2. Include Product description, model, dimensions, component sizes, rough-in requirements, service sizes and finishes.
 - 3. Include Product performance data.
- C. Shop Drawings:
 - 1. Provide support system detail drawings, indicating components, dimensions, and connections to structures, equipment and piping.
 - 2. Provide as-built drawings showing pipe supports, anchors, and guides.
- D. Manufacturer's Installation Instruction: Provide installation details and component assembly procedures.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Sections 01300 and 01700.
- B. Maintenance Data: Include methods for maintaining installed products, precautions against cleaning materials and methods detrimental to finishes and performance, inspection requirements, replacement part numbers and availability.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with State and local regulations and Section 01400.
- B. Perform Work in accordance with manufacturer's installation instructions.
- C. Fabrication and installation of pipe hangers and supports shall conform to the latest requirements of ASME B31.3 and MSS SP-89.
- D. Utilize an installer who is experienced in installation of the work of this section and per the minimum requirements of MSS SP-89.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle Products to site under provisions of Section 01610.
- B. Equipment shall be delivered to the site in shipping containers with labeling in place. Inspect for damage prior to accepting delivery. Maintain shipping packaging in place until installation.
- C. Materials delivered and placed in storage shall be stored with protection from the weather, excessive humidity variation, excessive temperature variation, dirt, dust and/or other contaminants.
- D. Proper protection and care of material before, during and after installation is the Contractor's responsibility. Any material found to be damaged shall be replaced at the Contractor's expense.

1.9 WARRANTY

- A. Provide warranty under provisions of Sections 01700 and 01740.

1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance for one year from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Standard Products: Provide material and equipment that are the standard products of the manufacturers listed and that essentially duplicate items that have been in satisfactory use for at least 1 year prior to bid opening. Nominal sizes for standardized products shall be used.
 - 1. B-Line Systems, Inc., 509 West Monroe Street, Highland, Illinois 62249-0326 (618) 654-2184 www.b-line.com
 - 2. Anvil International, 110 Corporate Drive, Suite 10 • P.O. Box 3180, Portsmouth, NH 03802-3180 Ph: 603-422-8000 • Fax: 603-422-8033. www.anvilintl.net
 - 3. TOLCO, 1375 Sampson Avenue, Corona, California 92879. Ph: 951-737-5599 / 800.786.5266 Fax: 951-737-0330 www.nibco.com
 - 4. Standon Material Resources Inc., 2800 Taylor way Bldg. 2-C P.O. Box 247, Forrest Grove, OR 97116. Toll Free - (877)693-0727 Fax - (503)533-5501 www.standon.net
- B. Substitutions: Under provisions of Section 01630.

2.2 UPPER ATTACHMENTS

- A. Ceiling Flanges: AISI Type 304 stainless steel for attachment to wood beams, ceilings, or metal decks.

- B. Concrete Plates: AISI Type 304 stainless steel for structural attachment to concrete ceiling where flexibility is desired. Use type where the hanger rod attaches directly to support bracket. Before installation ensure that concrete and anchorage are sufficient to carry the load.
- C. Concrete Inserts
 - 1. Cast in place spot concrete inserts shall be used where applicable; stainless steel body. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Select inserts to suit threaded hanger rod sizes.
 - 2. Continuous concrete inserts shall be used where applicable. Channels shall be AISI Type 304 stainless steel, complete with styrofoam inserts and end caps with nail holes for attachment to forms. The continuous concrete insert shall have a load rating of not less than 2,000 lbs/ft. in concrete. Select channel nuts suitable for strut and rod sizes.

2.3 HANGERS

- A. Hangers shall be fabricated of AISI Type 304 stainless steel.
- B. All hangers shall be of a uniform type and material for a given pipe run and application.
- C. Coated or plated hangers shall be used to isolate hangers from dissimilar metal tube or pipe.
- D. Hangers shall incorporate a means of vertical adjustment after erection while supporting the load. The minimum available adjustment shall be 1.5 inches.
- E. For piping systems with liquid temperatures up to 122 degrees F the following shall be used: MSS SP-58 Types 1, 3 through 12, Types 24 and 26 with overhead support, or Types 35 through 38 with support from below.

2.4 PIPE CLAMPS

- A. When flexibility in the hanger assembly is required due to horizontal movement, use pipe clamps. For non-insulated pipe, use standard pipe clamps.
- B. Where pipes are indicated as offset from wall surfaces, supply a double-leg design two-piece pipe clamp.

2.5 MULTIPLE PIPE RACKS AND TRAPEZE HANGERS

- A. Multiple pipe racks or trapeze hangers shall be fabricated from AISI Type 304 stainless steel and designed to suit the conditions at the points of installation.
- B. Pipes shall be kept in their relative positions to each other by the use of 2 piece clamps or clips sized for outside diameter of pipe.
- C. Pipelines subject to thermal expansion must be free to slide or roll.

2.6 HANGER RODS

- A. Hanger Rods shall be AISI Type 304 stainless steel rod threaded at both ends or continuous threaded rods of circular cross section. Use ASTM A 194 GR F8 stainless steel adjusting locknuts at upper attachments and hangers.
- B. Wire, chain, or perforated straps are not allowed.

2.7 WALL SUPPORTS

- A. MSS SP-58 Types 31 through 33, stainless steel AISI Type 304, pre-punched with a minimum of two fastener holes designed for supporting pipe from walls or structures. Provide adjustable strut where lateral adjustment is required.

2.8 FLOOR SUPPORTS

- A. Adjustable pipe saddle support with yoke, stainless steel AISI Type 304, designed for support of horizontal pipe from floor stanchions where vertical adjustment is required, with u-bolt and hex nuts to hold pipe securely to saddle, stainless steel AISI Type 304 and unthreaded square base plate stand with anchor holes, stainless steel AISI Type 304.
- B. Adjustable flanged pipe supports, AISI Type 304 stainless steel with 1/4" stainless steel base plate, stainless steel extension pipe per manufacture's recommendation and stainless steel anchors, bolts and nuts.

2.9 RISER CLAMPS

- A. Vertical runs of piping shall be supported at each floor, or closer where required, with AISI Type 304 stainless steel clamps bolted around pipes and attached to the building construction.

2.10 COPPER PIPING SUPPORTS

- A. The copper piping system shall be supported using epoxy-painted copper, padded stainless steel, or PVC coated stainless steel piping supports that conform to MSS SP-58, MSS SP-69 and MSS SP-89.
- B. Conventional steel and galvanized pipe hangers shall not be used for copper piping systems.
- C. All valves, instruments and other equipment attached to the copper piping system shall be individually supported.

2.11 PLASTIC PIPING SUPPORTS

- A. V-Bottom clevis, standard clevis, or split ring type hanger with 18-gauge stainless steel support channel or protective sleeve to form support system for plastic pipe or flexible tubing.

2.12 SUPPLEMENTAL STEEL

- A. Provide supplemental steel where the support of piping systems and equipment is required between building structural elements.
- B. Supplemental steel shall be designed per AISC Steel Construction Manual and Local Building Codes.
- C. The Contractor has the option to use pre-engineered support systems. However, a mixture of support system manufacturers' products is not permitted.
- D. Supplemental steel shall be AISI TP304 stainless steel.

2.13 PIPE GUIDES

- A. Intermediate Guides
 - 1. For piping 6 inch and smaller, a pipe clamp with an oversize pipe sleeve shall be provided for a minimum 0.16 inch clearance.
 - 2. For piping 8 inch and larger, U-bolts with double nuts that are manufactured for the purpose shall be used to provide a minimum 0.28 inch clearance around pipe. The stock sizes for the U-bolts are as follows:
 - a. For a 8 inch pipe use a 0.625 inch U-bolt
 - b. For a 10 inch pipe, use a 3/4 inch U-bolt
 - c. For a 12 inch to 16 inch pipe, use a 0.875 inch U-bolt
 - d. For 18 inch to 30 inch pipes use 1 inch U-bolts.
- B. Alignment Guides
 - 1. For piping, 8 inch and smaller, alignment guides shall be stainless steel, spider or sleeve type.
 - 2. For piping, 10 inch and larger, alignment guides shall be stainless steel, roller type guides.

2.14 ANCHORS AND FASTENERS

- A. Impact expansion (hammer and explosive charge drive-type) anchors and fastener systems are not acceptable. Lead shields, plastic or fiber inserts, and drilled-in plastic sleeve/nail drive systems are also not acceptable.
- B. Drilled-In Expansion Anchors and Fasteners
 - 1. For masonry brick and precast concrete hollow-core block anchoring/fastening systems:
 - a. Anchors shall be designed to accept both machine bolts and/or threaded rods. Such anchors shall consist of an expansion shield and expander nut contained inside the shield.
 - b. The expander nut shall be fabricated and designed to climb the bolt or rod thread and simultaneously expand the shield as soon as the threaded item, while being tightened, reaches, and bears against the shield bottom.

- c. The shield body shall consist of four legs, the inside of each shall be tapered toward shield bottom (or nut end). The end of one leg shall be elongated and turned across shield bottom. The outer surface of shield body shall be ribbed for grip-action.
 - d. The expander nut shall be of square design with sides tapered inward from bottom to top.
 - e. The anchor materials of construction shall be TP304 stainless steel of 43,541 psi minimum tensile strength.
 - f. Fasteners shall be machine bolts for use with above anchors; nuts and washers shall conform to ASTM A 194/A 194M.
 - g. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.
2. For cast-in-place concrete and solid precast concrete structural elements:
- a. The anchor/fastener assembly shall be UL listed with a one-piece stud (bolt) that has integral expansion wedges, nuts and washers.
 - b. The stud shall be constructed of TP304 stainless steel, and nut and washer of TP304 stainless steel.
 - c. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.

C. Drilled-In Adhesive Anchors

- 1. Drilled-in adhesive anchors shall not be used for overhead applications.
- 2. The anchors shall be composed of an anchor rod assembly and an anchor rod adhesive cartridge.
- 3. The anchor rod assembly shall be a chamfered and threaded stud rod of TP304 stainless steel with a nut and washer of TP316 stainless steel.
- 4. The anchor length, diameter, and embedment depth shall meet the manufacturer's requirements for the maximum allowable working load of the application.
- 5. The adhesive cartridge shall be a sealed capsule containing premeasured amounts of resin, quartz sand aggregate, and a hardener contained in a separate vial within the capsule. The capsule ingredients shall be activated by the insertion procedure of the anchor rod assembly.

2.15 THRUST BLOCKS

- A. Concrete: 3,000 psi in accordance with Section 03300.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Engineer of any discrepancy before performing the work.

3.2 INSTALLATION

- A. The absence of pipe supports and details on the contract drawings shall not relieve the Contractor of responsibility for sizing and providing supports throughout project.
- B. Install pipe support system in accordance with manufacturer's instructions.
- C. All pipe hangers and supports allow for the expansion and contraction of the piping system.
- D. Design hangers to provide assembly without disengagement of supported pipe.
- E. Piping connections to equipment shall be supported by pipe supports and not off the equipment.
- F. Large or heavy valves, fittings, and/or equipment shall be supported independently of associated piping.
- G. Pipes shall not be supported off other pipes.
- H. Supports shall be provided at piping changes in direction or in elevation, adjacent to flexible joints and couplings, and where otherwise shown on the contract drawings. Place supports within 12 inches of each horizontal elbow.
- I. Coordinate placement of pipe support system with the installation of other Work.
- J. Pipe supports and hangers shall not be installed in equipment access areas, bridge crane runs, doorways, designated pedestrian or vehicle travel pathways or as to interfere with use of space or other Work.
- K. Hanger rods shall be subjected to tension only and must not exceed four-degrees from vertical.
- L. At each channel type support, every pipe shall be provided with an intermediate pipe guide, except where pipe anchors are required.
- M. Existing support systems may be used to support additional new piping only if the Contractor can demonstrate that the existing support systems are adequate for the additional loads, or if the existing systems are strengthened to support the additional loads.
- N. Pedestal type pipe supports shall be provided under base flanges adjacent to rotating equipment and where required to isolate vibration.
- O. Dielectric barriers shall be installed between supports and copper or stainless steel piping, and between stainless steel supports and non-stainless steel ferrous piping.

3.3 SUPPORT METHODS

- A. Piping support shall be provided as specified and as shown in the contract drawings.
- B. Single horizontal suspended piping shall be supported by adjustable swivel-ring, split-ring, or clevis hangers.
- C. Multiple horizontal suspended piping shall be supported by trapeze hangers with channel type supports.

- D. Horizontal pedestal mounted piping shall have saddle with yolk type supports. Horizontal piping with a centerline elevation of less than 4 feet shall be supported from the floor.
- E. Horizontal wall mounted piping shall have wall brackets.
- F. F.Vertical piping shall be supported independently of any connected horizontal pipe by wall brackets, base elbows, or riser clamps on floor penetrations.
- G. G. Support and provide thrust blocking for underground piping per details on accompanying Drawings.

3.4 SUPPORT FOR PVC PIPING

- A. Support horizontal PVC piping using V-Bottom clevis, standard clevis or split ring type hangers. Provide at each location an 18 gauge stainless steel protective sleeve, minimum 6" long, to increase bearing area.
- B. At valves 2" and larger, provide additional support at valve location to reduce torque on piping run.
- C. Support PVC in accordance with the following schedule:
 - 1. 1/2"to 3/4" - 4' OC.
 - 2. 1" - 4-1/2'O.C..
 - 3. 1-1/4" to 2" - 5' OC.
 - 4. 2-1/2" to 3" - 6' O.C.
 - 5. 3-1/2" to 4" - 6-1/2' O.C.

END OF SECTION

DIVISION 16
ELECTRICAL

SECTION 16060
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes: Grounding systems and equipment.
- B. Section includes grounding systems and equipment, plus the following special applications: Service grounding.
- C. Underground distribution grounding.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

2.2 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

PART 3 - EXECUTION

3.1 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

3.4 LABELING

- A. Comply with requirements of NFPA 70 for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed 100 ohms.

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

END OF SECTION

SECTION 16073

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Support components.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA4.
 - 4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Galvanized steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - 2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 4. Through Bolts: Structural type, hex head, and high strength. Comply with
 - 5. ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Light Steel: Sheet metal screws.
 - 6. Items Mounted on 1--10110w Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03300 "Cast-in-Place Concrete. "
- C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

END OF SECTION

SECTION 16901

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
- 2. Sleeve-seal systems.
- 3. Grout.
- 4. Silicone sealants.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Wall Sleeves:

- 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.3 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 - 4. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- C. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 - 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

END OF SECTION

SECTION 16120
CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Qualification Data: For testing agency.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70/1CEA S-95-658.
- B. Conductor Insulation: Comply with NEMA WC 70/1CEA S-95-658 for Type THHN-2THWN-2, or Type XHHW-2, or Type UF, or Type USE and, or Type SO.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SYSTEM DESCRIPTION

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

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders and Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, or Type USE single conductors in raceway.
- B. Exposed Branch Circuits, Including in Crawlspace: Type THHN-2-THWN-2, single conductors in raceway.
- C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 16130 "Raceways and Boxes" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Color-code conductors and cables according to NFPA 70.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 16091 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling. "

3.7 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
- C. Test and Inspection Reports: Prepare a written report to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION

SECTION 16130
RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, fittings including direct-buried or concrete-encased underground conduits.
3. Metal wireways and auxiliary gutters.
4. Surface raceways.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

- A. GRC: Galvanized rigid steel conduit.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Coordination Drawings: For conduits 3-inch and larger. Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 1. Structural members in paths of conduit groups with common supports.
 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. FMC: Comply with UL 1; zinc-coated steel.
- D. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- F. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC2 and UL 651 unless otherwise indicated.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep

2.4 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "ELECTRIC."
 6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

2.5 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to MST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC.
 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried or concrete encased.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.

2. Exposed and Subject to Physical Damage or in Hazardous Areas: GRC. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Headworks interior.
 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 5. Damp or Wet Locations: GRC.
 6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 7 in hazardous locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. GRC: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
- E. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 16073 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 4. Do not embed thread less fittings in concrete unless specifically approved by Architect for each specific location.
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- K. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- S. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
- T. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Expansion-Joint Fittings:

1. 1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in Non-hazardous, damp or wet locations subject to physical damage.

W. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 02221 "Trench Excavation, Backfilling and Compaction." Install backfill as specified in Section 02221 "Trench Excavation, Backfilling and Compaction. "
2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 02221 "Trench Excavation, Backfilling and Compaction. "
3. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.

4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Provide detectable laminate, red colored — inscribed "ELECTRIC."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 16091 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling. "

3.6 PROTECTION

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

END OF SECTION

SECTION 16140
WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Snap switches.
 - 3. Wall-switch.
 - 4. Communications outlets.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:

1. Cooper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD6 Configuration 5-20R, UL 498, and FS W-C-596.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; CR5362 (duplex).
 - b. Hubbell; HBL5352 (duplex).
 - c. Leviton; 5352 (duplex).
 - d. Pass & Seymour; 5362 (duplex).

2.4 GFCI RECEPTACLES

- A. General Description:
 1. Straight blade, feed-through type.
 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cooper; VGF20.
 - b. Hubbell; GFR5352L.
 - c. Pass & Seymour; 2095.
 - d. Leviton; 7590.

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Single Pole:
 - b. Cooper; AH1221.
 - c. Hubbell; 1--1BL1221.
 - d. Leviton; 1221-2.
 - e. Pass & Seymour; CSB20AC1.
 - f. Two Pole:
 - g. Cooper; AH1222.
 - h. Hubbell; HBL1222.
 - i. Leviton; 1222-2.
 - j. Pass & Seymour; CSB20AC2.
 - k. Three way:
 - l. Cooper; AH1223.
 - m. Hubbell; HBL1223.
 - n. Leviton; 1223-2.
 - o. Pass & Seymour; CSB20AC3.
 - p. Four Way:
 - q. Cooper; AH1224.
 - r. Hubbell; HBL1224.
 - s. Leviton•, 1224-2.
 - t. Pass & Seymour; CSB20AC4.

C. Pilot-Light Switches, 20 A:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; AH1221PL for 120 and 277 V.
 - b. Hubbell; HBL1201PL for 120 and 277 V.
 - c. Leviton•, 1221 -LHI.
 - d. Pass & Seymour; PS20ACIRPL for 120 V, PS20ACIRPL7 for 277 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "off. "

2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather resistant, die-cast aluminum with lockable cover.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- E. Receptacle orientation:
 - 1. Install ground pin of vertically mounted receptacles down.
- F. Devices Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard devices plates do not fit flush or do not cover rough wall openings.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single multigang wall plates.

END OF SECTION

APPENDIX 1
GEO TECHNICAL INVESTIGATION

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R E P O R T

GEOTECHNICAL INVESTIGATION PROPOSED HEADWORKS BUILDING AND GRIT CHAMBER

WASTE WATER TREATMENT PLANT TOWN OF MONTVILLE, CONNECTICUT

Prepared for
Waste Pollution Control Authority
310 Norwich-New London Turnpike
Uncasville, CT 06382

May 1, 2012

URS

URS Corporation
335 Commerce Drive
Suite 300
Fort Washington, PA 19034-2623
215.367.2500

36938892



May 1, 2012
36938892

Mr. Brian Lynch
Administrator
Waste Pollution Control Authority
310 Norwich-New London Turnpike
Uncasville, CT 06382

**Re: Geotechnical Investigation
Proposed Headworks Building and Grit Chamber
Waste Water Treatment Plant
Town of Montville, Connecticut**

Dear Mr. Lynch:

We are pleased to present herein our report of a geotechnical investigation for the proposed headworks building and grit chamber. This investigation was performed in accordance with the contract dated November 28, 2011, Work Order No. 7.

Soil samples obtained during the investigation will be retained in our laboratory for a period of three months, after which they will be discarded unless other arrangements are made.

We sincerely appreciate the opportunity to be of service to you on this project. If you have any questions regarding the contents of this report, or if we may be of additional service, please do not hesitate to contact us at 215-367-2488.

Very truly yours,

Yongli Min, P.E.
Principal Engineer

Neil Scafonas, E.I.T.
Geotechnical Engineer

cc: John C. Volk, P.E., URS
Richard D. Kruczek, P.E., URS
Evan Andrews, P.E., URS

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The Geotechnical Investigation reported herein was performed at the request of Montville Waste Pollution Control Authority (WPCA) in connection with the proposed design and construction of a headworks building and grit chamber tank at a waste water treatment facility in Montville, Connecticut. The project location is shown on Plate 1, Regional Location Plan.

The purpose of this investigation was to evaluate the geotechnical conditions at the site and to formulate conclusions and recommendations pertaining to the design and construction of the foundations for the proposed structures. Our services consisted of planning the investigation, a subsurface exploration program consisting of test borings, laboratory testing of representative soil samples, engineering analysis of the data obtained, and preparation of this report.

A description of the subsurface exploration program and test boring logs are presented in Appendix A. The geotechnical laboratory testing program is described and the results are summarized in Appendix B. Relevant findings, conclusions, and recommendations derived from this investigation are presented in the following sections.

The proposed structures will be located in the area shown on Plate 2, Boring Location Plan.

The new headworks structure at the treatment plant will be a one-story masonry structure measuring 32 feet by 36 feet in plan. There will be a fine wastewater screen and grit classifier located in the proposed new building, with a combined weight on the order of 15 kips. The structures will handle a peak flow capacity of 14 million gallons per day (MGD). The finish grade will be at El. 38.6 feet.

The partially buried grit chamber tank will be a concrete tank to be located southeast of the proposed building, with an outside diameter of 22 feet and a total height of 24 feet in height. The finish floor elevation at the bottom of the tank will be at El. 20.54 feet, and El. 41.50 feet at the rim. The total capacity of this tank will be approximately 43,000 gallons.

The site is located in the existing waste water treatment facility site in Montville, Connecticut. An existing small building is located immediately north of the proposed building. Another building is located approximately 10 feet east of the proposed grit chamber tank. In the immediate project area, the ground surface is generally flat and supports a cover of grass, with approximately ground surface elevations ranging from El. 36.5 feet to 38.0 feet. Beyond the project area, the terrain slopes downward towards west and north.

The elevations indicated in the report are based on the contour lines and spot elevations shown on a drawing titled Topographical Survey –Wastewater Treatment Facility dated January 2012, provided by URS Corporation AES of Rocky Hill, CT.

Montville is located in the Northeast Hills Region of the state, an area of glacially worked hills, valleys and outwash plains. Glacially formed elongated parcels of sand or sand and gravel overlying sand, gravel and or fines, stretch from the northwest to southeast in the northern half of town and close to the southern border with Waterford. Areas of swamp, alluvium and alluvium overlying sands, gravel and/or fines occur in less frequent and smaller parcels throughout Montville.

Bedrock geology underlying the Town of Montville consists mainly of three types: Hope Valley Alaskite Gneiss, a light-pink to gray, medium to coarse-grained granitic gneiss; Plainfield Formation, an interlayered thinly bedded quartzite, mica schist, and dark-gray gneiss; and Potter Hill Granite Gneiss, a light-pink to gray, tan weathering, fine- to medium-grained, well-foliated granitic gneiss. In the Montville area, bedrock formations generally occur in broad, banding formations running west to east.

The subsurface conditions at the site were explored by three test borings with depths ranging from approximately 32 to 42 feet below grade. The locations of test borings are shown on Plate 2, Boring Location Plan. Logs of test borings are presented in Appendix A, together with a description of the drilling and sampling methods. The results of geotechnical laboratory tests are presented in Appendix B. Various subsurface materials encountered at the site, together with the groundwater conditions, are described below.

4.1 TOPSOIL

Topsoil was encountered with a thickness ranging from approximately 3 to 6 inches in all borings.

4.2 STRATUM 1 - SAND

This stratum was encountered below the topsoil in all three borings. All three borings were terminated in this stratum. The material is identified as light brown coarse to fine sand with trace silt and gravel. Standard Penetration Test (SPT) values range from 3 to 75 blows per foot (bpf). Based on the SPT values, the top 6 feet of this stratum is judged to be in a medium dense to dense condition. A loose zone was encountered from approximately 6 feet depth, extending to a depth approximately 13 to 18 feet. Below the loose zone, the material is generally judged to be in a medium dense to dense condition.

Results of six moisture tests indicate a moisture content ranging from 4 to 13 percent.

Corrosivity testing on one combined sample indicates non-detectable concentrations of chlorides, sulfates and sulfides, pH of, and resistivity of 220,000 Ω -cm.

4.3 GROUNDWATER

Groundwater was observed during drilling at a depth of approximately 30.5 to 31.3 feet below ground surface, corresponding to El. 5.8 to El. 6.6 feet. It should be noted that groundwater levels fluctuate due to seasonal, climatic, tidal, and man-made conditions.

5.1 FOUNDATIONS

Based on the test borings, the subsurface generally consists of 6 feet of medium dense to dense sand, followed by approximately 7 to 12 feet of loose sand, overlying in turn by medium dense to dense sand.

Considering the estimated foundation loads and the results of this investigation, shallow based foundations are considered appropriate for support of all proposed structures.

The soils of Stratum 1 would be capable of safely supporting the new building on shallow-based spread and/or continuous wall foundations with a maximum net bearing pressure of 2,000 pounds per square foot (psf). Total settlement is not expected to exceed ½ inch. Differential settlement across the structure is not expected to exceed 3/8 inch. The majority of the estimated settlement is anticipated to occur concurrently with the construction of the proposed building.

5.2 PROTECTION OF EXISTING STRUCTURES

New foundations for the grit chamber tank and headworks building are immediately adjacent to two existing buildings. Care should be exercised to avoid undermining existing foundations during foundation construction. If the excavation is required within the zone of influence and below existing foundations (1H:1V bearing splay), protection of the existing foundation is required.

The construction of the grit chamber will require some 20 feet of excavation. Since the existing building is only about 11 feet east of the new chamber, the excavation is expected to enter the zone of influence of the existing foundations. The existing foundations should be protected during construction of the grit chamber.

The new headworks building will be some 13 feet west of the grit chamber. Therefore, protection of the new foundation for the headworks building is also required. Alternatively, the building foundations may be built following the completion of the grit chamber. In this case, protection of the foundation will not be required. Any methods of protecting the existing foundations should be brought to the Geotechnical Engineer for review and approval.

5.3 GROUNDWATER

Groundwater is not expected to be encountered during construction. However, the contractor should be prepared to remove any accumulation of water due to a “perched” water condition or due to surface water runoff.

Recommendations pertaining to the design and construction of the foundations for the proposed structures are presented below.

6.1 SITE PREPARATION

Site preparation should consist of removing topsoil and vegetation from the area of the proposed construction. Site clearing should extend at least 5 ft beyond the limits of proposed structures. Subsurface utilities in the areas of the proposed structures should either be re-routed or abandoned in place by filling with grout. Loose backfill above and around existing utilities or other unsuitable fill materials should be removed and replaced with structural fill. The subgrade area should then be proof-rolled and compacted on grade utilizing a vibratory drum compactor that imparts a total applied force (static plus dynamic) of at least 500 pounds per lineal inch of drum width.

Any loose or soft materials detected by proof-rolling that cannot be stabilized by additional compaction should be removed to stable material and replaced with structural fill, or otherwise as directed by the Geotechnical Engineer.

6.2 FOUNDATIONS

Design: The proposed tank foundation should consist of shallow foundations supported on the decomposed rock with a maximum net bearing pressure 2,000 psf. The recommended bearing value may be increased by 33 percent for short-term loading such as wind and seismic loads. All spread and continuous footings should have a minimum width of 36 and 18 inches, respectively, regardless of the actual bearing pressures developed. All interior footings in heated areas should be based a minimum of 2 ft below the finished floor. Exterior footings and those interior footings in unheated areas should be based a minimum of 4 ft below adjacent exterior finished grades for frost protection.

A coefficient of friction of 0.30 may be used between the concrete and subgrade soils.

Construction: Foundation excavations should be protected from freezing and the accumulation of ponded water. Concrete should be placed as soon as the excavation is completed. All footing excavation surfaces should be protected until the concrete and backfill are placed. Footing bearing surfaces should be cleaned of all material loosened by the excavation process prior to concrete placement. Should loose or soft materials be encountered which cannot be densified by additional compaction, the loose or soft materials should be removed and replaced with lean concrete or compacted structural fill in accordance with Section 6.4 below.

6.3 SEISMIC CRITERIA

Based on the 2009 International Building Code (IBC 2009), the site soil classification should be D.

6.4 STRUCTURAL FILL

Structural fill will be required for backfilling load bearing areas around the foundations and the new grit chamber tank. Materials to be used for structural fill should be predominantly granular, and free from roots, vegetation, organic material, trash, wood, or other deleterious matters. The

excavated site soils consist of predominantly clean sand. Therefore the on-site soils are considered suitable for use as structural fill. Any imported fill material should be well-graded, predominately granular soils with a maximum particle size of 2 inches, no more than 12 percent finer than the No. 200 Sieve, and having a plasticity index of not greater than 6 percent.

Structural fill should be placed in essentially horizontal lifts with loose thickness of not more than 9 inches. Structural fill should be compacted to an average of no less than 95 percent of the maximum dry density as determined in the laboratory by the Modified Proctor compaction test, ASTM D1557, or not less than 80 percent of the relative density as determined by ASTM D4253/4254 for free-draining fill materials.

6.5 SLAB-ON-GRADE

Slabs-on-grade should be supported on the densified, granular on-site soils or structural fill. Prior to floor slab construction, all subgrades should be thoroughly proof-rolled with a smooth-drum vibratory compactor that imparts a total applied force (static plus dynamic) of at least 500 pounds per lineal inch of drum width. Any soft materials that cannot be densified by additional compaction should be removed and replaced with structural fill. Any materials that were loosened by previous construction activity or weather conditions should be recompacted to the requirements described below in Section 6.4, Structural Fill. A modulus of subgrade reaction, K_b of 100 tons per cubic foot should be used for the densified subgrade.

To preclude floor dampness, a capillary break consisting of a compacted 4-inch thick layer of AASHTO No. 57 stone should be constructed beneath the floor slab. Additionally, a 10-mil polyethylene membrane or similarly rated vapor barrier should be placed over the capillary break after compaction.

6.6 RETAINING WALLS

It is recommended that retaining walls which are restrained from rotational movement be designed to resist "at-rest" lateral earth pressures. The earth pressure should be equivalent to the hydrostatic pressure of a fluid weighing 61 pounds per cubic foot (pcf).

Site retaining walls that are not restrained from rotational movement should be designed for the active earth pressure condition. The active earth pressure should have an equivalent fluid pressure of 42 pcf. Passive pressure resistance would be equal to a fluid pressure of 320 pcf. Weep holes and/or backwall drains should be incorporated in site retaining walls to prevent the build-up of hydrostatic pressures behind the wall.

Pressures caused by surcharge loadings, if present, should also be incorporated in retaining wall designs, approximated as a uniform lateral loading of one-half the expected surcharge pressure on the backfill adjacent to restrained walls and one-third of the surcharge on unrestrained walls. A coefficient of friction of 0.3 should be used for sliding of walls on the natural soil and compacted structural fill.

6.7 GROUNDWATER CONTROL

Groundwater is not expected to be encountered within the depth of anticipated excavation. However, the contractor should be prepared to perform temporary dewatering if perched water is

encountered during excavations. Likewise, foundation excavations should be kept dry until the concrete is poured. No accumulation of water should be allowed on subgrade surfaces.

6.8 EXCAVATION SLOPES

Temporary excavations above the groundwater level should have side slopes not steeper than 1.5H:1V. All excavations should be performed in accordance with current OSHA regulations. Conformance to OSHA requirements is the sole responsibility of the Contractor.

6.9 PROTECTION OF EXISTING STRUCTURES

The existing building foundation east of the proposed new grit chamber should be protected prior to excavating for the new tank. All excavation support should be designed by a professional engineer licensed in Connecticut with demonstrated past experience in designing such structures. Any design related to protection of the existing foundations should be brought to the Geotechnical Engineer for review and approval.

Similarly, it is recommended that the foundations for the new headworks building be constructed following the completion of the new grit chamber tank. Any soils disturbed by the construction of the new tank should be compacted and backfill be placed following the recommendations for structural fill, Section 6.4. Alternatively, the new foundations for the headworks building should be protected from being undermined during the construction of the new grit chamber tank.

6.10 CORROSION POTENTIAL

Comparison of the laboratory results on one sample for pH, resistivity, sulfate and chloride tests with IBC indicates that the concrete in contact with the site soils would have negligible sulfate exposure and that no special type cement would be necessary. The corrosion potential for steel should be evaluated by the structural and utility designers.

6.11 CONSTRUCTION MONITORING

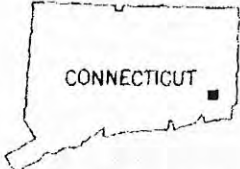
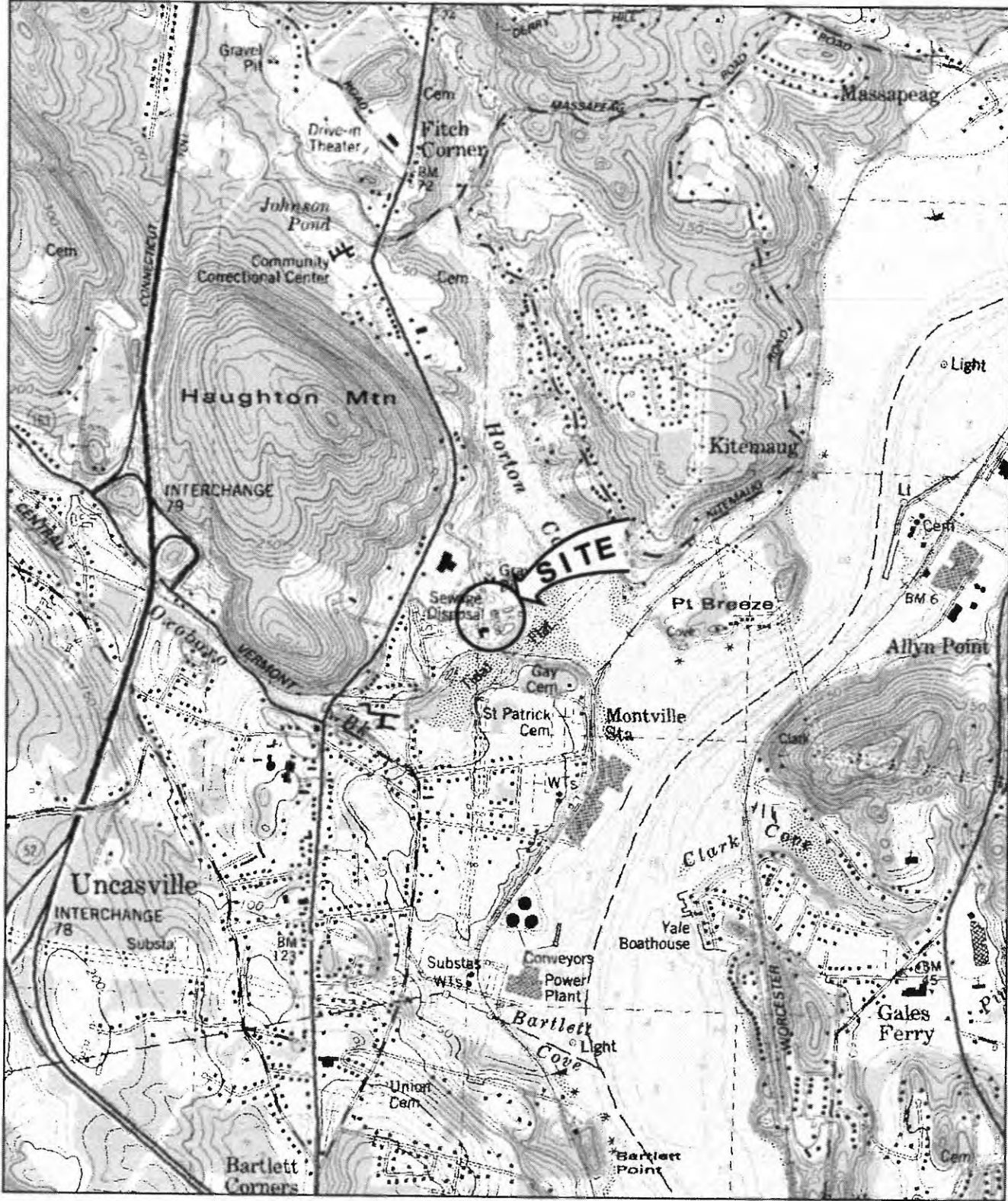
It is recommended that construction monitoring be provided full time during foundation construction by URS. The items that should be observed, monitored include excavation, evaluation of foundations soils, backfill, and/or dewatering.

The services described in this report were provided in accordance with applicable standards of professional care. No warranty or guarantee, expressed or implied, is intended. The conclusions and recommendations are based on the assumptions that the subsurface conditions do not deviate appreciably from those revealed by the test borings drilled during this investigation, and that the loads are similar to those given in the project description. If the structures are moved or loads have changed, URS should be given the opportunity to modify recommendations accordingly. The conclusions and recommendations are also based on competent field engineering, monitoring, and testing during construction. The recommendations presented in this report are solely for the use of our client for the design of this particular project. Any re-use of this document, particularly by third parties, without the express written permission of URS is solely at their own risk.



Drawn By & Date/Time: Joseph_Shell Apr 24, 2012 - 3:30pm

Drawing Location & Name: S:\Resources\CADD\Montville WWTF\Fig-01 Regional Location Plan.dwg



QUADRANGLE LOCATION

SCALE: 1 INCH=2000 FEET



MAP SOURCE:
UNCASVILLE, CONNECTICUT USGS
QUADRANGLE, 1984.

Job: 36938892.00001

Prepared by: JES

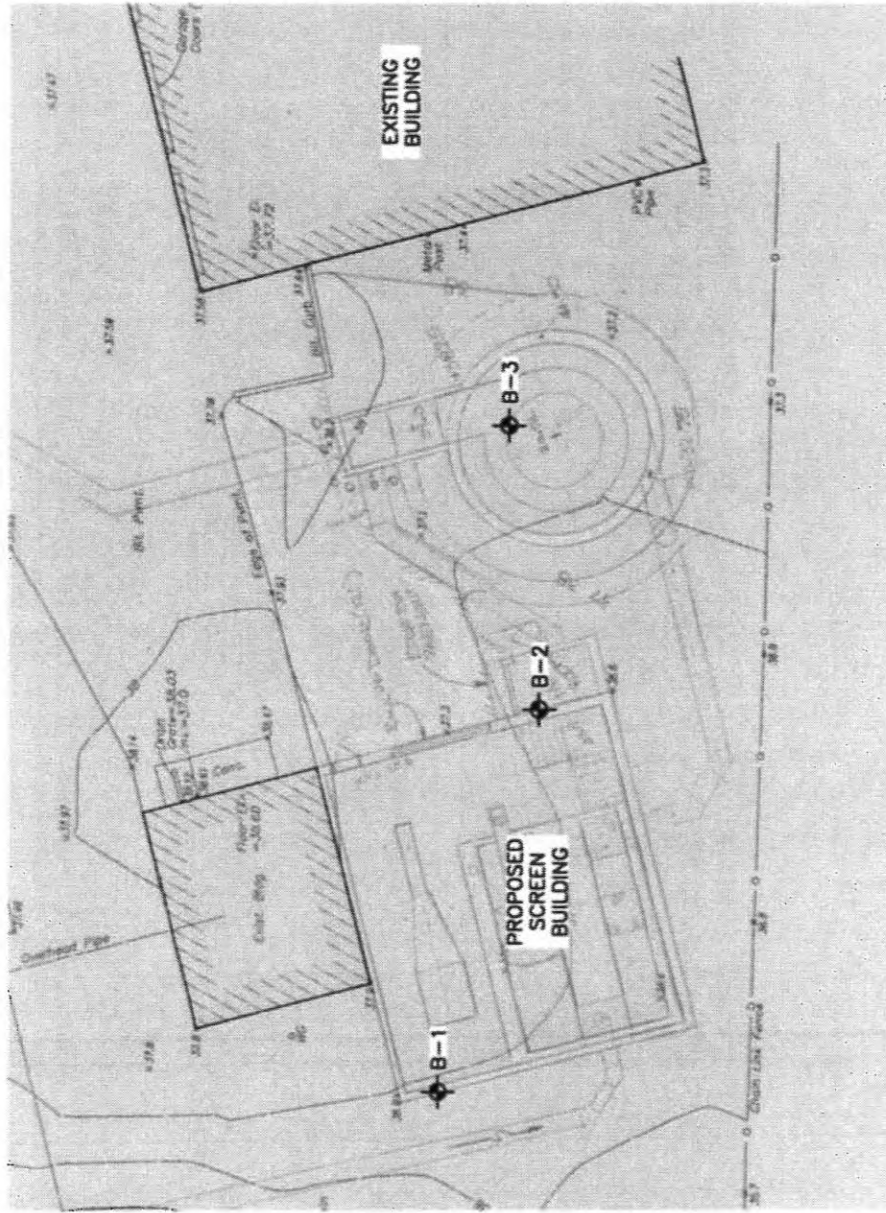
Checked by: YM

Date: 04/23/2012

REGIONAL LOCATION PLAN
WASTEWATER TREATMENT FACILITY

MONTVILLE, CONNECTICUT

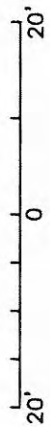
FIGURE 1



LEGEND
 B-1 TEST BORING LOCATION AND ID

NOTE:
 BASE DRAWING WAS PROVIDED
 BY URS CORPORATION AES,
 ROCKY HILL, CONNECTICUT.

SCALE: 1 INCH = 20 FEET



BORING LOCATION PLAN
 WASTEWATER TREATMENT FACILITY
 MONTVILLE, CONNECTICUT

Job:	36938892.00001
Prepared by:	JES
Checked by:	YM
Date:	04/23/2012

FIGURE 2

Appendix A

Subsurface Exploration

Appendix A

Subsurface Exploration

The subsurface exploration for the geotechnical investigation for the proposed grit chamber and headworks building consisted of 3 test borings, as shown on Plate 2, Test Boring Location Plan. The borings were drilled between February 24, 2012 and March 2, 2012 by New England Boring Contractors of Connecticut, Inc. of Glastonbury, CT, under subcontract and full-time technical observation of URS. All test boring locations were laid out in the field by URS Corporation.

All borings were drilled using a Mobile B-51 truck mounted rig and were advanced using hollow stem auger drilling techniques. Samples of subsoils were obtained from the borings for visual classification, identification, and laboratory testing by means of a 2-inch O.D. split-spoon sampler driven up to 24 inches by blows of a 140-pound automatic hammer falling 30 inches (Standard Penetration Test, ASTM D 1586). The number of hammer blows required for a 2-inch O.D. sampler penetration in the interval from 6 to 18 inches, or fraction thereof, is presented on the boring logs as "Sampling Resistance".

A "Key to Soil Symbols and Terms" used in this report is presented on Page A-2, and the logs of the test borings are on Pages A-3 through A-5.

LOG of BORING No. B-1

Sheet 1 of 1

DATE 3/3/12 SURFACE ELEVATION 37.1 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (6 inches)	36.6					
		26	SS							
		24	SS	Medium dense to dense light brown coarse to fine SAND, trace silt, gravel						
5		7	SS							
		3	SS	- loose						
		12	SS							
10		3	SS	- loose						
15		3	SS	- very loose						
20		19	SS	- becoming medium dense						
25		20	SS	- becoming silty sand						
30		17	SS		5.1					
35				Notes: 1. Soil sample was wet at approximately 30 ft depth. 2. Water was observed in the borehole during drilling at approximately 30.5 ft.						
40										

Completion Depth: 32.0 ft.Water Depth: See ft., After _____ hrs.Project No.: 36938892Notes ft., After _____ hrs.Project Name: MWPCF

_____ ft., After _____ hrs.

Drilling Method: Hollow Stem Augers

_____ ft., After _____ hrs.

42712 BORLOGR 36938892 MWPCF GPJ

LOG of BORING No. B-2

Sheet 1 of 1

DATE 2/24/12SURFACE ELEVATION 36.9LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (3 inches)	36.7					
		24	SS							
		47	SS	Medium dense to dense light brown coarse to fine SAND, trace silt, gravel						
5		16	SS							
		6	SS							
		3	SS	- loose						
10		3	SS	- loose						
15		4	SS	- loose						
20		21	SS							
25		33	SS							
30		18	SS		4.9					
35				Notes: 1. Soil sample was wet at approximately 30 ft depth. 2. Water was observed in the borehole during drilling at approximately 30.8 ft.						
40										

Completion Depth: 32.0 ft.Water Depth: See ft., After _____ hrs.Project No.: 36938892Notes ft., After _____ hrs.Project Name: MWPCF

_____ ft., After _____ hrs.

Drilling Method: Hollow Stem Augers

_____ ft., After _____ hrs.

LOG of BORING No. B-3

Sheet 1 of 1

DATE 2/24/12 SURFACE ELEVATION 37.1 LOCATION See Plate 2

DEPTH, FT.	SAMPLES	SAMPLING RESISTANCE	SAMPLE TYPE	DESCRIPTION	STRATUM ELEVATION	POCKET PENETROMETER (TSF)	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OTHER TESTS
0				Topsoil (3 inches)	36.9					
21			SS	Medium dense to dense light brown coarse to fine SAND, trace silt, gravel			3.9			M
25			SS							
5			10							
7			SS							
10			4							
			SS	- loose			5.0			M X
15			26	- loose			3.7			M
20			6							
			SS							
25			35	- becoming silty sand			8.6			M
30			32							
			SS							
35			23	Notes: 1. Soil sample was wet at approximately 30 ft depth. 2. Water was observed in the borehole during drilling at approximately 31.3 ft.			13.1			M
40			75							
			SS		-4.9		12.5			M

Completion Depth: 42.0 ft.Water Depth: See ft., After _____ hrs.Project No.: 36938892Notes ft., After _____ hrs.Project Name: MWPCF

_____ ft., After _____ hrs.

Drilling Method: Hollow Stem Augers

_____ ft., After _____ hrs.



Appendix B

Laboratory Testing

Appendix B

Laboratory Testing

Physical property tests were conducted in the laboratory on selected representative soil samples to aid in classification and for correlation with engineering behavior of the soils. These tests included natural water content (ASTM D 2216) and grain-size distribution (ASTM D 422). Corrosivity test suite (resistivity, pH, sulfates, sulfides, and chlorides) are tested on selected samples.

The numerical results are summarized on Page B-2. Grain-size distribution curves are presented on Pages B-3 through B-4.

Project: MWPCF
Project No.: 36938892



SUMMARY OF LABORATORY TEST RESULTS

Boring and Sample Number	Depth (feet)	Classification	USCS Symbol	Water Content (%)	Dry Unit Weight (pcf)	Atterberg Limits		Specific Gravity	Organic Content (%)	Grain Size		Compaction	Consolidation	Analytical Results (ppm)			Triaxial Compression		Resistivity (Ohm-cm)	pH
						Liquid Limit	Plastic Limit			<#200 (%)	<2µ (%)			Chloride	Sulfate	Sulfide	UU	UC		
B-3 S-2	2.0-4.0	Brown POORLY GRADED SAND with SILT	SP-SM	3.9						12										
B-3 S-4 & 5	7.0-12.0	Brown POORLY GRADED SAND with SILT	SP-SM	5.0						8										
B-3 S-4 & 5	7.0-12.0			5.4	117.8									ND	ND	ND			220,000	7.5
B-3 S-6	15.0-17.0	Brown POORLY GRADED SAND with SILT and GRAVEL	SP-SM	3.7						7										
B-3 S-7	20.0-22.0	Brown POORLY GRADED SAND with SILT	SP-SM	8.6						7										
B-3 S-9	30.0-32.0	Brown SILTY SAND	SM	13.1						14										
B-3 S-11	40.0-42.0	Brown POORLY GRADED SAND	SP	12.5						5										

The soil classification and USCS symbols are based partially on visual classification unless both Atterberg limits and grain size analysis tests are performed.

★ Refer to Laboratory Test Curves

Sheet 1 of 1

