

**TECHNICAL SPECIFICATIONS
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FOR
CITY OF CANTON
EAST SIDE INTERCEPTOR SANITARY SEWER RELOCATION
G.P. #1113**

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**SECTION 01380
PRECONSTRUCTION PHOTOGRAPHY**

PART - GENERAL

1.1 SUMMARY

- A. Prior to the delivery of any equipment, materials or supplies to any work site, or to the beginning of any construction activity, the Contractor shall provide preconstruction photography for the purpose of establishing the existing surface conditions in all of the areas of construction or of intended use by the Contractor.
- B. The preconstruction photography shall be performed by an independent company that has had previous experience in similar type work. The name of the company must be submitted to the Engineer for approval prior to engaging in the work.

1.2 SCOPE OF WORK

- A. Ground photography shall consist of taking a color audio-video recording of the surface features along the entire length of the project. All work and storage areas and all intersecting roadways shall also be taped. Prior to audio-video recording the project, all areas to be inventoried shall be investigated visually with notations made of items not readily visible by recording methods.
- B. The purpose of obtaining a color audio-video recording of the project is to provide a record of the preconstruction conditions for proper restoration of surface features after completion of the project. The recording will assist in restoring areas affected by construction to their original condition with as little controversy as possible.

1.3 QUALIFICATIONS

- A. The color audio-video recording must be prepared by a professional electrographer that is actively engaged in making color audio-video recordings of similar projects for municipal agencies. The name of the company must be submitted to the Engineer and be approved prior to the start of any recording.

1.4 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Preconstruction Photography.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Color audio-video digital recordings shall be standard DVD Format, and compatible with all commercially available DVD player/recorders.

- B. The digital color camera used for video recording shall be a commercially available camera and shall produce color signals equal to or better than the recognized, published industry standards. It shall be capable of providing a video signal-to-noise ratio of at least 40 DB and a horizontal focal length lens (i.e., Zoom) that will allow clear images to be recorded at varying distances. It shall have multi-axis mobility, (Pan and Tilt). The camera must be capable of producing an acceptable quality color picture as determined by the Owner or Engineer while operating under the recording conditions specified.

2.2 OWNERSHIP OF RECORDINGS

- A. All recordings produced will become the permanent property of the Owner. The Contractor shall delivery all recordings to the Owner at least seven (7) days prior to the start of any construction work.
- B. Any portion of the recording coverage deemed unacceptable by the Owner or the Engineer must be re-recorded by the Contractor prior to the start of construction work at no additional charge. The new recording shall be delivered to the Owner prior to the start of any construction work.

PART 3 - EXECUTION

3.1 COVERAGE OF RECORDING

- A. Color audio-video recording coverage shall include, but is not limited to, all existing driveways, sidewalks, curbs, streets, signs, landscaping, trees, catch basins, fences, visible utilities, and all buildings located within the zone of influence. It is imperative that existing surface features which have faults, fractures, defects, or other imperfections be included on the video tape record. Audio descriptions shall be made simultaneously with the video coverage to support the visual record.
 - 1. Streets shall be recorded on audio-video media for the full width of the right-of-way, except where specifically noted otherwise by the Engineer.
 - 2. Work agreement easement, or temporary construction areas shall be recorded on audio-video media and include all adjacent areas lying within the zone of influence of construction.
 - 3. Building Exteriors - The Contractor shall furnish color audio-video recordings of the exterior surfaces of all buildings within the zone of influence of construction as well as those specifically designated by the Engineer. Buildings identified for audio-video coverage may include houses, garages, and other structures. Coverage shall include, but is not limited to, walls, visible foundations, chimney, porches, and trim.

3.2 LOCATION INFORMATION

- A. All recordings (media and cases) shall be properly identified by media number, locations, and project name in a manner acceptable to the Owner.

- B. A record of the contents of each recording shall be supplied on a run sheet identifying each segment in the recording by location, i.e., street viewing side, traveling direction, engineering stationing, and all referenced by counter numbers.
- C. A brief report and inventory of all recordings completed, referenced by location and recording number, shall be furnished to the Owner when the recordings are delivered.
- D. All video recordings shall begin with the date and time of recording, the project name, the sheet numbers or engineering stationing as shown on the plans, the name of the street, the side of the street, area or building being recorded, the compass direction of travel, and the counter at the beginning and end of each segment.
- E. Houses and buildings shall be identified visually by house or building number, when possible, in such a manner that the progress of the recording and the proposed system may be located by reference to the houses and buildings.
- F. Provide a brief, but accurate, description of lawn areas, landscaping, driveways, aprons, sidewalks, culverts, trees, roadways, etc. which depicts the condition(s) of these features.
- G. The engineering stationing numbers must be continuous and correspond to the project stationing and include the standard engineering symbols (i.e., 37+38). This information must appear in the lower left half of the viewing screen. Below the engineering stationing the name of the project, name of the area covered, direction of travel, viewing side, etc. shall also appear.
- H. All recordings shall be accompanied by a notarized statement verifying the original unedited quality of the recordings.

3.3 ACCESS

- A. If it becomes necessary to enter onto private property, the owner of the property shall be notified by the Contractor at least twenty-four (24) hours in advance of the planned entry in order to obtain their permission to do so. If the owner of the property refuses to give permission, the Contractor shall notify the Engineer.
- B. The Contractor shall not enter onto any private property without permission of the property owner or notification from the Engineer that he has the legal right to do so. The Contractor shall be held liable for entry made other than stated above.

3.4 SITE RECORDING CONDITIONS

- A. All recording shall be done during times of good visibility. Recording outside shall not be done during periods of visible precipitation or when the ground area is covered with snow, leaves, or debris unless otherwise authorized by the Engineer.
- B. In order to record the proper detail and perspective on the media, adequate auxiliary lighting will be required to fill in shadow areas caused by trees, utility poles, road signs, etc. as well as other conditions which require artificial illumination.

- C. The average rate of speed in the general direction of travel of the conveyance used during recording shall not exceed sixty feet (60') per minute. Panning rates and zoom-in zoom-out rates shall be controlled so that during playback adequate clarity of the objects being viewed will be maintained.
- D. When describing features, stop moving, and hold camera on the feature while describing, then resume moving.
- E. When conventional wheeled vehicles are used as the conveyance for the video camera, the distance from the camera lens to the ground shall be maintained in a manner to insure proper perspective at all times. In instances where media coverage will be required in areas not accessible to conventional wheeled vehicles, coverage shall be obtained by walking or other special means of conveyance approved by the Engineer. Regardless of the method of conveyance the same requirements for media quality and content remain in effect as specified except as may be specifically exempted in writing by the Engineer.

END OF SECTION

SECTION 02050

DEMOLITION

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Work of this section includes portions of the existing sanitary sewer collection system and related structures as shown on the Drawings, but is not limited to:
 - 1. Complete Structural Demolition
 - a. Complete structural demolition.
 - b. Below-grade construction or demolition.
 - 2. Existing Utilities
 - a. Existing utilities remaining in use.
 - b. Existing utilities being shut down temporarily.
 - c. Existing utilities being removed.
 - d. Existing utilities being abandoned in place.
 - 3. Salvage Items
 - a. Salvage items removed by Contractor for Owner reuse.
 - i. None.

1.2 RELATED WORK

- A. Section 02200 – Earthwork
- B. Division 15 – Mechanical
- C. Division 16 – Electrical

1.3 SUBMITTALS

A. DEMOLITION SCHEDULE

- 1. Proposed methods and detailed sequence of operations.
- 2. Include coordination for shut-off, capping and continuation of utility services as required, together with details for dust and noise control protection.
- 3. Preliminary inspection report.

4. Work performance plan.
5. Final report.

B. PERMITS

1. Secure and pay for all required permits for and related to demolition activities.

1.4 JOB CONDITIONS

A. GENERAL

1. Any demolition indicated on the Drawings or in this section shall be for purposes of indicating the limits of demolition. Not indicated is the full extent or details for the existing items to be demolished.
2. Obtain Record Drawings, if any, from the Owner for reference. If there are Record Drawings, reliance cannot be made on such as to how extensive the demolition or the details of such due to the quality of the records and possible modifications to the original project.
3. The Contractor shall be responsible for all demolition and any consequences of demolition, no matter how extensive or the details of such, within the limits indicated on the Drawings or in this section.

B. OWNER OCCUPANCY

1. Conduct demolition work in manner that will minimize need for disruption of Owner's normal operations.
2. Provide minimum of 72 hours advance notice to Owner of demolition activities which will severely impact Owner's normal operations.

C. SALVABLE ITEMS

1. Items of salvable value to be retained by the Owner, as selected by the Owner, shall be moved by the Contractor to a location designated by the Owner and provide written permission from Owner.
2. Items of salvable value to the Contractor shall be removed from the site as the work progresses and transported from the site. Storage or sale of removed items on the site will not be permitted.

D. DAMAGES

1. Promptly repair damages caused to adjacent facilities by demolition operations, as directed by the Owner and at no cost to the Owner.

E. UTILITY SERVICES

1. Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.
 - a. Do not interrupt existing utilities serving occupied or used facilities, except where authorized in writing by the Owner. Provide temporary services during interruptions to existing utilities, as acceptable to the Owner.
 - b. Disconnect and seal utilities serving each area in which utilities are being removed.

F. EXPLOSIVES

1. The use of explosives shall not be permitted.

1.5 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Demolition.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 INSPECTION

A. GENERAL

1. Prior to commencement of demolition work, inspect areas in which work will be performed.
2. Photograph existing conditions of structure surfaces, equipment, and surrounding properties which could be misconstrued as damage resulting from demolition work; submit prior to starting work.
3. Conduct any appropriate field testing to determine the nature of the existing structure to be demolished.

3.2 PREPARATION

A. GENERAL

1. Provide shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

B. DUST-PROOF PARTITIONS AND CLOSURES

1. Erect and maintain dust-proof partitions and closures as required to prevent spread of dust or fumes to adjacent buildings, site, and properties.

3.3 DEMOLITION

A. GENERAL

1. Coordinate and sequence demolition with the Owner's Representative and Owner.
2. Locate demolition equipment throughout structure and remove.
3. Proceed with demolition in a systematic manner and coordinate all trades involved.
4. Demolish concrete and masonry in small sections. Cut concrete.
5. In addition to Demolition Drawings, refer to all other Drawings for demolition work.
6. The work includes the removal of items of existing construction not to remain as a part of the final Project.
7. Complete all demolition work in the area indicated, including any concealed items or any existing items not shown on the Drawings.
8. Remove all materials completely and neatly, leaving surfaces smooth and ready for new work. Saw cut where necessary. Do not use jackhammers as a means of cutting.
9. Clean adjacent structures and improvements of dust, dirt, and debris caused by demolition operations and as required by governing authorities. Return adjacent areas to condition existing prior to the start of the work.

B. PROTECTION AND SAFETY

1. Provide all protection, safety, and health requirements in accordance with OSHA, U.S. EPA, and other laws, regulations, and safe practices.

2. Ensure safe passage of persons around the area of demolition. Conduct operations to prevent injury to adjacent property and persons.
3. Protect existing work remaining in place.
4. Promptly repair damage caused to adjacent properties or existing construction not noted to be demolished at no change in the Contract Sum or Date of Substantial Completion.
5. Remove temporary protection at completion of work.

C. ENVIRONMENTAL CONTROLS

1. Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.
 - a. Do not use water when it may create hazardous or objectionable conditions such as flooding, pollution and electrical shock.

D. COMPLETE STRUCTURAL DEMOLITION

1. GENERAL

- a. Remove structures as indicated.
- b. Fill, compact and grade excavated areas resulting from the demolition of structures. Comply with Section 02200, Earthwork, for fill material and compaction requirements.

2. BELOW-GRADE CONSTRUCTION

- a. Demolish foundation walls to a depth of not less than 36" below existing ground surface, unless noted otherwise. Demolish and remove below-grade wood or metal construction. Break-up below-grade concrete slabs.

E. EXISTING UTILITIES

1. GENERAL

- a. Arrange timing of all shut-offs or shut-downs, removal or abandonment with the Owner. Do not shut-off or shut-down any utility without prior written approval of the Owner.

F. ELECTRICAL ITEMS

1. The Contractor shall remove all items as follows:
 - a. Disconnect or shut off service to areas where electrical work is to be removed.
 - b. Remove all electrical fixtures, equipment and related switches, outlets, conduit and wiring which are not to remain as a part of this Contract.

3.5 SALVAGE ITEMS

A. SALVAGE ITEMS REMOVED BY CONTRACTOR FOR OWNER REUSE

1. Items selected by the Owner shall be removed by the Contractor and stored on site where directed by the Owner, for reuse in remodeled areas or for storage for future reuse. All such items shall remain the property of the Owner.
2. Carefully remove and clean items and store for the Owner on the site where directed, for later reuse.

- B. Owner reserves the right to review all other items to be removed and retain any items he may require. Remove all other items from the site.

3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. GENERAL

1. All materials, equipment, fixtures and debris become the property of the Contractor and shall be removed from the site unless otherwise indicated.
2. Burning of removed materials shall not be permitted on the site.
3. Transport materials resulting from demolition operations and legally dispose of off the site in accordance with local, state, and federal requirements.
4. Items indicated to be removed but of salvable value to Contractor may be removed from structure as work progresses. Transport salvaged items from site as they are removed. Storage or sale of removed items on site shall not be permitted.

3.7 CLEANUP

A. GENERAL

1. Leave all areas graded, seeded and free of debris.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.1 SCOPE

- A. This section includes earthwork and related operations, including but not limited to clearing and grubbing the construction site; dewatering; excavating all classes of material encountered; pumping, draining, and handling of water encountered in the excavations; handling, storage, transportation, and disposal of all excavated and unsuitable material; construction of fills and embankments; backfilling around structures and pipe; backfilling all trenches and pits; compacting; all sheeting, shoring, and bracing; preparation of subgrades; surfacing and grading; and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the work.
- B. Provide all services, labor, materials, and equipment required for all earthwork and related operations necessary or convenient to the Contractor for furnishing a complete work as shown on the Drawings or specified in these Contract Documents.

1.2 GENERAL

- A. The elevations shown on the Drawings as existing are taken from the best available data and are intended to give reasonable, accurate information about the existing elevations. They are not precise, and the Contractor should satisfy himself as to the exact quantities of excavation and fill required.
- B. Perform earthwork operations in a safe and proper manner taking appropriate precautions against all hazards.
- C. Maintain in good condition at all times all excavated and fill areas for structures, trenches, fills, topsoil areas, embankments, and channels until final acceptance by the Owner. Repair all damage caused by erosion or other construction operations using material of the same type as the damaged materials.
- D. If soil borings are available for the area of this work, they will be located in Appendix A at the end of the Bid documents where they have been made available for review. This information is made available for such use as Contractor may choose to make of it in the preparation of his bid, but the Owner gives no guarantee, either expressed or implied, that it represents a true or complete cross section of all of the material to be encountered in performing the excavation and earthwork on this project.

- E. Earthwork operations within the rights-of-way of the Ohio Department of Transportation, the County Road Department, and respective cities and villages shall be conducted in accordance with the requirements and provisions of the permits issued by those agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence over and supersede the provisions of these Specifications.
- F. Control grading to prevent water running into excavations. Obstruction of surface drainage shall be avoided and a means shall be provided whereby storm water can be uninterrupted in existing gutters, other surface drains, or temporary drains. Material for backfill or for protection of excavation in public roads from surface drainage shall be neatly placed and kept shaped so as to cause the least possible interference with public travel. Free access must be provided to all fire hydrants, watergates, meters, and private drives.
- G. No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.
- H. Tests for compaction and density shall be conducted by the Owner's Representative or by an independent testing laboratory selected by him. Costs of compaction tests performed by an independent testing laboratory shall be paid for directly by the Owner and not as a part of this contract. Make all necessary excavations and supply any samples of materials necessary for conducting compaction and density tests. Pay the cost of all retests made necessary by the failure of materials to conform to the requirements of these Contract Documents.
- I. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, "Excavations, Trenching, and Shoring," and Subpart O, "Motor Vehicles, Mechanized Equipment, and Marine Operations," and shall be conducted in a manner acceptable to the Owner's Representative.
- J. It is understood and agreed that a thorough investigation by the Contractor has been made of the surface and subsurface conditions of the site and any special construction problems which might arise as a result of nearby watercourses and floodplains, particularly in areas where construction activities may encounter water-bearing sands and gravels or limestone solution channels. Provide all services, labor, equipment, and materials necessary or convenient for completing the work within the time specified in these Contract Documents.

1.3 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment will be allowed for this work. Payment for all work performed under this section shall be included in other items of work.

PART 2 - EXECUTION

2.1 INITIAL SITE PREPARATION

- A. Preparatory to beginning construction operations, remove from the site all vegetative growth, trees, brush, stumps, roots, debris, and any other objectionable matter, including fences, buildings, and other structures shown on the Drawings in the construction areas which are designated for removal or which, if left in place, would interfere with the proper performance or completion of the contemplated work, would impair its subsequent use, or would form obstructions therein.
- B. Grub and remove stumps and roots to a depth not less than 5 feet below grade. Fill all holes or cavities which extend below the subgrade elevation of the proposed work with compacted layers of crushed rock or earth backfill conforming to the requirements specified here for backfill. Do not incorporate organic material from clearing operations in excavation backfill or embankment material.
- C. Exercise special precautions for the protection and preservation of trees, cultivated shrubs, sod, fences, buildings, and other structures located in the construction area but not within designated clearing limits as shown on the Drawings or within the limits of embankments, excavations, or proposed structures. Repair or replace any of the aforementioned items damaged by Contractor's operation or construction activities.
- D. Remove and dispose of any excess material resulting from clearing or site preparation operations. Dispose of such materials in a manner acceptable to the Owner's Representative and at an approved location where such materials can be lawfully placed.
- E. All disposal of excess soil, debris and materials must be done in an environmentally sound manner in accordance with local, state, and federal regulations. There shall be no disposal in or near any water body, floodplain, wetland, drainage course or environmentally sensitive area, even with permission of the property owner.

2.2 DEWATERING

- A. Provide and maintain at all times during construction ample means and devices with which to promptly remove and properly dispose of all water from any source entering the excavations or other parts of the work. Dewatering shall be accomplished by methods which will ensure a dry excavation and preservation of the final lines and grades of the bottoms of excavations. Methods of dewatering may include sump pumps, well points, deep wells, or other suitable methods which do not damage or weaken structures, foundations, or subgrades. Shallow excavations may be dewatered using open ditches, provided such ditches are

kept open and free-draining at all times. The actual dewatering methods used shall be acceptable to the Owner's Representative.

- B. Do not place concrete or mortar in water nor allow water to rise over newly placed concrete or mortar for at least 24 hours after placement, unless specifically authorized by the Owner's Representative. No concrete structure shall be exposed to unequal hydrostatic forces until the concrete has reached its specified 28-day strength. Do not allow water to rise above bedding during pipe-laying operations. Exercise care to prevent damage to pipelines or structures resulting from flotation, undermining, or scour. Dewatering operations shall commence when ground or surface water is first encountered and shall be continuous until water can safely be allowed to rise in accordance with the provisions of this section. Protect excavations from the entrance of surface water to the extent possible by the use of dikes and/or covers.
- C. Standby pumping equipment shall be on the jobsite. A minimum of 1 standby unit (a minimum of 1 for each 10 in the event well points are used) shall be available for immediate installation should any pumping unit fail. The design and installation of well points or deep wells shall be suitable for the accomplishment of the work. Submit drawings or diagrams on proposed well point or deep well dewatering systems to the Owner's Representative for review.
- D. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, excavate and replace the affected areas with crushed rock at no cost to the Owner.
- E. Dispose of the water from the work in a suitable manner without damage to adjacent property. Conveyance of the water shall not interfere with traffic flow or treatment facilities operation. Do not drain water into work built or under construction without prior consent of the Owner's Representative. The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
- F. Provide sedimentation and desilting basins as necessary or when directed by the Owner's Representative to prevent the entrance of excessive or injurious amounts of sand and silt from surface runoff or dewatering operations into storm drains or receiving waters. The system used for desanding or desilting the water shall be a baffled structure and shall provide not less than 5 minutes detention time and shall be designed to have a "flow-through" velocity not exceeding 0.2 foot per second at the anticipated peak flow. The method of desanding or desilting and the point of disposal shall be subject to the approval of the Owner's Representative.
- G. Dispose of water safely and in accordance with applicable Environmental Protection Agency, U.S. Army Corps of Engineers, Owner's Representatives, and State Water Quality Control Division standards and permits.

2.3 SHEETING, SHORING, AND BRACING

- A. The sides of all excavations shall be sufficiently sheeted, shored, and braced as necessary to prevent slides, cave-ins, settlement, or movement of the banks; to maintain the excavation clear of all obstructions; and to provide safe working conditions. Wood or steel sheeting of approved design and type shall be used in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have sufficient strength and rigidity to withstand the pressure exerted and to maintain shape and position under all circumstances. Used sheeting may be utilized for temporary use as long as it is safe, sound, and meets the requirements of this section.
- B. Correctly assessing the need for sheeting, analyzing the stresses induced, and maintaining regulatory compliances shall be totally the responsibility of the Contractor. Since the Owner's Representative does not dictate or determine the Contractor's sequence or limits of excavation, the Owner's Representative assumes no responsibility for sheeting and shoring. The Contractor must employ or otherwise provide for adequate professional structural and geotechnical engineering supervision to assess the need for sheeting and shoring and design same. Results of sheeting and shoring analysis and design shall be submitted to the Owner's Representative on request.
- C. Excavations adjacent to existing or proposed buildings and structures, or in paved streets or alleys, shall be sheeted, shored, and braced adequately to prevent undermining beneath or subsequent settlement of such structures or pavements. Underpinning of adjacent structures shall be done when necessary to maintain structures in safe condition. Any damage to structures or pavements occurring through settlements, water or earth pressures, slides, caves, or other causes due to failure or lack of sheeting or bracing, or improper bracing or occurring through negligence or fault of the Contractor in any other manner shall be repaired by the Contractor at his own expense.
- D. Sheeting, shoring, or bracing materials shall not be left in place unless otherwise specified or shown on the Drawings or ordered by the Owner's Representative in writing. Such materials shall be removed in such manner that no danger or damage will occur to new or existing structures or property, public or private, and so that cave-ins or slides will not take place. Trench sheeting shall be left in place until backfill has been brought to a level 12 inches above the top of the pipe. It shall then be cut off and the upper portion removed. Sheeting for structures shall be left in place until backfill has been brought to a level 12 inches above the top of the bottom footing. It shall then be cut off and the upper portion removed.
- E. All holes and voids left in the work by the removal of sheeting, shoring, or bracing shall be filled and thoroughly compacted.

2.4 EXCAVATION

A. General

1. Excavation shall include the removal of all material from an area necessary for the construction of a pipeline or structure. Excavations shall provide adequate working space and clearances for the work to be performed therein.
2. All material excavated below the bottom of concrete walls, footings, and foundations shall be replaced, by and at the expense of the Contractor, with Class B concrete to the lines and grades shown on the Drawings, except where otherwise shown on the Drawings, specified herein, or authorized by the Owner's Representative.
3. Where quicksand, soft clay, spongy or swampy earth, or other materials unsuitable for subgrade or foundation purposes are encountered below the excavation limits, they shall be removed and disposed of to the level of suitable material. Areas so excavated shall be backfilled with Class B concrete or with compacted layers of crushed rock, sand, or other approved material conforming to the requirements specified herein for backfill to the lines and grades shown on the Drawings.
4. Place barriers at each end of all excavations and at such places as may be necessary along excavations to warn all pedestrian and vehicular traffic of such excavations. Place lights along excavations from sunset each day to sunrise of the next day until the excavations are backfilled. Barricade all excavations in such a manner as to prevent persons from falling or walking into any excavation.

B. Rock Excavation

1. Rock encountered in the process of excavation for structures shall be uncovered and stripped of all loose materials over the entire limits of excavation. Rock encountered for removal in a trench section shall be uncovered for a distance of not less than 50 feet.
2. Excavate rock and large boulders in trenches over the horizontal limits of excavation and to depths as shown on the Drawings.
3. Backfill the space below grade for pipelines to the proper grade with compacted layers of crushed rock or sand conforming to the requirements specified herein for backfill. Where pipe sewers are constructed on concrete cradles, excavate rock to the bottom of the cradle as shown on the Drawings.

4. Excavate rock under structures to lines and grades shown on the Drawings. Unless specified otherwise, where rock excavation has been carried below grade, the Contractor shall backfill to grade with Class B concrete at his own expense.
5. Where rock foundation is obtained at grade for over 50 percent of the area of any one structure, the portion of the foundation that is not rock shall be excavated below grade to reach a satisfactory foundation of rock. The portion below grade shall be backfilled with Class B concrete.
6. Where rock foundation is obtained at grade for less than 50 percent of any one structure and satisfactory rock cannot be found over the remaining area by reasonable additional excavation, the rock shall be removed for a depth of 12 inches below grade and the space below grade shall be backfilled to the proper grade with compacted layers of crushed rock conforming to the requirements specified herein for backfill.
7. Drilling and blasting operations shall be conducted with due regard for the safety of persons and property in the vicinity and in strict conformity with requirements of all ordinances, laws, and regulations governing blasting and the use of explosives. Conduct rock excavation near existing pipelines or other structures with the utmost care to avoid damage. Promptly repair injury or damage to other structures and properties to the satisfaction of the Owner by the Contractor at his own expense. The Contractor is advised to hire qualified consultants to perform a "preblast survey" in area where damage could occur due to blasting; all expenses for such survey must be borne by the Contractor, and no separate payment for same will be made.
8. Complete rock excavation for all structures and adjacent trenches under this Contract and any other rock excavation directed by the Owner's Representative before construction of any structure is started in the vicinity.

C. Borrow Excavation

1. Wherever the backfill of excavated areas or the placement of embankments or other fills requires specified material not available at the site or material in excess of suitable material available from the authorized excavations, such materials shall be obtained from other sources. This may require the opening of borrow pits at points not immediately accessible from the work. In such cases make suitable arrangements with the property owner and pay all costs incident to the borrowed material including royalties, if any, for the use of the material. Before a borrow pit is opened, the quality and suitability of the material to be obtained therefrom shall be approved by the Owner's Representative.

2. Borrow pits shall be cleared, grubbed, and finish-graded in accordance with the requirements specified herein.
- D. Roadway Excavation. Roadway excavation shall consist of excavation for roadways and parking areas in conformity with lines, grades, cross sections, and dimensions shown on the Drawings. After shaping to line, grade, and cross section, the subgrade shall be rolled until compacted to a depth of at least 6 inches to 100 percent of the maximum density at optimum water content as determined by AASHTO T99, Method A. This operation shall include any reshaping and wetting required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.
- E. Trench Excavation
1. Trench excavation shall consist of the removal of materials necessary for the construction of water, sewer, and other pipelines and all appurtenant facilities including manholes, inlets, outlets, headwalls, collars, concrete saddles, piers, and pipe protection called for on the Drawings.
 2. Excavation for pipelines shall be made in open cut unless shown otherwise on the Drawings. Trenches shall be cut true to the lines and grades shown on the Drawings or established by the Owner's Representative on the ground. The banks of trenches shall be cut in vertical, parallel planes equidistant from the pipe centerline. From an elevation 12 inches above the top of the pipe to the bottom of the trench, the horizontal distances between vertical planes for different sizes of pipe shall not exceed those shown on the Drawings. When sheeting is used, the width of the trench shall be considered as the distance between the inside faces of the sheeting. The bottom of the trench shall be cut carefully to the required grade of the pipe except where bedding materials or cradles are shown, in which case the excavation shall extend to the bottom of the bedding or cradles as shown on the Drawings. Minimum pipe cover shall be as shown on the Drawings or specified in these Contract Documents.
 3. The use of a motor-powered trenching machine will be permitted, but full responsibility for the preservation, replacement, and/or repair of damage to any existing utility services and private property shall rest with the Contractor.
 4. Bell holes for bell and spigot pipe and/or mechanical joint pipe shall be excavated at proper intervals so the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of all joints in the pipe. Bell holes shall not be excavated more than 10 joints ahead of pipe laying. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

5. Excavation for manholes, outlets, collars, saddles, piers, and other pipeline structures shall conform to the additional requirements specified herein for structural excavation.
6. Pipe trenches shall not be excavated more than 400 feet in advance of pipe laying and all work shall be performed to cause the least possible inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.
7. Wherever pipe trenches are excavated below the elevation shown on the Drawings, the Contractor, at his own expense, shall fill the void thus made at the proper grade with Class B concrete or with compacted layers of crushed rock or sand conforming to the requirements specified herein for backfill, unless otherwise specified herein or shown on the Drawings.
8. In all cases where materials are deposited along open trenches, they shall be placed so that no damage will result to the work and/or adjacent property in case of rain or other surface wash.

F. Structural Excavation

1. Structural excavation shall consist of the removal of all materials necessary for the construction of structures, including tanks, foundations, footings, wetwells, dry wells, box culverts, flumes, channels, buildings, and other miscellaneous structures.
2. The bottoms of structural excavations shall be true to the lines and grades shown on the Drawings. Faces of excavations shall not be undercut for extended footings. Except as provided herein for excavation of unsuitable material or rock, where the excavation is carried below the grade elevation shown on the Drawings, the Contractor shall backfill the void thus made to the proper grade with Class B concrete at his own expense.

2.5 BACKFILLING

A. Materials for backfilling shall conform to the following requirements:

1. Select Earth Backfill: Fine, sound, loose earth containing optimum moisture content for compaction to 90 percent of maximum density, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete less than 2 inches in maximum dimension except that the maximum particle size shall be 3/4 inch when used with PVC or other flexible thermoplastic pipe.

2. Common Earth Backfill: Sound, loose earth containing optimum moisture content for compaction to 90 percent of maximum density, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete and pavement less than 6 inches in maximum dimension.
3. Sand: Natural or imported sand conforming to ASTM D 1073.
4. Crushed Rock: Crushed rock conforming to Section 903.23, Size 7 (1/2-inch to No. 4) of the SSRBC.
5. Class B Concrete: Class B concrete as specified elsewhere in these Specifications or on the Drawings.

B. General

1. Earth backfill shall be compacted to not less than 90 percent of the maximum density as determined by ASTM D 698 at a moisture content within 3 percentage points, unless otherwise specified herein. Crushed stone and sand shall be compacted to not less than 83 percent of the solid volume density as determined from the bulk specific gravity by AASHTO T-84 and T-85 and the dry weight of the aggregate.
2. Material that is too dry for adequate compaction shall receive a prior admix of sufficient water to secure optimum moisture content. Material having excessive water content shall not be placed at any time.
3. Backfill material required to be compacted shall be placed in horizontal layers not to exceed 6 inches in thickness (before compaction) and compacted in place by ramming, tamping, or rolling, unless otherwise specified herein. Compaction shall be accomplished by power-driven tools and machinery wherever possible. Compaction and consolidation of sand and crushed stone backfill shall be accomplished using vibrating equipment in a manner acceptable to the Owner's Representative.

C. Backfilling Trenches

1. The backfilling of sewers, water, and other pipeline trenches shall be started immediately after the construction of same has been inspected and approved by the Owner's Representative. Sand backfill as shown on the Drawings shall be placed in the trench under and on each side of the sewer pipe in 6-inch layers for the full width of the trench and thoroughly and uniformly compacted by ramming and/or tamping to a minimum of 90 percent of the maximum density determined as specified herein. Sand backfilling or crushed stone as shown on the Drawings shall start above the sewer pipe bedding. Sufficient sand backfill as shown on the Drawings shall be placed around the sewer pipe and compacted to

provide a cover of not less than 12 inches over the top of the pipe. Mechanical compactors or tampers shall not be used within 12 inches of pipe. Compaction in this area shall be accomplished by hand methods. Sand or specified crushed stone bedding material shall be substituted for select earth backfill when the pipe material is other than ductile iron or when crushed stone trench backfill is required. Backfilling shall proceed simultaneously on both sides of the pipe to prevent lateral displacement.

2. Caution shall be used during backfill operations for PVC or other flexible thermoplastic pipe to prevent pipe deformation. PVC or other flexible thermoplastic pipe shall not be subjected to roller or wheel loads until a minimum of 36 inches of backfill has been placed over the top of the pipe. A hydrohammer shall NOT be used until a minimum depth of 48 inches of backfill has been placed over the top of the pipe.
3. Backfilling of PVC pressure pipe or other flexible thermoplastic pipe (water pipe) shall be as described in Paragraph 1 above.
4. In streets and alleys, across sidewalks and driveways, and at any other places subject to vehicular traffic or other superimposed loads, sand backfill shall be placed and compacted in 12-inch layers from the level of 12 inches above the top of the pipe upward for the full depth of the trench. Sand backfill shall be compacted by use of a hydrohammer or approved vibratory compactor. The top 6 inches of the finished subgrade shall be equal to not less than 100 percent of the maximum density as determined by ASTM D 698 at a moisture content of within 3 percentage points of optimum. When field tests show failure to meet the density requirement, the subgrade shall be loosened by disking, harrowing, or other approved methods to a depth of not less than 6 inches, then reshaped and recompact as indicated in this paragraph.
5. Trenches under concrete slabs and footings of structures shall be completely backfilled with compacted sand or crushed rock or filled with Class B concrete as shown on the Drawings.
6. All backfilling shall be done in such a manner that the pipe or structure over or against which it is being placed will not be disturbed or injured. Any pipe or structure injured, damaged, or moved from its proper line or grade during backfilling operations shall be removed and repaired to the satisfaction of the Owner's Representative and then rebackfilled.

D. Backfilling Around Structures

1. Backfilling around structures shall consist of common earth backfill placed in 6-inch layers and compacted by tamping to a minimum of 90 percent of the maximum density determined as specified herein for the full depth of the excavation from the bottom to the finished grade. No backfill shall be

placed against concrete structures until the concrete has reached its specified 28-day compressive strength. Where practical, compaction of structural backfill shall be accomplished by power-driven tamping equipment.

2. Where crushed rock mats under slabs and foundations are called for on the Drawings, excavate below grade to the depth of the crushed rock mat as shown on the Drawings and install a compacted crushed rock bed. This shall be finished to a true line or plane and even with the subgrade of the concrete foundations, piers, footings, or slabs. Before placing any crushed stone, remove all loose earth or debris. This crushed rock mat shall extend 12 inches beyond all slabs and foundations or to edges of sheet piling.
3. Crushed rock mats 12 inches or less in thickness shall be constructed of compacted layers of crushed rock conforming to Section 903.23, Size 7 (1/2-inch to No. 4), of the SSRBC.
4. Crushed rock mats of thickness greater than 12 inches shall have the top 12 inches constructed of compacted layers of crushed rock as specified above. That portion below the top 12 inches shall be constructed of compacted layers of crushed rock conforming to section 903.05, Class A, with a modified gradation of 6 inches to dust as received from the crusher.
5. The use of earth backfill to support footings, foundations, and structures shall not be permitted, unless otherwise shown on the Drawings.

2.6 FILLS AND EMBANKMENTS

- A. Fills and embankments shall consist of all earth fills except backfills in trenches or around structures. Unless special material is specified or shown on the Drawings, material for fills and embankments shall consist of excavated material from structures or of a mixture of such excavated materials and materials borrowed from other sources by the Contractor. All material used for fills and embankments shall be free from wood, vegetable matter, debris, soft or spongy earth or clay, large rock, or other objectionable material and shall be acceptable to the Owner's Representative.
- B. Materials shall be placed in the fill or embankment in successive layers 8 inches or less in thickness before compaction, each layer being approximately horizontal and extending to the full limit of the required cross section, and shall be compacted over the entire surface to not less than 95 percent of the maximum density as determined by ASTM D 698 at a moisture content of within 3 percentage points of optimum. The process shall be repeated for each layer of material until the fill or embankment conforms to the plan lines, grades, and cross sections. The degree of compaction and moisture content required, the method

of tamping, and the equipment used shall be approved by the Owner's Representative.

- C. The area over which the fill or embankment is to be constructed shall first be cleared of all vegetation, debris, and other objectionable material and, if the ground is in a loose, uncompacted condition, it shall be compacted to a minimum 95 percent of maximum density determined as specified herein.
- D. No material shall be placed beyond the sloping lines of embankment unless so ordered by the Owner's Representative. Material allowed to be placed beyond the lines of embankment shown on the Drawings will be compacted as required above unless otherwise authorized by the Owner's Representative.
- E. Material for embankments or roadway fills shall be placed in 6-inch maximum lifts and shall be compacted by rolling with power rollers weighing not less than 10 tons, with sheepfoot rollers, with vibrating rollers, or with pneumatic tire rollers, as required to accomplish the work. While and as each layer is deposited, water shall be applied in sufficient amount to ensure optimum moisture to secure the compaction specified.
- F. The use of trucks, carryalls, scrapers, tractors, or other heavy hauling equipment shall not be considered as rolling in lieu of rollers, but the traffic of such hauling equipment shall be distributed over the fill in such a manner as to make the use of the compaction afforded thereby as an addition to compaction by the use of rollers.
- G. Wherever a trench passes through a fill or embankment, the fill or embankment material shall be placed as compacted to an elevation 12 inches above the top of the pipe before the trench is excavated.
- H. Subgrades for all roadbeds shall meet the requirements of Subsection 2.5 C.4.

2.7 DISPOSAL OF WASTE AND UNSUITABLE MATERIALS

- A. All materials removed by excavation which are suitable for the purpose shall be used to the extent possible for backfilling pipe trenches, foundations, and footings and for making embankment fills or for such other purposes as may be shown on the Drawings. All materials not used for such purposes shall be considered as waste materials and the disposal thereof shall be made in a manner and at locations approved by the Owner's Representative.
- B. Waste materials shall be spread in uniform layers and neatly leveled and shaped. Spoil banks shall be provided with sufficient and adequate openings to permit surface drainage of adjacent lands.
- C. Unsuitable materials, consisting of wood, vegetable matter, debris, soft or spongy clay, peat, and other objectionable material so designated by the Owner's

Representative, shall be removed from the work site and disposed of in a manner and at a location approved by the Owner's Representative.

- D. No unsuitable or waste material shall be dumped on private property unless written permission is furnished by the owner of the property and unless a dumping permit is issued from the local jurisdiction.
- E. The Contractor is responsible for any and all permits and other requirements, such as sediment runoff control necessitated by the disposal of waste material.
- F. All disposal of excess soil, debris and materials must be done in an environmentally sound manner in accordance with local, state, and federal regulations. There shall be no disposal in or near any water body, floodplain, wetland, drainage course or environmentally sensitive area, even with permission of the property owner.

2.8 FINAL GRADING

- A. After other earthwork operations have been completed, the sites of all structures, roads, and embankments shall be graded within the limits and to the elevations shown on the Drawings. Grading operations shall be so conducted that materials shall not be removed or loosened beyond the required limits. The finished surfaces shall be left in smooth and uniform planes such as are normally obtainable from the use of hand tools. If Contractor is able to obtain the required degree of evenness by means of mechanical equipment, the use of hand labor methods will not be required. Neatly trim and finish slopes and ditches to slopes shown on the Drawings unless otherwise approved by the Owner's Representative.
- B. Grade and dress all finished ground surfaces to present a surface varying not more than plus or minus 0.10 foot as regards local humps or depressions, unless otherwise specified or shown on the Drawings, and shall be acceptable to the Owner's Representative.

2.9 TOPSOIL

- A. All areas to be planted with trees or shrubs, or with sprigged grass as shown on the plans, shall be prepared by grading to a smooth, even surface to a level 4 inches below the elevation of the finished grade shown on the Drawings. It shall then be brought to a neat and finished grade by the addition of 4 inches of approved topsoil.
- B. Topsoil removed from the construction area may be stockpiled and reused or topsoil may be obtained from approved borrow areas. If obtained from borrow areas, make suitable arrangements with the property owner and pay all costs incident to the borrowed material including royalties.

2.10 SETTLEMENT

- A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within 1 year after final acceptance of the work by the Owner.
- B. Make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after receipt of written notice from the Owner's Representative or Owner.

END OF SECTION

SECTION 02270

SLOPE PROTECTION AND EROSION CONTROL

PART 1 - GENERAL

1.1 SCOPE

- A. This section shall consist of temporary control measures as shown in the plans or directed by the Engineer during the life of the Contract to control erosion and water pollution through the use of berms, dikes, dams, sediment basins, fiber mats, netting, mulches, grasses, slope drains, temporary silt fences, and other control devices.
- B. The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features to assure economical, effective, and continuous erosion control throughout the construction and post-construction periods.
- C. Develop a site-specific sediment and erosion control or storm water management plan for all construction activities that disturb 1 acre or more. The Storm Water Pollution Plan (SWP3) shall incorporate the sediment and erosion control measures shown on the Drawings as well as written procedures and methods that the Contractor shall utilize during the performance of the work to mitigate stream pollution due to storm water runoff.
- D. The SWP3 shall be in conformance with Section 319 of the Federal Clean Water Act and the Ohio EPA, Division of Surface Water requirements as listed in their "Checklist for Construction Sites". The SWP3 shall be submitted by the Owner and the Contractor shall comply with the approved SWP3 plan.
- E. While performing work, utilize Best Management Practices (BMP) similar to those listed in the publication titled "Rainwater and Land Development, Ohio's Standards for Stormwater Management Land Development and Urban Stream Protection" as prepared by the Ohio Department of Natural Resources Division of Soil and Water Conservation, Fountain Square Court, Columbus, Ohio, 43224, (614) 265-6610.

1.2 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Slope Protection and Erosion Control.

PART 2 - PRODUCTS

2.1 TEMPORARY BERMS

- A. A temporary berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes or transverse to centerline on fills.
- B. These berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.

2.2 TEMPORARY SLOPE DRAINS

- A. A temporary slope drain is a facility consisting of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half-round pipe, metal pipe, plastic pipe, sod, or other material acceptable to the Engineer that may be used to carry water down slopes to reduce erosion.

2.3 SEDIMENT STRUCTURES

- A. Sediment basins, ponds, and traps are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect properties and stream channels below the construction areas from excessive siltation.

2.4 CHECK DAMS

- A. Check dams are barriers composed of logs and poles, large stones, sand bags, or other materials placed across a natural or constructed drainway.
- B. Stone check dams shall not be utilized where the drainage area exceeds 50 acres. Log and pole structures shall not be used where the drainage area exceeds five acres.

2.5 TEMPORARY SEEDING AND MULCHING

- A. Temporary seeding and mulching are measures consisting of seeding, mulching, fertilizing, and matting utilized to reduce erosion. All cut and fill slopes, including waste sites and borrow pits, shall be seeded when and where necessary to eliminate erosion.

2.6 BRUSH BARRIERS

- A. Brush barriers shall consist of brush, tree trimmings, shrubs, plants, and other approved refuse from the clearing and grubbing operation.
- B. Brush barriers are placed on natural ground at the bottom of fill slopes, where the most likely erodible areas are located, to restrain sedimentation particles.

2.7 BALED HAY OR STRAW CHECKS

- A. Baled hay or straw erosion checks are temporary measures to control erosion and prevent siltation. Bales shall be either hay or straw containing 5 cubic feet or more of material.
- B. Baled hay or straw checks shall be used where the existing ground slopes toward or away from the embankment along the toe of slopes, in ditches, or other areas where siltation, erosion, or water run-off is a problem.

2.8 TEMPORARY SILT FENCES

- A. Silt fences are temporary measures utilizing woven wire or other approved material attached to posts with filter cloth composed of burlap, plastic filter fabric, etc., attached to the upstream side of the fence to retain the suspended silt particles in the run-off water.

PART 3 - EXECUTION

3.1 PROJECT REVIEW

- A. Prior to the Preconstruction Conference, meet with the Engineer and go over in detail the proposed SWP3 and the expected problem areas in regard to the erosion control work. Different solutions should be discussed so that the best method might be determined. It is the responsibility of the Owner to submit the SWP3 to the Stark County Soil and Water Conservation District for review and approval. The Contractor shall comply with the SWP3.

3.2 PRECONSTRUCTION CONFERENCE

- A. At the Preconstruction Conference, submit for acceptance the schedule for accomplishment of temporary and permanent erosion control work as applicable for clearing and grubbing, grading, bridges and other structures at watercourses, construction, and paving. Also submit for acceptance the proposed method of erosion control on haul roads and borrow pits and the plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operation have been accepted by the Owner.

3.3 CONSTRUCTION REQUIREMENTS

- A. The Owner has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, and the surface of erodible earth material exposed by excavation, borrow, and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other

water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, or slope drains, and the use of temporary mulches, mats, seeding, or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds to the extent directed by the Owner.

- B. Incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the accepted schedule. Temporary pollution control measures shall be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.
- C. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, erosion control measures may be required between successive construction stages. Preconstruction vegetation ground cover shall not be destroyed, removed, or disturbed more than 20 calendar days prior to grading or earth moving unless approval is granted otherwise.
- D. The Engineer will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress to keep the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- E. Under no conditions shall the amount of surface area or erodible earth material exposed at one time by excavation or fill within the project area exceed 750,000 square feet without prior approval by the Owner.
- F. The Owner may increase or decrease the amount of surface area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, and borrow and fill operations as determined by his analysis of project conditions.
- G. In the event of conflict between these requirements and pollution control laws, rules, or regulations of other federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

3.4 CONSTRUCTION MANAGEMENT TECHNIQUES

- A. Clearing and grubbing must be held to the minimum necessary for grading and equipment operation.

- B. Construction must be sequenced to minimize the exposure time of cleared surface area.
- C. Construction must be staged or phased for large projects. Areas of one phase must be stabilized before another phase can be initiated. Stabilization shall be accomplished by temporarily or permanently protecting the disturbed soil surface from rainfall impacts and runoff.
- D. Erosion and sediment control measures must be in place and functional before earth moving operations begin, and must be constructed and maintained throughout the construction period. Temporary measures may be removed at the beginning of the work day, but must be replaced at the end of the work day.
- E. All control measures shall be checked, and repaired as necessary, weekly in dry periods and within 24 hours after any rainfall of 0.5 inch within a 24-hour period. During prolonged rainfall, daily checking and repairing is necessary. The permittee shall maintain records of checks and repairs.
- F. A specific individual shall be designated to be responsible for erosion and sediment controls on each project site.

3.5 CONSTRUCTION OF STRUCTURES

- A. Temporary Berms. A temporary berm shall be constructed of compacted soil, with a minimum width of 24 inches at the top and a minimum height of 12 inches with or without a shallow ditch, constructed at the top of fill slopes or transverse to centerline on fills. Temporary berms shall be graded so as to drain to a compacted outlet at a slope drain. The area adjacent to the temporary berm in the vicinity of the slope drain must be properly graded to enable this inlet to function efficiently and with minimum ponding in this area. All transverse berms required on the downstream side of a slope drain shall extend across the grade to the highest point at approximately a 10 degree angle with a perpendicular to centerline. The top width of these berms may be wider and the side slope flatter on transverse berms to allow equipment to pass over these berms with minimum disruptions. When practical and until final roadway elevations are approached, embankments should be constructed with a gradual slope to one side of the embankment to permit the placement of temporary berms and slope drains on only one side of the embankment.
- B. Temporary Slope Drains
 - 1. Temporary slope drains shall consist of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half-round pipe, metal pipe, plastic pipe, flexible rubber, or other materials which can be used as temporary measures to carry water accumulating in the cuts and on the fills down the slopes prior to installation of permanent facilities or growth of adequate ground cover on the slopes.

2. Fiber matting and plastic sheeting shall not be used on slopes steeper than 4:1 except for short distances of 20 feet or less.
3. All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base for temporary slope drains shall be compacted and concavely formed to channel the water or hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain. Energy dissipaters, sediment basins, or other approved devices shall be constructed at the outlet end of the slope drains to reduce erosion downstream. An ideal dissipater would be dumped rock or a small sediment basin which would slow the water as well as pick up some sediment. All temporary slope drains shall be removed when no longer necessary and the site restored to match the surroundings.

C. Sediment Structures

1. Sediment structures shall be utilized to control sediment at the foot of embankments where slope drains outlet, at the bottom as well as in the ditchlines atop waste sites, and in the ditchlines or borrow pits. Sediment structures may be used in most drainage situations to prevent excessive siltation of pipe structures. All sediment structures shall be at least twice as long as they are wide.
2. When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed, and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural or intended condition.

D. Check Dam

1. Utilize check dams to retard stream flow and catch small sediment loads. Materials utilized to construct check dams are varied and should be clearly illustrated or explained in the Contractor's erosion control plan.
2. Key all check dams into the sides and bottom of the channel a minimum depth of 2 feet. A design is not needed for check dams but some typical designs are shown in the standard plans.
3. Do not use stone check dams where the drainage area exceeds 50 acres. Log and pole structures should generally not be used where the drainage area exceeds five acres.

E. Temporary Seeding and Mulching. Perform seeding and mulching in accordance with Section 02485, Seeding.

- F. Brush Barriers. Brush barriers shall consist of brush, tree trimmings, shrubs, plants, and other approved refuse from the clearing and grubbing operation. The brush barriers shall be constructed approximately parallel to original ground contour. Each brush barrier shall be compressed to an approximate height of 3 to 5 feet and approximate width of 5 to 10 feet. The embankment shall not be supported by the construction of brush barriers.
- G. Baled Hay or Straw Erosion Checks. Hay or straw shall be embedded in the ground 4 to 6 inches to prevent water flowing underneath. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the Engineer. Keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris clean-out will be considered routine maintenance.
- H. Temporary Silt Fences
 - 1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill slopes, in ditches, or other areas where siltation is a problem. Silt fences are constructed of wire mesh fence with a covering of burlap or some other suitable material on the upper grade side of the fence and anchored into the soil.
 - 2. Maintain the silt fence in a satisfactory condition for the duration of the project or until its removal is requested by the Engineer. The silt accumulation at the fence may be left in place and seeded, removed, etc., as directed by the Engineer. The silt fence becomes the property of the Contractor whenever the fence is removed.

3.6 MAINTENANCE

- A. The temporary erosion control features installed by the Contractor shall be acceptably maintained by the Contractor until no longer needed or permanent erosion control methods are installed. Any materials removed shall become the property of the Contractor.
- B. In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of work as scheduled, and are ordered by the Engineer, such work shall be performed by the Contractor at his own expense.
- C. Where the work to be performed is not attributed to the Contractor's negligence, carelessness, or failure to install permanent controls and falls within the specifications for a work item that has a contract price, the units of work shall be paid for at the proper contract prices.

3.7 EROSION CONTROL OUTSIDE PROJECT AREA

- A. Temporary erosion control shall include construction work outside the project area where such work is necessary as a result of construction such as borrow pit operations, haul roads, and equipment storage sites. Bid price in such cases shall include all necessary clearing and grubbing, construction incidentals, maintenance, and site restoration when no longer needed.

END OF SECTION

SECTION 02310
ENGINEERED SHORING

PART 1 – GENERAL

1.1 SCOPE

- A. Furnish all engineering, labor, materials, supervision, and equipment necessary to provide shoring as required for construction of structures shown or indicated on the Drawings.

1.2 RELATED WORK

- A. Section 02200 – Earthwork.
- B. Section 02322- Geotechnical Instrumentation and Monitoring
- C. Section 05500 – Metal Fabrications.
- D. Appendix “A”- Subsurface Investigation

1.3 SUBMITTALS

- A. Submit piling cross section data, mill test report, and driving template drawings. Plans shall be signed and sealed by the qualified professional Engineer responsible for their preparation and registered in the state in which the project is located.
- B. Submit to the City of Canton Engineer for project records engineered shoring design for the project. Shoring design shall be signed and sealed by the qualified professional Engineer responsible for their preparation and registered in the state in which the project is located. All designs shall meet OSHA guidelines.

1.4 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Engineered Shoring.

PART 2 – PRODUCTS

2.1 STEEL SHEETPIILING

- A. All steel sheetpiling shall be new, unused, and free from excessive rust and mill scale and shall meet or exceed the requirements of the ASTM A572, Grade 60 specifications for steel sheetpiling.
- B. All steel sheetpilings and their fabricated connection assembly pieces shall have the continuous interlock-type jointing and shall meet or exceed the section properties of the piling shape designation(s) shown on the Drawings. All bolting within fabricated connection assembly pieces shall use ASTM A325 Type 3, higher corrosion resistance bolts. Welded connections shall utilize E70 electrodes.
- C. Steel sheetpiling not meeting these specifications shall be rejected, removed from the Project site, and replaced with pilings which comply.

PART 3 – EXECUTION

3.1 TEMPLATES

- A. Provide suitable driving templates for use as guides to ensure that the pilings are driven in proper vertical plumbness, alignment, and at the proper radius. Templates shall provide two levels of support approximately 10 feet between levels. Templates shall be supported by spud pilings in sufficient numbers, spacing, stiffness, and penetration to adequately maintain their proper positions during sheetpile driving operations.

3.2 DRIVING

- A. Pilings shall be located as shown on the Drawings and shall be driven to a maximum, vertically out-of-plumb tolerance of ¼-inch in 4 feet. Each pile shall interlock with adjacent piles for its entire length thus forming a continuous wall or ring throughout the structure. For enclosure type structures, all piles shall be positioned around the entire perimeter before any pile is driven deeper than the depth necessary for support and guidance.
- B. Piles shall be driven by normally acceptable procedures using hammers of sufficient energy to drive the piling to proper depth without causing serious damage to the piles or any existing structure, or in any way compromising a continuous interlocking to adjacent pilings. Once driving resistance is encountered, the maximum lead of any pile to adjacent pilings shall be limited to 5 feet.
- C. All piles shall be driven to the elevations shown on the Drawings or “practical refusal”, whichever occurs first. “Practical refusal” shall be defined as the driving resistance encountered when the penetration of the pilings, driven impairs, is at

the rate of 20 blows per inch when using a 7500 foot-pounds/blow pile driving hammer.

- D. Piles driven out of interlock with adjacent pilings, or otherwise severely damaged, shall be completely removed and replaced with new piles. All pilings in any single enclosure-type structure shall be of the same overall length and driven to within 1 foot of the required tip elevation. Special care should be exercised to ensure vertical plumbness when driving pilings on sloped surfaces.
- E. In the event that a pile strikes an obstruction, piles adjacent to this pile shall be driven to or below the elevation of the obstruction before the Contractor attempts to drive through the obstruction.
- F. In attempting to drive through an obstruction, if the pile meets practical refusal, the Owner may require that additional pilings be driven, or the excavation and removal of the obstruction, or that pilings be extracted and the pile structure relocated.

3.3 OVERDRIVING

- A. While driving pilings, if it is determined that penetration below tip elevations shown on the Drawings is required, the Owner shall direct the Contractor to furnish, splice, and drive additional pilings to the desired depth of penetration. Contractor shall be compensated in accordance with the Contract Documents for such directed extra Work.

3.4 DRIVING RECORDS

- A. Prepare and maintain a driving record for each piling driven. Record data shall include pile number, location, driving resistance in numbers of blows for each foot of penetration, and tip elevations. Furnish Owner and Engineer with typed copies of the driving records upon completion of construction contract and before requesting final payment.

3.5 SPLICING

- A. Pilings under 60 feet in overall length or maximum length allowed to be transported over the roads shall be driven without splices. If necessary to accomplish longer overall lengths, pilings may be spliced in place, on alternate piles, at a 5-foot vertical difference between splices on adjacent piles, and at 60-foot-minimum intervals on each pile. Splices shall be accomplished by a currently certified welder using E-70 welding rod to make a full penetration groove weld across the piling web and then adding 3/8-inch steel reinforcing plate, properly fillet welded in place on the fill side of the pile, to cover 90 percent of the flat surface groove welded joint.

3.6 CUTTING

- A. All cutting or trimming of piles shall be performed in a neat manner true to line and elevation. Pile ends which are excessively damaged shall be cut off square to their length at a location where the pile section is not deformed.

3.7 REPAIRS

- A. After pilings have been driven, all handling holes shall be repaired either by welding mill punchings into the holes or by cover plating holes with 3/8-inch steel plate welded on the fill side of the sheets. Welds shall be 5/16-inch fillet welds 100 percent around the perimeter of the hole or plate and use E70 rod.
- B. Piling interlocks shall be welded at the locations and for the lengths indicated on the Drawings.

END OF SECTION

SECTION 02322

GEOTECHNICAL INSTRUMENTATION AND MONITORING

PART 1 - GENERAL

1.1 DESCRIPTION

A. SCOPE

The work to be done under this Section includes monitoring all activities on the project in such a manner that damage is prevented to adjacent structures, tanks, pipes, property and work, and such that vibrations and displacements of the existing facilities, structures and utilities are verified to be below the maximum levels specified in this Section.

The purpose of the geotechnical instrumentation and monitoring program is to provide the following:

A forewarning against unforeseen conditions that may develop during construction.

A "snap shot" of existing conditions prior to start of construction, which will be of assistance to the Engineer, the Owner and the Contractor should unforeseen conditions occur.

Collecting baseline data from relevant geotechnical instruments such as surface markers, and seismographs and a precondition survey of surrounding structures. Monitoring of soil movement during and after construction. Monitoring of all existing habitable structures, tanks, and facilities, and new structures and facilities being constructed under this contract.

B. COORDINATION-- not used

C. RELATED SECTIONS

Section 02050 Demolition
Section 02200 Earthwork
Section 02310 Engineered Shoring

- D. The Owner is not responsible for guaranteeing the safety of the work based on the results of the geotechnical instrumentation program. The Contractor may choose to use all or any part of the results of the instrumentation and monitoring program in the assessment or evaluation of the Contractor's safety program. The Contractor is solely responsible for any conclusions or observations that he may arrive at with regard to the implications of the data and with respect to his safety program.
- E. Attention is directed to the close proximity of the proposed construction to the above ground structures, in particular, the Fresh Mark, Inc. structures and tanks along the sewer route. Construction activities shall be conducted in a manner that will not damage or distress these structures or any other structures and utilities in the vicinity. Any damage caused by or related to the construction operations shall be repaired by the Contractor at no additional cost to the Owner. It is required that, for the above-mentioned existing structures, monitoring at locations indicated in this specification section shall be carried out during construction activities such as demolition, excavation, sheeting, shoring, construction, installation of pipes, and at any other times as directed by the Engineer.
- F. Notify the Engineer prior to conducting any vibration producing activity including but not necessarily limited to demolition, excavation, and installation of posts for the slide rail system, as required. Notify the Engineer prior to conducting monitoring at existing structures in accordance with the plan prepared by the Contractor's independent specialist and approved by the Engineer.
- G. The Contractor shall provide a geotechnical instrumentation plan for approval by the Engineer, based on the outlined scope contained in the following section and the project drawings.
- H. The Contractor shall furnish and install all geotechnical instrumentation and calibrate all instrumentation as required, and collect, reduce, process, plot and report all instrumentation data to the Engineer. The Contractor shall retain the services of a qualified Geotechnical Engineering firm, at his own expense, for these purposes.
- I. It is the Contractor's responsibility to protect from damage and maintain all installed instrumentation during construction. Any instrumentation that is rendered inoperative or unreadable by the Contractor's operations shall be replaced by the Contractor at no expense to the Owner. This shall include the obtaining of all baseline readings and associated expenses for the new instrumentation.

- J. The Contractor shall perform a pre-construction condition survey prior to any construction activities, to observe and document the preconstruction condition of all buildings, tanks, infrastructure, sidewalks, roadways, and all other facilities within 30 feet of the sewer line construction. Regular visual observations will be made for signs of ground or building movements in the vicinity of demolition. The Contractor shall immediately inform the Engineer if signs of movement such as new cracks in buildings, increased size of old cracks or separation of joints in buildings, street or other paved surfaces are observed.
- K. Where required, the Contractor shall perform more frequent monitoring on particular structures by means such as crack monitors, or additional geotechnical instrumentation
- L. The geotechnical instrumentation elevations and plan location shall be determined relative to a fixed reference point, undisturbed and unaffected by any construction operations and at least 200 feet from the face of any construction area.
- M. Whenever any product is specified by brand name and model number, such specifications shall be deemed to be used for the purpose of establishing a standard of quality and facilitating the description of the product desired. The term "acceptable equivalent" product is the same or better than the product named in the Specifications in function, performance, reliability, quality and general configuration. This procedure is not to be construed as eliminating from competition other products of equal quality by other manufacturers where fully suitable in design. The Contractor may, in such cases, submit complete comparative data to the Engineer for consideration of another product which shall be equivalent in every respect to that so specified.

1.2 REFERENCES-- not used

1.3 QUALITY ASSURANCE

- A. Install all instruments in accordance with specifications and drawings.
- B. The Contractor, at his own expense, shall retain a qualified Geotechnical Engineering firm to review the on-going results of the instrumentation monitoring program on a daily basis and those results shall be provided to the ENGINEER. The firm shall have the following qualifications:

The Contractor's geotechnical instrumentation Engineer shall be a licensed Professional Engineer in the State of Ohio

Has a minimum of at least five years of experience in the field of geotechnical Engineering and in installation and monitoring of the types of instruments specified herein.

Provide a field representative with at least three years of experience in installation inspection of geotechnical instrumentation and has previously inspected not less than five projects of equal type and complexity as the proposed instruments. The field representative shall be present at the job site during the entire time of installation of the instruments.

- C. Employ drilling Sub Contractors to install the geotechnical instruments. The drilling Sub Contractors shall have the following qualifications:

Have a minimum five years of experience in installation of geotechnical instruments of similar type and complexity as the proposed instruments.

The superintendent and/or foreman shall have at least three years of experience in the installation of geotechnical instruments and has previously installed not less than five projects of equal type and complexity as the proposed instruments. The superintendent and/or foreman shall be present at the job site during the entire time of installation of instruments. If the superintendent or foreman does not have the required experience, then the Contractor's Engineer shall be on-site the entire time of installation of monitoring equipment.

1.4 SUBMITTALS

The following submittals shall be provided in accordance with the requirements of the supplemental specifications:

- A. A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks() shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

- B. Geotechnical Instrumentation plan, schedule, and procedure for performing the condition survey, including anticipated deliverable format.

Quantity, manufacturer, and model number for each of the instruments to be installed and used for this specification.

- C. Instruction manual for each of the instruments to be installed and used for this specification.

- D. Installation procedure for each of the instruments to be installed and used for this specification, including: Results of the pre-installation acceptance tests, Materials and tools required for installation, Installation procedures, Field calibration procedure, Data collection procedure for initial baseline and subsequent readings, and Maintenance and care of the equipment on- site.

- E. Installation work plan and schedule for each of the instruments to be installed and used for this specification.

- F. Calibration records for each of the instruments to be installed and used for this specification, where applicable.

- G. Location plan for the instrumentation program to be implemented and performed, as outlined in this specification.

- H. Sample reports of the required deliverable information.

1.5 SHIPMENT, PROTECTION AND STORAGE-- not used

1.6 WARRANTY -- not used

1.7 MOVEMENT AND VIBRATION LIMITS

- A. Existing structures and tanks will be monitored daily through the required instrumentation, unless otherwise specified by the Engineer. Tolerable vibration movements or range of movement will be determined by the Engineer in consultation with the project designers.

- B. Preliminary threshold limits to be used during the monitoring of the geotechnical instrumentation monitoring are as follows:

1. Surface Markers: ¼ inch cumulative displacement horizontal & vertical

C. Maximum vibrations at existing monitored facilities, structures and utilities shall not exceed the following as a result of demolition work, excavation, or other activities of the Contractor:

1. All monitored above ground and buried structures on site: Threshold limit, maximum peak particle velocity (PPV) of 0.3 inch per second; limiting value, maximum PPV of 0.5 inch per second.

D. Actions if threshold or limiting values are exceeded are as follow:

1. If any limiting value of vibration, or movement is exceeded, all work by the Contractor in the vicinity of the exceedance shall stop until a meeting takes place between the Contractor and the Engineer to assess the cause of the exceedance. A submittal shall be prepared and submitted to the Engineer indicating what activity caused the exceedance and what steps the Contractor will take to prevent further exceedances of the limits. No work in the vicinity of the exceedance shall be restarted until the submittal is reviewed and approved by the Engineer.
2. If any threshold limit of vibration, or movement is exceeded, the Contractor shall submit to the Engineer, within 24 hours of the exceedance, a submittal indicating the activity causing the exceedance, the adjustment(s) to Contractor's means and methods that will be required to complete the work, and what steps the Contractor has taken and will take to prevent further exceedance of the threshold limit.
3. The modification or termination of demolition, sheeting or excavation shall be done in a matter that precludes damage and disturbance to existing structures and maintains safety at all times.
4. Operations shall be discontinued until written authorization to proceed is issued by the Engineer

1.8 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Geotechnical Instrumentation and Monitoring.

PART 2 --PRODUCTS

2.1 PERFORMANCE REQUIREMENTS -- not used

2.2 MANUFACTURERS -- not used

2.3 MATERIALS

- A. For all Geotechnical Instrumentation products, refer to Part 3 EXECUTION of this section.

1. All materials and instruments shall be new.
2. Surface protection shall be flush with the ground surface in paved or other areas. For all instruments provide roadway boxes with a 5-1/4 inch lock lid as indicated and manufactured by Tyler Pipe, Tyler, TX, or Bresnahan Foundry, Hatfield, MA, or acceptable equivalent. Roadway boxes for surface markers shall be 2 feet in length as a minimum.

2.4 EQUIPMENT

A. SEISMOGRAPH FOR VIBRATION MONITORING

1. The seismograph shall be portable so that it can easily be moved around the construction site to monitor vibrations caused by construction activities. The equipment system shall be specifically designed for measuring ground vibrations resulting from these activities. This portable vibration monitoring equipment shall also include an indicator readout, and all other incidental system components (e.g., cables, wiring), mounting hardware and/or shields for geophones required to perform the specified monitoring.
2. Provide a minimum of one BlastMate Series III supplemented by three MiniMate Plus as manufactured by Instantel Inc., Kanata (Ottawa), Ontario, Canada, model VMS-200S as manufactured by Thomas Instruments Inc., Spofford, NH, or acceptable equivalent.
3. The seismograph shall be of compact design and suitable for outdoor use. Physical and operational parameters of the seismograph shall be as follows, unless otherwise approved by the ENGINEER:
 - a. Seismic Requirements:
 - i. Range: 0 to 5 inches per second (minimum) at frequencies from 2 to 200 Hz.
 - ii. Capable of using trigger levels (maximum 0.25 inches per second)
 - iii. Equipment shall be a 3-component seismograph capable of obtaining 1024 samples per second per channel and with internal calibration function.
 - b. Record Modes:
 - i. Manual and trigger
 - c. Event Storage and Printing

- i. Equipment shall be capable of printing event results in the field.
 - ii. Equipment shall be capable of reading the peak particle velocities (PPV) directly, on a real-time basis, in the field.
 - iii. Equipment shall be able to produce a record including both PPV and the vibration frequency.
4. The seismograph shall have been factory calibrated within the past three (3) months. This calibration shall be traceable to the National Bureau of Standards. Annual factory calibration is required throughout the duration of the work. If at any time during the work, the Engineer has reason to believe that the internal calibration indicates errors in the instrument calibration, factory re-calibration or replacement will be required. If the seismograph shows any indication of damage or vandalism, as determined by the Engineer, the seismograph shall immediately be re-calibrated.

C. SURFACE MARKERS

1. Surface markers in soil shall consist of 4 inch diameter capped pipes with filed cross lines in the caps for use when making horizontal deflection measurements. The bottom of the pipes shall be buried a minimum of 42 inches below the ground surface. Protect markers with four 2x4 posts or equivalent driven around each marker.
2. Surface markers on concrete structures shall consist of a 1/2 inch diameter steel rod, 6 inches long epoxied into a 1 inch diameter hole in the concrete. Rods shall have filed cross lines for use when making horizontal deflection measurements.
3. Individual Surface markers on asphalt roadways shall consist of a single PK nail driven into the asphalt.
4. Survey the surface markers for horizontal and vertical locations (x, y, z) at regular 2 hour intervals during sheeting operations but no less frequently than every two days otherwise. Survey measurements shall be taken to a precision of 0.01 inches.

PART 3 --EXECUTION

3.1 INSTALLATION

A. SCHEDULING OF WORK

1. The Contractor will coordinate installation of all instrumentation with the Engineer.
2. All instruments will be installed in sufficient time prior to a construction activity to take baseline readings herein.
 - a. Surface Markers to be installed in soil, on concrete structures, and on roadway prior to construction.
 - b. Seismographs: Monitor selected structures during all demolition operations, or any other construction operations that generate significant vibrations.
 - c. Variations in the above schedule may be necessary due to site conditions or schedule conflicts, and will be decided by the Engineer.
 - d. Instrument locations, number or types may be added, deleted, or changed by the Engineer.
3. Storage of Instruments: The Contractor will receive all geotechnical instrumentation equipment and materials at the site. After receipt at the site and prior to installation, the Contractor shall provide an indoor, clean, dry and secure storage place.

B. GEOTECHNICAL INSTRUMENTS AND INSTALLATION

1. CONDITION SURVEY

- a. The Contractor shall perform a condition survey of existing structures within a distance from construction indicated in Article 1.1.J of this specification. This survey shall include video documentation of existing conditions and detailed mapping, digital pictures, and sketches of existing conditions. This survey will provide a baseline of existing conditions of structures prior to the beginning of construction.

2. SURFACE MARKERS

- a. Install a sufficient number of surface markers on existing structures and roadways to monitor for the movement of critical locations within a distance from construction indicated in Article 1.1.J of this specification, Surface markers shall be installed adjacent to

excavations and at the ground surface above the sewer alignment. The Contractor should anticipate a minimum of thirty (30) surface markers will be installed.

3. SEISMOGRAPHS

- a. Provide a portable seismograph unit such as Instantel BlastMate III or acceptable equivalent. The Contractor should anticipate a minimum of three (3) seismographs may be used at the same time for the duration of vibration inducing demolition/construction operations.

C. INSTALLATION

The CONTRACTOR will be responsible for installation of all geotechnical instruments and will prepare installation records for each instrument installed.

3.2 FIELD TESTING

Testing shall conform to the requirements specified in this Section.

A. ACCEPTANCE TEST

When instruments are received at the site, the Contractor will make acceptance tests to ensure that the instruments are functioning correctly prior to installation. Acceptance tests shall follow the guidelines included in the manufacturer's instruction manuals.

3.3 TRAINING-- not used

3.4 FIELD CALIBRATION AND MAINTENANCE

The Contractor will conduct regular field calibrations of readouts units, and maintenance of all readouts units, field terminals and accessible instrument components, following the guidelines included in the manufacturer's instruction manuals.

3.5 DAMAGE TO INSTRUMENTATION

The Contractor shall protect all instruments and appurtenant fixtures, leads, connections, and other components of instrumentation systems from damage due to construction operations, weather, traffic, and vandalism.

If an instrument is damaged due to construction activities, the Contractor shall repair or replace the damaged instrument at no cost to the Owner. The Engineer will determine if repair or replacement is required. The Engineer

may impose a work stoppage in the vicinity of the damaged instrument until it is again operational, at no additional cost to the Owner.

3.6 INSTRUMENT MONITORING AND REPORTING

A. Frequency of Monitoring

1. Upon installation of each stationary instrument (surface markers); baseline readings shall be obtained by the Contractor within 48 hours of acceptance tests.
2. The seismographs shall be set at critical locations as directed by the Engineer each day prior to the beginning of the workday. The seismographs shall be set to monitor continuously throughout the day, with visual and audible alarm units set to be triggered upon reaching threshold frequencies. This frequency may be reduced at the direction of the Engineer as the demolition and construction proceeds.
3. Stationary instruments shall be continued to be monitored once a week following the completion of demolition.

B. Data Reduction, Processing, Plotting and Reports

1. The Contractor will reduce, process, plot and report data, following the guidelines included in the manufacturer's instruction manuals or as determined to be most practical and relevant to the on-going construction.
2. Survey all the monitoring points and record original elevations of the points. Submit the result to the Engineer five workdays before the start of construction.

C. Monitoring Records

The Contractor will maintain all monitoring records in a systematic, orderly, legible manner and will make them available to the Engineer at all times until the work is substantially complete. After substantial completion, records will be completely documented, compiled, and transferred in their entirety on forms acceptable to the Owner.

D. Availability of Data

Results of the monitoring will be submitted to the Engineer within 24 hours of reading an instrument.

The Contractor shall not disclose instrumentation data to third parties and shall not publish data without prior approval of the Owner.

E. Implementation of Data

1. The Contractor shall make his own independent interpretations of the data, and shall immediately notify the Engineer and take all corrective action as necessary whenever instrumentation data indicate that any of the following conditions exist:
 - a. There is progressive soil movement at or approaching any existing facility or existing structure.
 - b. There is any detectable potentially detrimental movement of any existing structure or existing facility.
 - c. There is any condition which the Contractor believes will require corrective action.

3.7 REMOVAL OF INSTRUMENTS

- A. Remove instruments only when directed by the Engineer, approximately three months after the demolition work is complete.
- B. Removal of surface instruments includes removing and disposing of protective covers, recovery of salvageable portions of instrumentation, restoring the surface, and grouting all holes left by instrument removal.

END OF SECTION

SECTION 02485

SEEDING

PART 1 – GENERAL

1.1 SCOPE

- A. The work covered by this section consists of furnishing all labor, equipment, and material required to place topsoil, seed, commercial fertilizer, agricultural limestone, and mulch material, including seedbed preparation, harrowing, compacting, and other placement operations on graded earthen areas as described herein and/or shown on the Drawings. In general, seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement, or sidewalks; all cleared or grubbed areas which are to remain as finish grade surfaces; and on all existing turf areas which are disturbed by construction operations and which are to remain as finish grade surfaces. Areas disturbed by borrow activities shall also be seeded according to these Specifications.
- B. The work shall include temporary seeding operations to stabilize earthen surfaces during construction or inclement weather and to minimize stream siltation and erosion. Temporary seeding shall be performed at the times and locations directed by the Engineer.

1.2 QUALITY ASSURANCE

- A. Prior to seeding operations, furnish to the Engineer labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the Contractor of any responsibility or liability for furnishing seed meeting the requirements of this section.
- B. Prior to topsoil operations, obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Services or other certified testing laboratory.

1.3 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Seeding.

PART 2 – PRODUCTS

2.1 TOPSOIL

- A. Place a minimum of 4 inches of topsoil over all graded earthen areas and over any other areas to be seeded. Sources of topsoil shall be approved by the Engineer prior to disturbance.
- B. Topsoil shall be a friable loam containing a large amount of humus and shall be original surface soil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2 inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips, or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and perennial weed seeds, and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements, or vegetable debris undesirable or harmful to plant life.
- C. Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, sandy loam, or a combination thereof. The pH shall range from 5.5 to 7.0. Topsoil shall contain not less than 5 percent nor more than 20 percent, by weight, of organic matter as determined by loss on ignition of samples oven-dried to 65 C.

2.2 SEED

- A. Deliver seed in new bag or bags that are sound and labeled in accordance with the U.S. Department of Agriculture Federal Seed Act.
- B. All seed shall be from the last crop available at time of purchase and shall not be moldy, wet, or otherwise damaged in transit or storage.
- C. Seed shall bear the grower's analysis testing to 98 percent for purity and 90 percent for germination. At the discretion of the Engineer, samples of seed may be taken for check against the grower's analysis.
- D. Species, rate of seeding, fertilization, and other requirements are shown in the Seeding Requirements Table.

2.3 FERTILIZER AND LIMING MATERIALS

- A. Fertilizer and liming materials shall comply with applicable state, local, and federal laws concerned with their production and use.

SEEDING REQUIREMENTS TABLE						
Area	Sowing Season	Species	Rates per 1,000 Square Feet			
			Seed	Fertilizer	Limestone	Maintenance ²
Flat to rolling terrain with slopes less than 3:1	3/1 to 6/1	Kentucky 31 Fescue Ladino White Clover ¹	4 lbs. 1/4 lb.	30 lbs. 6-12-12	100 lbs.	15 lbs. 10-10-10
	8/1 to 11/1	Kentucky 31 Fescue Ladino White Clover ¹ Annual Ryegrass	4 lbs. 1/4 lb. 2 lbs.	30 lbs. 6-12-12	100 lbs.	15 lbs. 10-10-10
Embankments with slopes greater than 3:1	3/1 to 6/1	Crownvetch ¹ Kentucky 31 Fescue Weeping Lovegrass	1 lb. 2 lbs. 1/4 lb.	30 lbs. 6-12-12	100 lbs.	10 lbs. 0-20-20
	8/1 to 11/1	Crownvetch ¹ Kentucky 31 Fescue Annual Ryegrass	1 lb. 2 lbs. 2 lbs.	30 lbs. 6-12-12	100 lbs.	10 lbs. 0-20-20

¹Requires inoculation.
²Maintenance fertilizer shall be applied in early spring following initial establishment of cover.

- B. Commercial fertilizer shall be a ready-mixed material and shall be equivalent to the grade or grades specified in the Seeding Requirements Table. Container bags shall be labeled with the name and address of the manufacturer, brand name, net weight, and chemical composition.
- C. Agricultural limestone shall be a pulverized limestone with a calcium carbonate content not less than 85 percent by weight. Agricultural limestone shall be crushed so that at least 85 percent of the material will pass a No. 10 mesh screen and 50 percent will pass a No. 40 mesh screen.

2.4 MULCH MATERIAL

- A. All mulch materials shall be air-dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.
- B. Mulch shall be composed of wood cellulose fiber, straw, or stalks, as specified herein. Mulch shall be suitable for spreading with standard mulch-blowing equipment.
- C. Wood cellulose fiber mulch shall be as manufactured by Weyerhaeuser Company, Conway Corporation, or equal.
- D. Straw mulch shall be partially decomposed stalks of wheat, rye, oats, or other approved grain crops.
- E. Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum, or other approved standing field crops.

2.5 MULCH BINDER

- A. Mulch on slopes exceeding a 3 to 1 ratio shall be held in place by the use of an approved erosion control fabric, such as Hold/Gro Erosion Control Fabric as manufactured by Gulf States Paper Corporation, or approved equal. Fabric

shall consist of strips of biodegradable paper interwoven with yarn that is subject to degradation by ultraviolet light.

2.6 INOCULANTS FOR LEGUMES

- A. All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen-fixing bacteria that is adapted to the particular seed involved.

2.7 WATER

- A. Water shall be clean, clear, and free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the Contractor.

PART 3 - EXECUTION

3.1 SECURING AND PLACING TOPSOIL

- A. Topsoil shall be secured from areas where topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the Engineer.
- B. The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage, and other characteristics as to offer assurance that when removed the product will be homogeneous in nature and will conform to the requirements of these Specifications.
- C. All areas from which topsoil is to be secured shall be cleaned of all sticks, boards, stones, lime, cement, ashes, cinders, slag, concrete, bitumen or its residue, and any other refuse which will hinder or prevent growth.
- D. When securing topsoil from a designated pit or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such material shall be removed from the topsoil or if required by the Engineer, the pit shall be abandoned.
- E. Before placing or depositing topsoil upon any area, all improvements within the area shall be completed, unless otherwise approved by the Engineer.
- F. The areas in which topsoil is to be placed or incorporated shall be prepared before securing topsoil for use.

3.2 SEEDBED PREPARATION

- A. Before fertilizing and seeding, the topsoil surfaces shall be trimmed and worked to true line free from unsightly variations, bumps, ridges, and depressions, and all detrimental material, roots, and stones larger than 3 inches in any dimension shall be removed from the soil.

- B. Not earlier than 24 hours before the seed is to be sown, the soil surface to be seeded shall be thoroughly cultivated to a depth of not less than 2 inches with a weighted disc, tiller, pulvimixer, or other equipment, until the surface is smooth and in a condition acceptable to the Engineer.
- C. If the prepared surface becomes eroded as a result of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be placed in a condition suitable for seeding.
- D. Ground preparation operations shall be performed only when the ground is in a tillable and workable condition, as determined by the Engineer.

3.3 FERTILIZATION AND LIMING

- A. Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve the application rates shown in the Seeding Requirements Table.
- B. Fertilizer shall be spread evenly over the seedbed and shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of 1/2 inch.
- C. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment. The seed shall not remain in water containing fertilizer for more than 30 minutes when a hydraulic seeder is used.
- D. Agricultural limestone shall be thoroughly mixed into the soil according to the rates in the Seeding Requirements Table. The specified rate of application of limestone may be reduced by the Engineer if pH tests indicate this to be desirable. It is the responsibility of the Contractor to obtain such tests and submit the results to the Engineer for adjustment in rates.
- E. It is the responsibility of the Contractor to make one application of maintenance fertilizer according to the recommendations listed in the Seeding Requirements Table.

3.4 SEEDING

- A. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the dates shown in the Seeding Requirements Table unless otherwise approved by the Engineer. Seed mixtures may be sown together, provided they are kept in a thoroughly mixed condition during the seeding operation.
- B. Seeds shall be uniformly sown by any approved mechanical method to suit the slope and size of the areas to be seeded, preferably with a broadcast type

seeder, windmill hand seeder, or approved mechanical power-drawn seed drills. Hydroseeding and hydromulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder to the proper rate before seeding operations are started and to maintain the adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.

- C. Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8 inch by a cultipacker or suitable roller.
- D. Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculant in accordance with the manufacturer's mixing instructions.

3.5 MULCHING

- A. All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and air to circulate, and at the same time shade the ground, reduce erosion, and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.
- B. One of the following mulches shall be spread evenly over the seeded areas at the following application rates:
 - 1. Wood Cellulose Fiber 1,400 lbs/acre
 - 2. Straw 4,000 lbs/acre
 - 3. Stalks 4,000 lbs/acre

These rates may be adjusted at the discretion of the Engineer at no additional cost to the Owner, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

- C. Mulch on slopes greater than a 3 to 1 ratio shall be held in place by the use of an approved erosion control fabric. Fabric shall be installed immediately after seeding and fertilizing area (mulch shall not be used under fabric).
- D. Erosion control fabric shall be installed and applied in accordance with the manufacturer's recommendations. Any fabric which becomes torn, broken loose from securing staples, or undermined shall be immediately and satisfactorily repaired. Areas where seed is washed out before germination shall be fertilized, reseeded, and restored. Any required restoration work shall be performed without additional compensation.

3.6 WATERING

- A. Maintain the proper moisture content of the soil to ensure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain an adequate water content in the soil.
- B. Watering shall be accomplished by hoses, tank truck, or sprinklers in such a way to prevent erosion, excessive runoff, and overwatered spots.

3.7 MAINTENANCE

- A. Upon completion of seeding operations, the Contractor shall clear the area of all equipment, debris, and excess material, and the premises shall be left in a neat and orderly condition.
- B. Maintain all seeded areas without additional payment until final acceptance of the work by the Owner, and any regrading, refertilizing, reliming, reseeding, or remulching shall be done at his own expense. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is achieved. Damage resulting from erosion, gulleys, washouts, or other causes shall be repaired by filling with topsoil, compacting, and repeating the seeding work at his expense.

END OF SECTION

SECTION 02500

NEW AND REPLACEMENT PAVING

PART 1 – GENERAL

1.1 SUMMARY

- A. The Contractor shall provide the labor, tools, equipment, and materials necessary to construct the driveways, parking areas, and pavement in accordance with the plans and as specified herein.

1.2 RELATED DOCUMENTS

- A. Drawings.
- B. Section 02200 – Earthwork
- C. ODOT Construction and Materials Specifications
- D. City of Canton Standard Drawings

1.3 QUALITY ASSURANCE

A. CODES AND REGULATORY AGENCIES

- 1. Perform all work in compliance with all applicable federal, state, and local codes and regulatory agencies.

B. STANDARDS

- 1. Material and work shall be in conformance with:
 - a. ODOT – Ohio Department of Transportation.
 - b. City of Canton Standard Drawings.

C. TESTING LABORATORY

- 1. Engage a testing laboratory acceptable to the Engineer to perform subgrade inspection and compaction tests.

1.4 SUBMITTALS

A. PRODUCT DATA

- 1. Submit Manufacturer's data on all material.

B. CERTIFICATION

1. Submit in writing certifying that all materials and mixes are in conformance with ODOT specifications.

C. TEST DATA

1. Submit test data as required under paragraph 3.1.B.1.

1.5 SITE CONDITIONS

A. COORDINATION

1. Coordinate all pavement installation with proper authorities.
2. Coordinate pavement installation with other work of Contract such that there is minimum disruption of the completed pavement and/or delays of other work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. DELIVERY

1. Comply with ODOT Item 401.09.

B. STORAGE

1. Comply with ODOT Item 106.06.

C. HANDLING

1. Comply with ODOT Item 106.07.

1.7 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the unit prices for Pavement Removal Including Saw Cutting and the respective New Asphalt Pavement items.

PART 2 – PRODUCTS

2.1 MATERIALS

A. GENERAL

1. All material shall be in accordance with ODOT “Construction and Material Specifications” except for method of payment.

B. BASES

1. Aggregate base shall meet the specifications of ODOT Item 304. The use of slag is not permitted
2. Bituminous aggregate base shall meet the specifications of ODOT Item 301.

C. PRIME COAT

1. Prime coat shall be RT-2, RT-3, MC70, or MC250 in accordance with ODOT Item 702.

D. TACK COAT

1. Tack coat shall be RC-250, RS-1, SS-1, or SS-1h in accordance with ODOT Item 702.

E. ASPHALT CONCRETE

1. Asphalt concrete surface course shall be in accordance with ODOT Item 448 Type 1.
2. Asphalt concrete intermediate course shall be in accordance with ODOT Item 448 Type 2.

F. CONCRETE WITH PORTLAND CEMENT

1. Concrete shall be in accordance with Section 03300 “Cast-in-Place Concrete” Class A or ODOT Item 452.

G. EXPANSION JOINT

1. Expansion joints shall be ½-inch thick premolded, nonextruding type.

H. PARKING BLOCKS

1. Parking blocks shall be precast concrete, standard curb type, 6" x 8" x 8' with tapered edges and predrilled for anchoring. Provide three (3) $\frac{3}{4}$ " x 16" hot dip galvanized steel anchor pins per unit.

PART 3 – EXECUTION

3.1 GENERAL

A. TOPSOIL

1. Topsoil shall be removed. See Section 02485 – Seeding.

B. SUBGRADE

1. Compaction. See Section 02200 – Earthwork.
2. All loose and foreign materials shall be removed and the subgrade shall be free of ruts and standing water when the base material is placed.

C. SLOPE

1. Driveways, parking areas, and walks shall be sloped to drain away from buildings and structures. Driveways in open areas shall have a center crown. Cross slope for driveways and walks shall be $\frac{1}{4}$ -inch per foot unless otherwise shown.

D. EXISTING PAVEMENT

1. Driveways, parking areas, and walks shall conform to the grade of existing driveways, parking areas, curbs and walks unless modifications are shown on the plans or required by the specification. Where it is necessary to disturb existing Portland cement concrete pavements, curbs or walks, the concrete shall be saw cut in neat, straight lines. The depth of saw cut shall be at least 2 inches. Where it is necessary to disturb existing asphalt concrete pavements, curbs or walks, the asphalt concrete shall be line cut with straight vertical edges by saw cutting. All cut bituminous surfaces shall be sealed with a bituminous material.

3.2 PAVEMENT

A. GENERAL

1. All construction shall be in accordance with ODOT "Construction and Material Specifications" latest edition, except for method of payment.

B. ASPHALT CONCRETE DRIVEWAYS AND PARKING AREAS

1. Aggregate base shall consist of compacted aggregate applied in layers of equal thickness to a depth shown on the City of Canton Standard Drawings in accordance with Item 304.03. No layer shall exceed 6 inches in thickness after compaction. Compaction shall be in accordance with ODOT Item 304.04.
2. Prime coat shall be applied according to ODOT Item 408 at the rate of 0.40 gallon per square yard.
3. Bituminous aggregate base shall be installed in two (2) layers each as shown on the Drawings after compaction.
4. Unless otherwise shown, wearing surface shall consist of asphalt concrete applied in two (2) layers. The surface course shall be as shown on the City of Canton Standard Drawings after compaction. The intermediate course shall be as shown on the Drawings after compaction.
5. Bituminous aggregate base and asphalt pavement shall be installed in accordance with ODOT Items 301, 401, and 448 Types 1 & 2.

3.3 CONCRETE WALKS

A. CONCRETE WALKS

1. Concrete walks shall be per City of Canton Standard Drawings.

B. FINISH

1. At a minimum, Concrete shall be float finished with a tooled joint every 4 feet and an expansion joint every 20 feet.

END OF SECTION

SECTION 02534

SEWER FLOW CONTROL

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Sewer flow control may be required to conduct sewer line replacement, joint testing, and manhole replacement operations effectively. In general, flow control will be required for sewer line replacement when sewer line flows are more than one-fourth (1/4) the pipe diameter. When the sewer line depth of flow at the upstream manhole in the sewer section where work is being performed is above the maximum allowable level at the time any work in the sewer is proposed, the flow shall be reduced by plugging or blocking of the flow, or by pumping and bypassing of the flow as specified. Flow control shall be coordinated with the operations of the Contractor's other crews.
- B. Sewer flow control may be required to conduct manhole/junction chamber installation effectively. A flow through type plug may be installed inside the manhole bench while rehabilitating the existing manhole. Pumping and bypassing of the flow is also an acceptable flow control method. Flow control shall be coordinated with the operations of the Contractor's other crews.
- C. Damages to private or public property that result from sewer flow control operations are the Contractor's responsibility.

1.2 RELATED WORK

- A. Section 02560- PRECAST MANHOLES AND COVERS
- B. Section 02567- Manhole Sealing With a Protective Polymer Lining

1.3 SUBMITTALS

- A. The Contractor shall submit to the Owner for review and approval his system set-up prior to implementation.

1.4 PLUGGING OR BLOCKING

- A. Insert a sewer line plug into the line at a manhole upstream from the line segment or manhole where work is to be conducted. The plug shall be designed so that a portion of the sewage flows can be released. A flow through type plug may be used while installing the manholes/junction chambers. During the inspection portion of the operation, flows shall be shut off or substantially reduced so that the manhole can be properly inspected.

1.5 BYPASS PUMPING

- A. When bypass pumping is required to ensure the completion of the above mentioned work items, furnish the pumping equipment, portable power generators, conduits, and all other related equipment necessary. Pumping equipment, conduits, etc., shall be of sufficient size and capacity to handle the maximum flow which can be expected in each respective sewer section in which bypass pumping equipment is installed. The pumping operation will be conducted from manhole to manhole, and no flow will be discharged on the surface or in natural waterways. All sewer relocation work requiring bypass pumping will be conducted on a timely basis during normal working hours. Work will be suspended at the end of each day, sewer line flow will be returned to normal, and bypass pumping will cease.

1.6 FLOW CONTROL PRECAUTIONS

- A. When flow in a sewer line is plugged, blocked, or bypassed, sufficient precautions must be taken to protect the sewer lines from damage that may result from sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved.

1.7 PROPERTY OWNER AND OR RESIDENT NOTIFICATION

- A. The Contractor shall provide 48-hour prior written notification to all property owners and or residents that may be affected by the diversion of flow in the sewer, explaining work that is to take place and its time frame. The notification shall include approximate time when sewage cannot be received during sewer work as well as when the sewer will be available again for receiving sewage. All commercial establishments shall be provided with temporary sewer service. The means and methods shall be coordinated with the managers and the affected residents.
- B. A door hanger reminder shall be placed 24 hours prior to reducing the sanitary service.

1.8 PROPERTY OWNER AND OR RESIDENT NOTIFICATION

- A. The existing 42-inch sanitary sewer has an estimated average daily flow of 5.3 MGD and a peak hourly flow of 7.5 MGD.

1.9 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the lump sum price for Sewer Flow Control.

END OF SECTION

SECTION 02560

PRECAST MANHOLES AND COVERS

PART 1 - GENERAL

1.1 SCOPE

- A. Contractor shall furnish all labor, materials, equipment, and incidentals required to install round precast concrete manhole sections, covers, pipe connectors, inverts, drops, and accessories as specified herein.

1.2 REFERENCES

- A. Section 02567 Manhole Sealing with a Protective Polymer Lining
- B. Prestressed Concrete Institute. Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
- C. National Precast Concrete Association. Quality Control Manual for Precast Concrete Plants.
- D. American Society for Testing and Materials (ASTM)
 - 1. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - 2. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
 - 3. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
 - 4. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipe and Laterals.
 - 5. ASTM C913 - Standard Specifications for Precast Concrete Water and Wastewater Structures.
- E. American Association of State Highway and Transportation Officials Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets (AASHTO M198).
- F. American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318).

G. Occupational Safety and Health Administration Standard 1926.704 - Requirements for Precast Concrete.

H. City of Canton Supplemental Specifications

1.3 SUBMITTALS SHALL BE AS FOLLOWS

A. Copy of certificate or report showing that the precast concrete manufacturer conforms to Article 1.4 - Qualifications.

B. Detail of each precast concrete section to be provided showing or charting the following:

1. Manufacturer's part number or catalog number.
2. Inside diameter.
3. Lay length excluding base slab.
4. Wall thickness and base or top thickness where applicable.
5. Handling weight.
6. Wire size, spacing, and area provided per vertical foot.
7. Reinforcing bar size and spacing.
8. Design load for flat slab or transition tops.
9. Step locations.
10. Concrete mix number and design strength.
11. Height, width, slope, and annular space of the tongue and groove.

C. Step detail and material specifications.

D. Pipe connector details and material specifications.

E. Joint material detail, material specifications and calculations showing that the joint material cross section is greater than the joint's annular space times its height.

F. Lifting device and hole detail for lifting precast components.

G. Submit the following at the request of the Engineer or Owner:

1. Structural analysis and design calculations for flat slab top and transition top precast components, performed in accordance with applicable codes and standards, showing that allowable stresses will not be exceeded. All calculations must be sealed by a registered professional engineer.
2. Calculations or test results verifying that the lifting device components and holes are designed in accordance with OSHA Standard 1926.704.

3. Concrete 28-day compression strength results for every day production of precast components for the project was performed showing the required strength according to the guidelines established in ACI 318.
4. Reinforcing and cement mill reports for materials used in the manufacture of precast components for this project.
5. The above test reports for similar precast components recently produced, submitted prior to production of precast components for this project.

1.4 QUALIFICATIONS

- A. The precast Manufacturer shall comply with one (1) of the following requirements:
 1. Manufacture precast components for the project in a plant certified in the Prestressed Concrete Institute's (PCI) Plant Certification Program.
 2. Manufacture precast components for the project in a plant certified in the National Precast Concrete Association's (NPCA) Plant Certification Program.
 3. Retain an independent testing or consulting engineering firm approved by the Engineer for precast plant inspection. The basis for plant inspection shall be the National Precast Concrete Association Quality Control Manual or the Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products. The above firm shall inspect the precast plant 2 weeks prior to and at 1 week intervals during production of materials for this project and issue a report, certified by a registered engineer that materials, methods, products, and quality control meet the requirements of the above quality control manuals.
- B. The precast Manufacturer shall have a recognized quality improvement process installed at the manufacturing facility.
- C. The precast manufacturer shall provide engineering certification as to the structural adequacy of any precast component, if requested.
- D. All concrete compressive strength testing shall be performed in a laboratory inspected by the Cement and Concrete Reference Laboratory CCRL of the National Bureau of Standards.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 50 degrees Fahrenheit prior to, during, and 48 hours after completion of masonry, grouting or concreting work.

1.6 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the unit price for Sanitary Manholes No. 3 & No. 4, 72-Inch Diameter, for Sanitary Manholes No. 2, No. 5, No. 6 & No. 7, 84-Inch Diameter, and for Manhole and Junction Structure Exterior Waterproofing, Coal Tar.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Concrete shall conform to ASTM C478 and as follows:
1. Compressive Strength: 5,000 psi minimum at 28 days.
 2. Air Content: 4 percent minimum.
 3. Alkalinity: Adequate to provide a life factor, $A_z = \text{Calcium carbonate equivalent times cover over reinforcement}$, no less than 0.35 for bases, risers and cones.
 4. Cementitious Materials: Minimum of 564 pounds per cubic yard.
 5. Coarse Aggregates: ASTM C33. Sound, crushed, angular stone only. Smooth or rounded stone shall not be used.
 6. Fine Aggregates: ASTM C33. Free from organic impurities.
 7. Chemical Admixtures: ASTM C494. Calcium chloride or admixtures containing calcium chloride shall not be used.
 8. Air Entraining Admixtures: ASTM C260.
 9. Waterproofing Admixture for Concrete
 - a. Admixture – cementitious, capillary waterproofing admixture which, when added at the approximate dosage rate of 1% by weight of cement (0.8% minimum), will create a crystalline growth in the pores, capillary tracts, and bleed water tracks of the concrete.
 - b. Manufacturer – Penetron (ICS Penetron International), or Xypex Chemical Corp.

- B. Reinforcing steel shall be ASTM A615 Grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.
- C. Lifting loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars shall not be allowed.
- D. Contractor shall remove and replace all pipe damaged during removal of existing manholes and installation of proposed manholes. Existing pipe to remain shall be neatly sawcut to provide a tight connection between existing and proposed pipe.
- E. Flexible joint sealants shall be butyl rubber based conforming to Federal Specification SS-S-210A, AASHTO M-198, Type B butyl rubber or as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 Fahrenheit.
- F. Epoxy gels used for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive meeting ASTM C881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.

2.2 COMPONENTS

- A. Precast component fabrication and manufacture shall be as described in this paragraph and as described in the paragraphs for the specific components.
 - 1. Precast components shall be manufactured in conformance with ASTM C478. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate references and specified below.
 - 2. Joint surfaces for joints between bases, risers, and cones shall be manufactured to the joint surface design and tolerance requirements of ASTM C361. The maximum slope of the vertical surface shall be 2 degrees. The maximum annular space at the base of the joint shall be 0.10 inch. The minimum height of the joint shall be 4 inches.
 - 3. Lift holes and inserts used for handling precast components shall be sized for a precision fit with the lift devices, shall not penetrate through the manhole wall, and shall comply with OSHA Standard 1926.704.
 - 4. Step holes shall be cast or drilled in the bases, risers, and cones to provide a uniform step spacing of 16 inches. Cast step holes shall be tapered to match the taper of the steps.

- B. Precast base sections shall have the base slab cast monolithically with the walls, or have and approved galvanized or PVC waterstop cast in the cold joint between the base slab and the walls. Extended bases shall be a minimum thickness of 6 inches. The bottom step in base sections shall be a maximum of 24 inches from the high point of the bench directly below the proposed step location.
- C. The minimum lay length of precast riser sections shall be 16 inches.
- D. Precast cone sections shall have an inside diameter at the top of 24 inches. The width of the top ledge shall be no less than the wall thickness required for the cone section. Concentric cones shall be used only for shallow manholes.
- E. Precast transition cone sections shall provide an eccentric transition from 60-inch diameter and larger manholes to 48-inch-diameter risers, cones, and flat slab top sections. The minimum slope angle for the cone wall shall be 45 degrees.
- F. Precast transition top sections shall provide an eccentric transition from 60-inch and larger manholes to 48-inch-diameter risers, cones, and flat slab top sections. Transition top sections shall be furnished with vents as shown on the manhole details. The maximum amount of fill over the transition top section shall be 20 feet. Transition tops shall not be used in areas subject to vehicle traffic.
- G. Standard precast flat slab top sections shall have an inside diameter at the top of 24 inches and shall be designed for HS-20 traffic loadings as defined in ASTM C890. Items to be cast into special flat slab tops shall be sized to fit within the manhole inside diameter and the top and bottom surfaces.
- H. Precast grade rings shall be used to adjust ring and covers to finished grade. No more than 12 vertical inches of grade rings will be allowed per manhole. Grade rings shall conform to ASTM C478, Canton Standard Drawing No. 10 (Sheet 3 of 3, Note 6), and shall be no less than 4 inches in height.
- I. Precast inverts shall meet the following requirements:
 - 1. Pipe openings shall provide clearance for pipe projecting a minimum of 2 inches inside the manhole. The height of the transition from the pipe opening to the invert trough shall be equal to $1/2$ of the opening inside diameter minus pipe inside diameter, plus or minus $1/4$ inch. The crown of small inside diameter pipe shall be no lower than the crown of the outlet pipe. When the fall between the inlet and the outlet holes is greater than 4 inches, the inlet end of the trough shall be below the inlet pipe invert and aligned horizontally within 1 inch.

2. Troughs shall be formed and finished to provide a consistent slope from the pipe outlet to the inlets up to 4-inch fall. The minimum fall shall be 1 inch. The minimum bending radius of the trough centerline is to be 1.5 times the pipe inside diameter. Provide a 1/2-inch radius at the intersection of 2 or more channels. The minimum concrete thickness from the bottom of the trough to the bottom of the base shall be 7 inches.
 3. Float finish benches to provide a uniform 4:1 slope, , from the high point at the manhole wall to the low point at invert trough. Provide a 1/4-inch radius at the edge of the bench and trough.
 4. Depressions, high spots, voids, chips, or fractures over 1/4-inch in diameter or depth shall be filled with a sand cement paste and finished to a texture reasonably consistent with that of the formed surface.
- J. Provide steps in bases, risers, cones, transition cones, and transition top sections aligned vertically. All steps shall be evenly spaced with a minimum of 12 inches and maximum of 16 inches between each step. Secure steps to the wall with a compression fit in tapered holes or cast in place. Steps shall not be vibrated or driven into freshly cast concrete or grouted in place. The reinforced plastic steps shall be copolymer polypropylene plastic or equal, reinforced with a 1/2-inch diameter Grade 60 bar and have serrated tread and tall end lugs. . Step pullout strength shall be a minimum of 2,000 pounds when tested according to ASTM C497.
- K. Pipe to manhole connectors shall conform to ASTM C923. On large diameter flexible pipes, provisions for control of the pipe outside diameter to within the tolerances of the connector shall be made.
- L. Joints shall be sealed internally between the tongue and the groove and additionally around the external perimeter of the joint as follows:
1. Internal seals shall consist of a plastic or paper-backed butyl rubber rope no less than 28 feet long and having a cross-sectional area no less than the annular space times the height of the joint.
 2. Internal seals may consist of an O-ring gasket conforming to ASTM C443, installed according to the precast Manufacturer's recommendation, at the option of the Contractor.
 3. Joints with a perimeter greater than or equal to 18 feet shall be internally sealed with butyl rubber/bentonite sealant.
 4. Joints with a perimeter less than 18 feet shall be internally sealed with butyl rubber sealant.

5. External seals shall consist of a polyethylene backed flat butyl rubber sheet no less than 1/16-inch thick and 6 inches wide applied to the outside perimeter of the joint.

M. Manhole grade rings shall conform with City of Canton Standard Detail No. 10.

N. Manhole frames and covers shall conform with City of Canton Standard Detail No. 12.

O. Lifting devices complying with OSHA Standard 1926.704 for handling the precast components shall be provided by the precast Manufacturer.

P. The exterior of the manhole walls shall be coated with 21 mils of coal tar epoxy, Koppers 300M or equal, where shown on the plans. The coating shall be spray applied according to the Manufacturer's recommendations. The joints between precast sections shall not be coated. Use butyl rubber rope as specified above to seal the interior horizontal joint surface.

2.3 CONFIGURATION

A. Manholes are to be constructed as specified and as shown on the detail drawings.

B. The number of joints shall be minimized. no more than 1 riser for each additional 5 feet in height. One additional section will be allowed for transition manholes.

C. Where service lines enter manholes, locate them above the bench of the. primary (largest diameter) sewer

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect manhole components prior to unloading from the delivery truck.

3.2 DELIVERY, STORAGE, AND HANDLING

A. Coordinate delivery with the manufacturer. Handle and store the manhole components in accordance with ASTM C891 and the Manufacturer's recommendations using methods that will prevent damage to the components and their joint surfaces.

3.3 PLACING MANHOLE SECTIONS

A. Excavate the required depth and remove materials that are unstable or unsuitable for a good foundation. Prepare a level, compacted foundation extending 6 inches beyond the manhole base.

- B. Set base plumb and level, aligning manhole invert with pipe invert.
- C. Thoroughly clean bells and spigots to remove dirt and other foreign materials that may prevent sealing. Unroll the butyl sealant rope directly against base of spigot. Leave protective wrapper attached until sealant is entirely unrolled against spigot. Do not stretch. Overlap from side to side - not top to bottom.
- D. Set risers and cones so that steps align, taking particular care to clean, prepare and seal joints.
- E. After joining manhole sections, apply the butyl sealant sheet around the outside perimeter of the joint.
- F. Lift holes leaving less than 2 inches of wall thickness shall be plugged from the outside using a sand cement mortar. Lift holes penetrating the wall shall be additionally sealed with an interior application of an epoxy gel 1/8-inch thick extending 2 inches beyond the penetration.
- G. Sanitary manholes shall be tested according to City of Canton Supplemental Specification 04-01 (STANDARD TEST METHOD FOR CONCRETE SEWER MANHOLES BY THE NEGATIVE AIR PRESSURE TEST).
- H. Set the manhole frames to the required elevation using no more than. 12 inches of grade rings per City of Canton Standard Drawing No. 10.
- I. Perform the final finishing to the manhole interior by filling all chips or fractures greater than ½-inch in length, width or depth and depressions more than ½-inch deep in inverts with a high strength grout equal to SikaSet Plug. Do not fill the joints between the precast concrete sections. Clean the interior of the manhole, removing all dirt, spills, or other foreign matter.

END OF SECTION

SECTION 02567

MANHOLE SEALING WITH A PROTECTIVE POLYMER LINING

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The work under this section includes furnishing all equipment, materials, and labor required to line the interiors of manholes and tie-in junction structures as specified herein and shown on the Drawings. All manhole rehabilitation items shall be the responsibility of the Contractor.
- B. All manholes specified to receive manhole sealing shall be examined by the Contractor. Notify the Engineer in writing if surfaces are not acceptable. Contractor shall not begin liner application until unacceptable conditions have been corrected.
- C. The Contractor shall provide necessary sewer flow control for all manhole rehabilitation. Flow through type plugs installed in the manhole inlets and plumbed into the outlet allowing flow to pass through the structure without interference of bench and invert replacements are may be used by the Contractor. Flow through type plugs shall be removed by the Contractor at the end of each work day.
- D. Manhole rehabilitation shall consist of cleaning and preparing the surfaces for sealing with a polymer based liner material on the bench surfaces and on the walls and ceiling from the bench to bottom of frame as specified herein.
- E. All work shall be in strict accordance with the Engineers specifications and recommendations including application of all products as required and in accordance with Manufacturer's directions.

1.2 QUALITY ASSURANCE

- A. The Contractor shall have suitable equipment for performing the manhole rehabilitation work and shall have demonstrated satisfactory performance in completing previous comparable work.
- B. The Contractor shall have a minimum of five (5) years experience applying and installing the products specified herein.
- C. The Contractor must certify in writing from the Manufacturer that he is approved to install the Manufacturer's products specified herein.

- D. Manufacturer Qualifications: The Manufacturer of work of this section shall have five (5) years minimum proven experience in such work and shall have satisfactorily completed three (3) jobs of similar size and type within the last five (5) years.

1.3 RELATED WORK

- A. Section 02534 Sewer Flow Control
- B. Section 02560 Precast Manholes and Covers
- C. Section 02570 Monolithic or Sectional Precast Concrete Structures
- D. Section 03300 Cast-in-Place Concrete

1.4 REFERENCES

- A. ASTM D638 - Tensile Properties of Plastics.
- B. ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics.
- C. ASTM D695 - Compressive Properties of Rigid Plastics.
- D. ASTM D4541 - Pull-off Strength of Coatings Using a Portable
- E. ASTM D7234 - Pull-off Adhesion Strength of Coatings on Concrete Using Portable Adhesion Testers.
- F. ASTM D2584 - Volatile Matter Content.
- G. ASTM D2240 - Durometer Hardness, Type D.
- H. ASTM D543 - Resistance of Plastics to Chemical Reagents.
- I. ASTM C109 - Compressive Strength Hydraulic Cement Mortars.
- J. ACI 506.2-77 - Specifications for Materials, Proportioning, and Application of Shotcrete.
- K. ASTM C579 - Compressive Strength of Chemically Setting Silicate and Silica Chemical Resistant Mortars.
- L. ASTM - The published standards of the American Society for Testing and Materials, West Conshohocken, PA.
- M. NACE - The published standards of National Association of Corrosion Engineers (NACE International), Houston, TX.

- N. SSPC - The published standards of the Society of Protective Coatings, Pittsburgh, PA.
- O. Los Angeles County Sanitation District – Evaluation of Protective Coatings for Concrete.
- P. ASTM F1216 (Including Appendix XI): Design Parameters for Buried Structures (structural rehabilitation) utilizing the External Buckling Equation for thickness determination.
- Q. ASTM D2990: Test Methods for Tensile, Compressive and Flexural Creep and Creep Rupture in Plastics
- R. SSPWC 210-2.3.3 - Chemical resistance testing published in the Standard Specifications for Public Works Construction, 1997 edition (otherwise known as “The Greenbook”).

1.5 SUBMITTALS

A. SHOP DRAWINGS AND ENGINEERING DATA

1. Submit complete shop drawings and Engineering data to the Engineer in accordance with the requirements of Supplemental Specifications. Submit Manufacturer’s literature, design data, samples, and warranty with the submittal. Manufacturer’s literature shall include material specifications, product safety sheets (MSDS sheets) and application instructions for the material to be used for the manhole lining work.
2. Wall thickness design calculations for each manhole to be rehabilitated utilizing the specified resin technology systems must be submitted, along with supporting formulas that document that version of formula used. Additionally, product specific strength values, including the short term flexural modulus and the long term flexural modulus strength, must be substantiated by third party testing which will be submitted. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long term test with respect to the initial flexural modulus and the long term reduction factor used in design.
3. Submit certification that the equipment to be used for applying the products has been manufactured or approved by the protective coating manufacturer and applicator personnel have been trained and certified for proper use of the equipment.

1.6 STORAGE AND PROTECTION

- A. Deliver materials in original sealed containers with seals unbroken and labels legible and intact, as applicable. Materials shall be delivered in sufficient quantities so as not to cause delay in the work. Materials shall be stored in accordance with the Manufacturer's instruction.

1.7 GUARANTEE

- A. Provide a guarantee against defects and workmanship in accordance with the requirements of the General Specifications.

1.8 DESIGN CONDITIONS

- A. The following design conditions shall be assumed for all structures being rehabilitated with the approved resin system:

Parameter	Design Requirement
1. Structure Condition	Partially Deteriorated, based on condition of the existing structure.
2. Soil Type	Saturated
3. Design Thickness	ASTM 1216-Appendix. XI
4. Ovality	Not greater than 5%
5. Soil Load	120 lbs/cu. ft.
6. Traffic Load	AASHTO-HS-20-44 Highway
7. Soil Modulus	>500 psi.<1000 psi.
8. Safety Factor	2.0
9. Soil Cover	Distance from grade to invert of pipe.
10. Water Table	Same as Soil Cover unless changed by Owner or Engineer.

1.9 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the unit price for Manhole and Junction Structure Sealing With Protective Polymer Lining.

PART 2 – PRODUCTS

2.1 MANHOLE SEALING PRODUCTS

A. REPAIR MATERIAL

1. Standard Portland cement or new concrete (not quick setting high strength cement) must be well cured prior to application of the protective coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. Engineer may require Elcometer pull tests to determine suitability of concrete for coating.
2. Cementitious patching and repair materials should not be used unless their manufacturer provides information as to its suitability and procedures for topcoating with the approved coating. Project specific submittals should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the approved coating.
3. Repair materials shall be used to fill voids, structurally reinforce and/or rebuild surfaces, etc. as determined necessary by the protective coating applicator. Repair materials must be compatible with the specified coating and shall be applied in accordance with the manufacturer's recommendations.
4. The following products may be accepted and approved as compatible repair basecoat materials for approved topcoating for use within the specifications:
 - a. 100% solids, solvent-free grout specifically formulated for approved topcoating compatibility. The grout manufacturer shall provide instructions for trowel or spray application and for approved topcoating procedures.
 - b. Factory blended, rapid setting, high early strength, non-shrink repair mortar that can be troweled or pneumatically spray applied may be approved if specifically formulated to be suitable for approved topcoating. Such repair mortars should not be used unless their manufacturer provides information as to its suitability for topcoating with the approved topcoating. Project specific submittals should be provided including application, cure time and surface preparation procedures which permit optimum bond strength with the approved coating.

- c. In the case of excessive infiltration, a hydraulic cement or plug may be used to stop the flow of the infiltration. Manufacturer's include Strong, Sika, Preco or approved equal. The hydraulic cement shall be compatible with the spray applied resin coating.

B. PROTECTIVE LINING MATERIAL

- 1. Manufacturer: The protective lining material shall be SprayWall® as manufactured by Sprayroq, Inc., SpectraShield as manufactured by CCI Spectrum, Inc or approved equal.
- 2. The resin based material shall be used to form the sprayed structurally enhanced monolithic liner covering all interior surfaces of the structure, including benches and inverts of manholes. The physical requirements must be verified by an independent, certified, third party testing laboratory within the last five years and must be submitted with the shop drawings.

SprayWall lining shall conform to the following minimum properties:

Compressive strength	ASTM D 695	> 18,000 psi
Tensile strength	ASTM D 638	> 7,450 psi
Bond	Substrate Failure	
Flexural Modulus (initial)	ASTM D 790	> 735,000 psi
Flexural Modulus (long term)	ASTM D2990-01	> 520,000 psi
Density	87 ± pcf	
Chemical Resistance:	Severe Municipal Sewer: All types of service	

SpectraShield lining shall conform to the following minimum properties:

Compressive strength	ASTM D 1621	90-150 psi
Tensile strength	ASTM D 638	> 3,600 psi
Tear strength	ASTM D 624	550 pli
Bond	Substrate Failure	

Flexural Modulus (100%)		> 2,400 psi
Hardness (Shore D)	ASTM D2240	45
Density		4-10 pcf
Chemical Resistance:	Severe Municipal Sewer: All types of service	

3. When the wall of the resin based liner is to be structurally designed to withstand the hydraulic load generated by the groundwater table the long term (50yr) value of the flexural modulus of elasticity will be utilized to calculate the thickness of the structural liner. The initial flexural modulus of elasticity (short term) of the submitted resin material will be utilized with the long term deformation percentage as determined by ASTM D2990 (see below) in the design equation outlined in ASTM 1216-07b, Appendix X1. The value of the long term flexural modulus of the proposed product will be certified by an independent, certified, third party testing lab, independent of the Manufacturer and submitted with the bid package. The definition of long term value will be identified as initial flexural modulus of elasticity less the reduction in value caused by Creep over a fifty (50) year minimum period and verified by third party DMA testing (ASTM D2990). All design submittals will include this certified third party DMA testing (ASTM D2990) value in their respective design calculations for each structure being rehabilitated.
4. Unless dictated by the Owner or the Engineer, the finished corrosion lining will include the entire structure, including the bottom ceiling and any invert areas of the structure. The entire structure will be lined with the same material over the entire area of the structure.

C. PROTECTIVE LINING APPLICATION REQUIREMENTS

1. SprayWall® liner as manufactured by Sprayroq, Inc., shall have a minimum thickness of 250 mils.
2. SpectraShield liner as manufactured by CCI Spectrum, Inc shall have a minimum thickness of 500 mils.

D. PROTECTIVE LINING APPLICATION EQUIPMENT

1. Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective lining.

2.2 BENCH AND CHANNEL REPLACEMENT

- A. Concrete shall conform to the following ASTM standards: C-33; C-94; C-150; and C-494. Concrete shall have a 28 day cure strength of 4,500 psi and be resistant to weathering and abrasion.

2.3 WATER

- A. Water used to mix product shall be clean and potable and provided by the Contractor. Questionable water shall be tested by a laboratory per ASTM C-94 procedure.

PART 3 – EXECUTION

3.1 SEWER MANHOLE CLEANING

- A. Sewer manhole cleaning shall be performed as necessary to perform rehabilitation items as specified. It is recognized that there are some conditions such as deteriorated walls and major blockages that prevent cleaning from being accomplished or where additional damage would result if cleaning were attempted or continued. Should such conditions be encountered, the Contractor shall immediately notify the Engineer, who will decide whether to proceed with cleaning.
- B. Cleaning Precautions
 1. During manhole cleaning operations, satisfactory precaution shall be taken in the use of cleaning equipment. When hydraulic cleaning tools (which depend upon water pressure to provide their cleaning force) are used, precautions shall be taken to ensure that the water pressure created does not damage the manhole or cause flooding of public or private property being served by the sewer.
 2. Any foreign material, including sludge, mud, sand, gravel, rocks, bricks, grease, and other debris shall be removed from the manhole. The removal of debris shall be completed before any flushing of the manhole occurs. All debris shall be completely removed and not allowed to enter the sewer pipe. After the debris is completely removed, the manhole walls, invert and bench surfaces shall be flushed using a high velocity water gun (minimum 5,000 psi water spray), to complete the cleaning. Verification of the cleaning work will be by visual inspection by the Engineer.
 3. If all deposits have not been removed from the manhole, a 10% solution of muriatic acid will be applied by spraying from above the manhole. Manholes treated with acid solution shall be thoroughly flushed and the manhole allowed to dry. The mixing, application, and removal of the acid

solution shall be in strict accordance with the Manufacturers' specifications and recommendations. All safety procedures and protective devices applicable to the handling of the acid will be strictly adhered to.

4. Remove existing coatings prior to application of the new protective coating. Applicator is to maintain strict adherence to applicable NACE and SSPC recommendations with regard to proper surface preparation and compatibility with existing coatings.
5. All existing manhole steps within the manholes shall be removed or cut off flush with the wall surface.

3.2 MATERIAL REMOVAL

- A. Debris such as sludge, rocks, grease, and other solid or semisolid material resulting from the cleaning operation shall be removed at the manhole being cleaned by the use of vacuum or other suitable equipment. Passing material from sewer section to sewer section shall not be permitted. Placement of a temporary dam in the downstream manhole exit may be necessary to prevent debris from washing downstream.

3.3 DISPOSAL OF MATERIALS

- A. All solids or semisolids resulting from the cleaning operations shall be removed from the site and disposed of offsite. No additional payment shall be made for the removal and offsite disposal of materials resulting from cleaning operations

3.4 ENVIRONMENTAL CONDITIONS

- A. When freezing temperatures are expected, the Contractor shall take measures to keep applied materials warm and provide the required heat in the manhole before repair work is started and the 24 hour period following application. No application shall be made if ambient temperature is below 40 degrees Fahrenheit. No application shall be made to frozen surfaces or if freezing is expected to occur within the substrate within 24 hours after application. Precautions shall be taken to keep the temperatures at time of application below 90 degrees Fahrenheit. Water temperature shall not exceed 80 degrees Fahrenheit. Chill with ice if necessary.

3.5 SURFACE PREPARATION

- A. Each manhole shall be cleaned prior to the start of sealing operation, as described in Section 3.1 of this specification. The invert shall be covered during construction operations to prevent loose, extraneous materials from collecting in the invert and entering sewer lines. All loose, unsound, and protruding brick,

mortar and concrete shall be removed. Before application of each material, surfaces to be sprayed or coated will be inspected by the Owner or Engineer.

- B. Applicator shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Applicator shall notify Owner of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.
- C. All contaminants including: oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.
- D. All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.
- E. Surface preparation method(s) should be based upon the conditions of the substrate, service environment and the requirements of the resin protective coating to be applied.
- F. Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. Generally, this can be achieved with a high pressure water cleaning using equipment capable of 5,000 psi at 4 gpm. Other methods such as high pressure water jetting (refer to NACE Standard No. 5/SSPC-SP12), abrasive blasting, shotblasting, grinding, scarifying or acid etching may also be used. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the concrete. Whichever method(s) are used, they shall be performed in a manner that provides a uniform, sound clean neutralized surface that is not excessively damaged.
- G. Infiltration shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for topcoating with the specified protective coating. Flows should be totally plugged and/or diverted when coating the invert. All extraneous flows into the manhole at or above the area coated shall be plugged and/or diverted until the coating has set hard to the touch. As an option, hot air may be added to the manhole to accelerate set time of the coating.
- H. The area between the manhole and the manhole ring and any other area that might exhibit movement or cracking due to expansion and contraction, shall be grouted with a flexible grout or gel.
- I. Installation of the protective coating shall not commence until the concrete substrate has properly cured in accordance with these specifications.

- J. Temperature of the surface to be coated should be maintained between 50 degrees F and 120 degrees F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising (ie. late afternoon into evening vs. morning into afternoon).

3.6 APPLICATION OF REPAIR MATERIALS

- A. If using approved cementitious repair materials, such shall be troweled to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar.
- B. The repair materials shall be permitted to cure according to manufacturer recommendations. Curing compounds should not be used unless approved for compatibility with the specified protective coating.
- C. Application of the repair materials, if not performed by the coating certified applicator, should be inspected by the protective coating certified applicator to ensure proper finishing for suitability to receive the specified coating.
- D. After abrasive blast and leak repair is performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed by additional abrasive blast, shotblast or other approved method. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the approved coating.
- E. All surfaces should be inspected during and after preparation and before the protective coating is applied.

3.7 VOID REPAIR

- A. Patching of manhole walls shall be required in areas where large voids exist (greater than 2 inches in depth) including cracks, spalls in manhole walls, around steps, frames, pipes and mortar joints. All cracked or disintegrated material shall be removed from the area to be patched exposing a clean, sound substrate. Patching material shall be used as specified and water plug type materials shall not be used for general patching.

3.8 ACTIVE LEAK REPAIR

- A. Wall repair shall include the sealing of all visible leaks in the manhole with infiltration control material as specified. Weep holes shall be installed as required to localize infiltration during application of patching material or infiltration control material. Weep holes shall be plugged after material application with infiltration control material prior to application of protective coating material. Wherever heavy infiltration is present due to high ground water and cannot be reasonably stopped, 5/8" diameter holes will be drilled at intervals around the base of the manhole wall to relieve outside pressure. All pressure leaks shall be sealed with a rapid setting pressure grout that bonds both mechanically and chemically to saturated surfaces. Once the walls have been rehabilitated, the drilled holes shall be plugged as specified in Section 2.1 A of this specification.

3.9 BENCH AND CHANNEL REPLACEMENT

- A. Manholes will require bench and/or channel removal and replacement as indicated on the Drawings.
- B. Forming new manhole inverts shall provide a smooth, straight, and uniform flow line from the invert of the inlet pipe(s) to the invert of the outlet pipe. Where laterals are present, the system shall provide for a sanitary sweep into the main flow line.
- C. New concrete shall be placed to a minimum 2 inch thickness, over solid existing concrete base properly prepared as specified for manhole walls. Where solid concrete does not remain after preparation, new concrete shall be poured to a minimum 4 inch thickness. The new bench shall be tapered up to the manhole wall at a minimum slope of 4:1.
- D. Channel repair shall include patching of the invert, bench areas and sewer lines in the manholes using patching material in accordance with the Manufacturer's recommendations. The flow channel shall be checked for leaks, cracks, spalls or other discrepancies by plugging the upstream side and visually inspecting the channel. Repairs to the channel shall be made after the flow has been blocked and the invert cleaned. The patching material shall be uniformly troweled onto the damaged channel at a minimum thickness of ½ inch at the invert. Material shall be extended out onto bench of manhole to sufficiently tie into liner material. Repairs made to the channel shall create a smooth surface and provide for smooth flow through the manhole. Flow shall be established after a minimum of 30 minutes after application of patching material. All loose and deteriorated material shall be removed from the work site and properly disposed of by the Contractor.

3.10 APPLICATION OF PROTECTIVE LINING MATERIAL

- A. Application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.
- B. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.
- C. The protective coating material must be spray applied by a Certified Applicator of the protective coating manufacturer.
- D. Specified surfaces shall be coated by spray application of a solvent-free, 100% solids, polyurethane structural lining or 100% solids, silicone modified polyurea as further described herein.
- E. Airless spray application equipment approved by the coating manufacturer shall be used to apply each coat of the protective coating.
- F. If necessary, subsequent topcoating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

3.11 CURING

- A. Liner product shall be cured for a minimum of 1 hour before releasing sanitary sewer flows.
- B. After final application of the liner product, traffic shall be withheld 4 to 6 hours.

3.12 PRODUCT TESTING

- A. High Voltage Spark Test. After the protective coating has set hard to the touch it shall be inspected by the Contractor and witnessed by the Owner with high-voltage holiday detection equipment. This test is critical when applied to corrosion protection applications (i.e. mil coatings less than 250 mils). Surface shall first be dried, an induced holiday shall then be made on to the coated concrete or metal surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 100 volts per 1 mil (25 microns) of film thickness applied but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can

be hand applied to the repair area. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

- B. Adhesion Testing. The adhesion tests shall be performed by the Contractor on a minimum of one or 10% of all rehabilitated structures, which ever is greater, or as shown on the Plan and/or specified in the Special Provisions. Adhesion testing shall be conducted after the lining or coating system has cured per manufacturer instruction and in accordance with ASTM D4541 or ASTM 7234 as modified herein. Adhesion is critical for proper performance of a corrosion barrier (i.e. < 250 mils). A minimum of one 20 mm dolly shall be affixed to the lined surface of the structure at the upper section or cone area, mid section and at the bottom, unless otherwise specified in the Special Provisions. Each testing location shall be identified by the Owner. The adhesive used to attach the dollies to the liner shall be rapid setting with tensile strength in excess of the liner material and permitted to cure in accordance with manufacturer recommendations. The lining material and dollies shall be adequately prepared to receive the adhesive. Prior to pull test, the Contractor shall utilize a scoring device to cut through the coating until the substrate is reached. Extreme care shall be required while scoring to prevent micro cracking in the coating, since cracks may cause failures at diminished strengths. Failure due to improper dolly adhesive or scoring shall require retesting. The pull tests in each area shall meet or exceed 200 psi. and shall include subbase adhered to the back of the dolly or no visual signs of coating material in the test hole. Pull tests with results between a minimum 150 psi and 200 psi shall be acceptable if more than 50% of the subsurface is adhered to the back of the dolly. A test result can be discarded, as determined by the Owner, if there is a valid nonstatistical reason for discarding the test results as directed by Sections 8.4 and 8.5 of ASTM D4541 and ASTM 7234. If any test fails, a minimum of three additional locations in the section of the failure shall be tested, as directed by the Owner. If any of the retests fail, all loosely adhered or unadhered liner in the failed area, as determined by the Owner shall be removed and replaced at the Contractor's expense.

NOTE: The mil thickness will be measured and confirmed with the scored and pulled test samples. In structural repairs (partially or fully deteriorated design assumptions), it is critical to confirm the design thickness with the pulled sample as adhesion is not assumed in the ASTM 1216 design. The primary purpose of the pull test in structural rehabilitation is to confirm applied thickness, not adhesion. Any derived adhesion is further enhancement to the final installation strength of the rehabilitated structure.

3.12 QUALITY CONTROL TESTING

- A. Once all manholes have been sealed and the proper curing time for the waterproofing materials has elapsed, the manholes shall be visually inspected by viewing from street level for the elimination of infiltration by the Contractor in the presence of the Owner. The inspection shall be performed at the discretion of

the Owner during the warranty period following rainfall sufficient to raise the ground water table above the problem areas. All leakage problems determined by this inspection shall be corrected by the Contractor within an agreed upon time, to the satisfaction of the Owner, at no additional cost.

END OF SECTION

SECTION 02570

MONOLITHIC OR SECTIONAL PRECAST CONCRETE VAULT STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

- A. As an option to cast-in-place construction, the Contractor may furnish all labor, materials, equipment, and incidentals required to install rectangular, monolithic, or sectional precast vault structures as specified herein.

1.2 RELATED SECTIONS

- A. Section 02200 – Earthwork

1.3 REFERENCES

- A. Prestressed Concrete Institute. Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
- B. National Precast Concrete Association. Quality Control Manual for Precast Concrete Plants.
- C. American Society for Testing and Materials (ASTM)
 - 1. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - 2. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
 - 3. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
 - 4. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipe and Laterals.
 - 5. ASTM C913 - Standard Specifications for Precast Concrete Water and Wastewater Structures.
- D. American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318).

- E. Occupational Safety and Health Administration Standard 1926.704 - Requirements for Precast Concrete.

1.4 SUBMITTALS SHALL BE AS FOLLOWS

- A. Copy of certificate or report showing that the precast concrete manufacturer conforms to Article 1.5 - Qualifications.
- B. Schedule of precast concrete structure sections to be provided on the project, charting the following items, when applicable:
 - 1. Sheet number where the precast structure plan and profile is shown on the plans.
 - 2. Line number (when there is more than one line on the project).
 - 3. Precast structure station number.
 - 4. Top elevation of the precast structure frame as indicated on the plans.
 - 5. Top elevation of precast structure base slab as calculated.
 - 6. Total height of precast structure required from top of base slab to top of frame.
 - 7. Total height of assembled base, risers, and cone or top provided from top of base to top of top.
 - 8. Manufacturer's part number or catalog number and number required of each base, riser, and top provided for the precast structure.
 - 9. Each pipe size and type and its connector's part number, distance from top of base slab, and horizontal distances from inner wall corners of precast structure.
- C. Detail of each precast concrete structure section to be provided showing or charting the following:
 - 1. Manufacturer's part number or catalog number.
 - 2. Inside dimensions.
 - 3. Lay length excluding base slab.
 - 4. Wall thickness and base or top thickness where applicable.

5. Handling weight.
 6. Wire size, spacing, and area provided per vertical foot.
 7. Reinforcing bar size and spacing.
 8. Design loads.
 9. Concrete mix number and design strength.
 10. Height, width, slope, and annular space of the tongue and groove.
- D. Pipe connector details and material specifications.
- E. Joint material detail, material specifications and calculations showing that the joint material cross section is greater than the joint's annular space times its height.
- F. Lifting device and hole detail.
- G. Submit structural analysis and design calculations for precast components, performed in accordance with applicable codes and standards, showing that allowable stresses will not be exceeded. All calculations must be signed and sealed by the qualified professional Engineer responsible for their preparation and registered in the state in which the project is located.
- H. Submit the following at the request of the Engineer or Owner:
1. Calculations or test results verifying that the lifting device components and holes are designed in accordance with OSHA Standard 1926.704.
 2. Concrete 28-day compression strength results for every day production of precast components for the project was performed showing the required strength according to the guidelines established in ACI 318.
 3. Reinforcing and cement mill reports for materials used in the manufacture of precast components for this project.
 4. The above test reports for similar precast components recently produced, submitted prior to production of precast components for this project.

1.5 QUALIFICATIONS

- A. The precast Manufacturer shall comply with one of the following requirements:
 - 1. Manufacture precast components for the project in a plant certified in the Prestressed Concrete Institute's (PCI) Plant Certification Program.
 - 2. Manufacture precast components for the project in a plant certified in the National Precast Concrete Association's (NPCA) Plant Certification Program.
 - 3. Retain an independent testing or consulting engineering firm approved by the Engineer for precast plant inspection. The basis for plant inspection shall be the National Precast Concrete Association Quality Control Manual or the Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products. The above firm shall inspect the precast plant 2 weeks prior to and at 1 week intervals during production of materials for this project and issue a report, certified by a registered engineer that materials, methods, products, and quality control meet the requirements of the above quality control manuals.
- B. The precast Manufacturer shall have a recognized quality improvement process installed at the manufacturing facility.
- C. The precast Manufacturer shall provide engineering certification as to the structural adequacy of any precast component, if requested.
- D. All concrete compressive strength testing shall be performed in a laboratory inspected by the CCRL of the National Bureau of Standards.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 50 F prior to, during, and 48 hours after completion of masonry, grouting or concreting work.

1.7 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the Lump Sum Price for the precast concrete option of Manhole Junction Structure Manhole No. 1 & No. 8.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete shall conform to ASTM C478 and as follows:

1. Compressive Strength: 5,000 psi minimum at 28 days.
2. Air Content: 4 percent minimum.
3. Alkalinity: Adequate to provide a life factor, $A_z = \text{Calcium carbonate equivalent times cover over reinforcement}$, no less than 0.35 for bases, risers and tops.
4. Cementitious Materials: Minimum of 564 pounds per cubic yard.
5. Coarse Aggregates: ASTM C33. Sound, crushed, angular stone only. Smooth or rounded stone shall not be used.
6. Fine Aggregates: ASTM C33. Free from organic impurities.
7. Chemical Admixtures: ASTM C494. Calcium chloride or admixtures containing calcium chloride shall not be used.
8. Air Entraining Admixtures: ASTM C260.
9. Waterproofing Admixture for Concrete
 - a. Admixture – cementitious, capillary waterproofing admixture which, when added at the approximate dosage rate of 1% by weight of cement (0.8% minimum), will create a crystalline growth in the pores, capillary tracts, and bleed water tracks of the concrete.
 - b. Manufacturer – Penetron (ICS Penetron International), or Xypex Chemical Corp.

B. Reinforcing steel shall be ASTM A615 Grade 60 deformed bar, ASTM A82 wire or ASTM A185 welded wire fabric.

C. Lifting loops shall be ASTM A416 steel strand. Lifting loops made from deformed bars shall not be allowed.

D. Butyl rubber sealant shall conform to Federal Specification SS-S-210A, AASHTO M-198, Type B - Butyl Rubber and as follows: maximum of 1% volatile matter and suitable for application temperatures between 10 and 100 F.

- E. Butyl rubber with bentonite sealant shall conform to Federal Specification SS-S-210A, ASTM D-297, and containing no asphaltics as follows: maintaining 99% solids with a maximum of 1% volatile matter and suitable for application temperatures between 5 and 125 F.
- F. Epoxy gels used for interior patching of wall penetrations shall be a 2-component, solvent-free, moisture-insensitive, high modulus, high-strength, structural epoxy paste adhesive meeting ASTM C881, Type I and II, Grade 3, Class B and C, Epoxy Resin Adhesive.

2.2 COMPONENTS

- A. Precast component fabrication and manufacture shall be as described in this paragraph and as described in the paragraphs for the specific components.
 - 1. Precast structures shall be manufactured in conformance with ASTM C913. Wall and inside slab finishes resulting from casting against forms standard for the industry shall be acceptable, except form ties through the wall of the product are not allowed. Exterior slab surfaces shall have a float finish. Small surface holes, normal color variations, normal form joint marks, minor depressions, chips and spalls will be tolerated. Dimensional tolerances shall be those set forth in the appropriate references and specified below.
 - 2. Joint surfaces for joints between precast structure components shall be keyways or tongue and grooves manufactured to the joint surface design and tolerance requirements of ASTM C913.
 - 3. Lift holes and inserts used for handling precast structures shall be sized for a precision fit with the lift devices, shall not penetrate through the precast structure wall, and shall comply with OSHA Standard 1926.704.
 - 4. The Contractor shall coordinate with the manufacturer for the installation of wall pipe, door frames, and any other embedded items, prior to casting base, walls, and top slabs.
- B. Precast base sections shall have the base slab cast monolithically with the walls, or have an approved galvanized or PVC waterstop cast in the cold joint between the base slab and the walls.
- C. Precast riser sections. The minimum lay length of precast riser sections shall be 36 inches.
- D. Precast top sections. Flat slab top sections shall be designed for a minimum superimposed live load of 300 psf in accordance with ACI 318 and ASTM C890.

- E. Joints shall be sealed internally between the tongue and the groove and additionally around the external perimeter of the joint as follows:
 - 1. External seals shall consist of a polyethylene backed flat butyl rubber sheet no less than 1/16-inch thick and 6 inches wide applied to the outside perimeter of the joint.
 - 2. Joints with a perimeter greater than or equal to 18 feet shall be internally sealed with butyl rubber/bentonite sealant.
 - 3. Joints with a perimeter less than 18 feet shall be internally sealed with butyl rubber sealant.
- F. Manhole rings, covers, hatches and doors, frames and grate to be provided as equal to those shown on the precast structure details. Materials shall be cast iron, steel, or aluminum as conforming to details per application. For dimensions of castings see precast top details.
- G. Lifting devices complying with OSHA Standard 1926.704 for handling the precast components shall be provided by the precast manufacturer. The design of lifting devices shall comply with ASTM C913, Paragraph 5.8 standards.
- H. The interior/exterior of the precast structure wall shall be coated with 21 mils of coal tar epoxy, Koppers 300M or equal, where shown on the plans. The coating shall be spray applied according to the manufacturer's recommendations by an applicator with a minimum of 5 years experience. The joints between precast sections shall not be coated. Use joint sealant as specified above to seal the interior horizontal joint surface.

2.3 CONFIGURATION

- A. Precast concrete structures are to be constructed as specified and as shown on the detail drawings.
- B. The number of joints shall be minimized. Use no more than two (2) sections up to 8 feet of depth and no more than one additional section for each 4 feet of depth.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Inspect precast components prior to unloading from the delivery truck.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate delivery with the Manufacturer. Handle and store the precast components in accordance with ASTM C891 and the Manufacturer's recommendations using methods that will prevent damage to the components and their joint surfaces.

3.3 PLACING PRECAST CONCRETE SECTIONS

- A. Excavate the required depth and remove materials that are unstable or unsuitable for a good foundation. Prepare a level, compacted foundation extending 6 inches beyond the precast base and follow ASTM C891 excavation standards.
- B. Set base plumb and level, aligning pipe opening with pipe invert.
- C. Set risers and tops, aligning internal wall surfaces, so that proper alignment is achieved taking particular care to clean, prepare, and seal joints.
- D. Connect piping as indicated on Drawings.
- E. Fill the void between horizontal joint surfaces with a sand cement grout around the outside perimeter, when recommended by the Manufacturer.
- F. After joining sections, apply the butyl sealant sheet around the outside perimeter of the joint.
- G. Lift holes leaving less than 2 inches of wall thickness shall be plugged from the outside using a sand cement mortar. Lift holes penetrating the wall shall be additionally sealed with an interior application of an epoxy gel 1/8 inch thick extending 2 inches beyond the penetration.
- H. Perform the final finishing to the manhole interior by filling all chips or fractures greater than ½ inch in length, width or depth and depressions more than ½ inch deep in inverts with a sand cement mortar. Grout joints according to manufacturer's specifications. Clean the interior of the precast structure, removing all dirt, spills, or other foreign matter.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. This section specifies cast-in-place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplemental Conditions or General Provisions and Division 1 specification sections, apply to this section.

1.3 QUALITY ASSURANCE

- A. Codes and Standards. Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:
 - 1. ACI 318, "Building Code Requirements for Reinforced Concrete."
 - 2. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice."
- B. Concrete Testing. The Owner will engage an independent testing laboratory to conduct testing of materials and concrete to ensure compliance with this Specification.
- C. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting, of rejected materials or installed work which fails its initial testing, shall be done at Contractor's expense.

1.4 SUBMITTALS

A. SHOP DRAWINGS AND ENGINEERING DATA

- 1. Submit complete shop drawings and engineering data to the Engineer in accordance with the requirements of the Supplemental Specifications.
- 2. Product data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching

compounds, waterstops, joint systems, curing compounds, and others as requested by Engineer.

3. Shop drawings for reinforcement, describing the fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures. Splices, clearances, and tolerances shall comply with ACI 318 requirements.
4. Shop drawings for formwork, prepared by a registered professional engineer, for fabrication and erection of forms for suspended slabs, beams, and other elevated concrete elements.
 - a. Engineer's review is for general design compliance only. Design of formwork for structural stability and efficiency is Contractor's responsibility.
5. Laboratory test reports for concrete materials and mix design test.
6. Materials certificates for the items listed below. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with or exceeds specified requirements. Provide certification for admixture manufacturers that chloride content complies with specification requirements.
 - a. Aggregates.
 - b. Cement.
 - c. Admixtures.
 - d. Reinforcement (including welds).
 - e. Curing compounds.
 - f. Waterstops.
 - g. Bonding compounds.

1.5 GUARANTEE

- A. Provide a guarantee against defective products and workmanship.

1.6 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment will be allowed for this work. Payment for all work performed under this section shall be included in other items of work.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete. Plywood, metal, metal-framed plywood-faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on Drawings.
 - 1. Use overlaid plywood complying with U.S. Product Standard PS-1 "A- C or B-B High Density Overlaid Concrete Form," Class 1.
 - 2. Plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood," Class 1, Exterior Grade or better, mill-oiled and edge-sealed, with each piece bearing legible inspection trademark.
- B. Forms for Unexposed Finish Concrete. Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Forms for Cylindrical Columns and Supports. Metal, fiberglass-reinforced plastic, or paper or fiber tubes. Provide paper or fiber tubes of laminated plies with water-resistant adhesive and wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.
- D. Form Coatings. Provide commercial formulation form-coating compounds with a maximum VOC of 350 mg/l that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- E. Form Ties. Factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal. Provide units that will leave no metal closer than 1-1/2 inches to exposed surface. Provide ties that, when removed, will leave holes not larger than 1 inch diameter in concrete surface.

2.2 REINFORCING MATERIALS

- A. Reinforcing Bars. ASTM A 615, Grade 60, deformed unless noted otherwise.
- B. Steel Wire. ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric. ASTM A 185, welded steel wire fabric.

- D. Supports for Reinforcement. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire-bar-type or plastic supports complying with CRSI specifications.
1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.
 2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).
 3. Bricks or similar objects will not be allowed for use as reinforcement supports.

2.3 CONCRETE MATERIALS

- A. Portland Cement. ASTM C 150, Type I.
1. Use one brand of cement throughout project unless otherwise acceptable to the Engineer.
- B. Fly Ash. ASTM C 618, Type C or Type F.
- C. Normal Weight Coarse Aggregate. ASTM C 33, Class Designation 3S, Grading Size No. 57, and as herein specified. Provide coarse aggregate from a single source for all exposed concrete.
- D. Normal Weight Fine Aggregate. Natural siliceous river sand, consisting of hard, clean, sharp, strong, durable, and uncoated particles, conforming to the requirements of ASTM C 33.
- Fine aggregate shall have a fineness modulus of 2.40 minimum and 3.00 maximum and the material passing the No. 200 sieve shall not exceed 3.0 percent by weight of the total sample. Coal and lignite shall not exceed 0.5 percent by weight of the total sample for all concrete. The fineness modulus of fine aggregate incorporated in the work shall not vary more than 0.10 plus or minus from the fineness modulus of the fine aggregate in the appropriate preliminary mix design approved by the Engineer.
- E. Water: Drinkable.
- F. Admixtures, General. Provide admixtures for concrete that contain not more than 0.1 percent chloride ions.
1. Available Manufacturers: Provide admixtures from single source manufacturer for air entrainment and water reducing admixtures.

Manufacturers of admixtures shall include but not be limited to the following, provided single source availability requirements are met:

- a. Master Builders, Inc.
 - b. W. R. Grace and Company.
 - c. Euclid Chemical Company.
2. Air-Entraining Admixture. ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
 3. Water-Reducing Admixture: ASTM C 494, Type A.
 4. High-Range Water-Reducing Admixture (Super Plasticizer). ASTM C 494, Type F or Type G.
 5. Water-Reducing, Accelerating Admixture. ASTM C 494, Type E. Accelerating admixtures must be nonchloride type and are for use only when specifically authorized by the Engineer. Submittal of separate mix design using accelerating admixture will be required.
 6. Water-Reducing, Retarding Admixture. ASTM C 494, Type D. Retarding admixtures must be nonchloride type and are for use only when specifically authorized by the Engineer. Submittal of separate mix design using retarding admixture will be required.

2.4 RELATED MATERIALS

- A. Waterstops. Provide waterstops at construction joints and other joints as indicated on the Drawings.
 1. Polyvinyl Chloride Waterstops. Corps of Engineers CRD-C 572.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
 - 1) The Burke Company.
 - 2) Greenstreak Plastic Products Company.
 - 3) W. R. Meadows, Inc.
 - 4) Vinylex Corp.
 - b. PVC water stops shall be ribbed with a minimum nominal width of 6 inches and a minimum nominal thickness of 3/16 inches. Control joints shall utilize dumbbell type water stop.
 2. Bentonite Clay Waterstops. Specially formulated joint sealant, manufactured in coils with a rectangular cross section, which swells upon

contact with water. Adhesive supplied by the water stop manufacturer shall be used to secure the waterstop to existing concrete prior to placing adjoining concrete.

- a. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, "Waterstop-RX," American Colloid Company.
- B. Granular Base. Evenly graded mixture of fine and coarse aggregates to provide, when compacted, a smooth and even surface below slabs on grade.
- C. Sand Cushion. Clean, manufactured or natural sand.
- D. Vapor Barrier. Multi-ply lamination of polyethylene film and glass scrim reinforced paper to form a moisture, scuff, and puncture-resistant membrane. Moisture permeance shall not exceed 0.10 perms in accordance with ASTM E 96, Procedure A.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Moistop," St. Regis Paper Company.
 - b. "Plybar," Glas-Kraft.
- E. Liquid Membrane-Forming Curing Compound. Liquid-type membrane-forming curing compound with fugitive dye complying with ASTM C 309, Type I-D, Class A. Moisture loss not more than 0.055 gr./sq. cm. when applied at 200 sq. ft./gal.
1. Available Products: Subject to compliance with requirements, manufacturers whose products may be incorporated in the work include, but are not limited to, the following:
 - a. Dayton Superior Corp.
 - b. Euclid Chemical Co.
 - c. Sonneborn-Rexnord.
- F. Epoxy Bonding Agent. ASTM C 881, two-component material suitable for use on dry or damp surfaces. Provide material "Type," "Grade," and "Class" to suit project requirements.
1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Burke Epoxy M.V.," The Burke Company.
 - b. "Euco Epoxy System #452 or #620," Euclid Chemical Co.

- c. "Sikadur 32 Hi-Mod," Sika Corporation.
- G. Chemical Hardener. U.S. Army Corps of Engineers Specification 204, liquid hardener composed of magnesium and zinc fluorosilicates combined with an anionic surfactant to improve wetting penetration. Hardener to be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent topping and/or coatings. Install hardener in accordance with manufacturer's recommendations on interior concrete floors of shops, garages, vehicle service areas, and elsewhere as indicated on the Drawings.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
 - a. "Lapidolith," Sonneborn.
- H. Joint Filler. At joints in slabs and elsewhere as indicated on the Drawings, use preformed strips of asphalt saturated fiberboard (½-inch nominal thickness) complying with ASTM D 1751.
- I. Epoxy Grout. Epoxy grout for installing rubber form tie plugs shall be as follows:
 - 1. Sikadur 32 Hi-Mod, Sika Corporation.

2.5 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to the Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
 - 1. Fly ash may be substituted for cement in amounts not to exceed 20 percent of the specified cement content by weight providing that the mix conforms with all other requirements.
- B. Submit written reports to the Engineer of each proposed mix for each class of concrete at least 15 days prior to start of concrete placement. Do not begin concrete production until proposed mix designs have been reviewed by the Engineer.
- C. Design mixes to provide normal weight concrete with the following properties:

Property	Concrete Class		Controlled Density Fill
	A	B	
28-day Compressive Strength:			
Average of Three Consecutive Specimens	4,000 psi	2,500 psi	-
Minimum Any One Specimen	3,200 psi	2,000 psi	-
Minimum Cement Content (sacks/cubic yard)	6.5	5.0	100 lbs
Maximum Water-to-Cement Ratio:			
By Weight (pound/pound)	0.49	0.54	0.86
By Sack (gallon/sack)	5.5	6.0	
Air Content (percent by volume):			
Minimum	4.5	4.5	1.0
Maximum	5.5	5.5	3.0
Ratio of Coarse to Fine Aggregate (by weight):			
Minimum	1.0	1.0	-
Maximum	2.0	2.5	-
Fly Ash	See 2.5.A.1	See 2.5.A.1	600 lbs
Fine Aggregate			2092 lbs

Class "A" concrete shall be used for all concrete work unless Class "B" is specifically called for on the Drawings. "CDF" as noted on drawings

- D. Adjustment to Concrete Mixes. Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as accepted by the Engineer. Laboratory test data for revised mix design and strength results must be submitted to and accepted by The Engineer before using in work.

2.6 ADMIXTURES

- A. Use water-reducing admixture or high-range water-reducing admixture (Superplasticizer) in all concrete.
- B. Use nonchloride accelerating admixture in concrete placed at ambient temperatures below 50°F (10°C) when authorized by the Engineer.
- C. Use high-range water reducing admixture (HRWR) in pumped concrete.

- D. Admixtures. Use admixtures for water reduction and set control in strict compliance with manufacturer's directions.

2.7 SLUMP LIMITS

- A. Proportion and design mixes to result in concrete slump at point of placement as follows:
 - 1. Ramps, slabs, and sloping surfaces: Not more than 3 inches.
 - 2. Walls and Columns: 3 to 4 inches.
 - 3. Floors and slabs: 3 to 4 inches.
 - 4. Beams: 3 to 4 inches.
 - 5. Blocks and Footings: 2 to 4 inches.

Concrete having a slump greater than 1 inch over the specified maximum shall be rejected.

- B. Pumped Concrete. The maximum slump of the concrete at the suction of the pump may be increased above the maximum slumps specified in 2.7 A. by the addition of high range water reducing agent at the jobsite in accordance with the manufacturer's recommendations. The adjustment to the slump shall be only that required to overcome the slump loss in the pumping equipment. In no circumstance shall the slump exceed 6 inches at the suction or discharge of the pump.
- C. Congested Placement. When specifically requested in writing by the Contractor and approved by the Engineer, increases in discharge slumps may be considered in placements that include congested areas of reinforcement or areas otherwise deemed to be difficult to place concrete and achieve necessary consolidation. The increases in slump, if approved, shall be achieved by the addition of high range water reducing agent at the site in accordance with the manufacturer's instructions. The request shall include the proposed amount of slump increase and the amount of high range water reducer to be added. The Engineer will evaluate each request independently.

2.8 CONCRETE MIXING

- A. Job-Site Mixing. Only allowed when specifically authorized by the Engineer.
- B. Ready-Mix Concrete. Comply with requirements of ASTM C 94, and as specified.
 - 1. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

2.9 EPOXY ANCHORS AND DOWELS

- A. Anchors. Unless shown otherwise, dowels or anchors placed in existing or hardened concrete shall be stainless steel Type 316 ASTM F 593 and ASTM F 594, threaded rod with hex nuts.
- B. Epoxy adhesive shall be as follows:
 - 1. Two component, 100% solid (containing no solvents), non-sag paste, insensitive to moisture, gray in color.
 - 2. Conform to NSF Standard 61 for use in conjunction with drinking water systems.
 - 3. Conform to ASTM C 881-90; Type IV; Grade 3; Class A, B, and C with the exception of gel time.
 - 4. Maximum shrinkage during cure per ASTM D 2566 of 0.00051 in./in.
 - 5. Compressive strength, ASTM D 695: 10,300 psi minimum.
 - 6. Shelf life: 3 years minimum.
 - 7. Water solubility: None.
 - 8. Heat deflection temperature, ASTM D648: 140°F minimum.
 - 9. Epoxy adhesive shall be Epcon C-6, manufactured by ITW Ramset.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate the installation of joint materials and vapor barriers with placement of forms and reinforcing steel.

3.2 FORMS

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

- B. Construct forms to sizes, shapes, lines, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
- C. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
- D. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- E. Chamfer exposed corners and edges at 3/4 inch unless indicated otherwise on the Drawings, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- F. Provisions for Other Trades. Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing such items. Accurately place and securely support items built into forms.
- G. Cleaning and Tightening. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.3 VAPOR BARRIER INSTALLATION

- A. General. Following leveling and tamping of granular base for slabs on grade, place vapor barrier sheeting with longest dimension parallel with direction of pour.
- B. Lap joints 6 inches and seal vapor barrier joints with manufacturers' recommended mastic and pressure-sensitive tape.

3.4 PLACING REINFORCEMENT

- A. General. Comply with ACI 318 and the CRSI's recommended practice for "Placing Reinforcing Bars," for details and methods of reinforcement placement and supports and as herein specified.
 - 1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
 - 2. Field bending of reinforcement using heat and/or welding of reinforcement is NOT permitted.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved by The Engineer.
- D. Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
 - 1. All bars on face of concrete cast against earth shall have 3 inches clear cover.
 - 2. All bars on face of concrete exposed or otherwise not cast against earth shall have clear cover as follows:
 - a. Bars No. 5 and smaller shall have 1.5 inches clear cover.
 - b. Bars No. 6 and larger shall have 2 inches clear cover.
- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Install dowels into existing concrete using EPCON C-6 ceramic epoxy as indicated on the Drawings and conforming to the provisions of this section.

3.5 JOINTS

- A. Construction and Control Joints. Locate and install construction and control joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure, as acceptable to The Engineer.
 - 1. Provide keyways at least 1-1/2 inches deep with a width of approximately one-half the thickness of the thinnest section being joined at construction and control joints in walls, slabs, between walls and slabs, and between

walls and footings unless otherwise indicated. Acceptable bulkheads designed for this purpose may be used for slabs.

2. Place construction and control joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated. Do not continue reinforcement through sides of strip placements or at control joints.
 3. Use bonding agent on existing concrete surfaces that will be joined with fresh concrete at construction joints.
 4. Wall and Structural Slab Construction Joints. Provide construction joints in walls and structural slabs as indicated or as specified herein if not indicated. Construction joints shall be placed in walls and structural slabs at intervals indicated on the Drawings or at intervals not exceeding 48 feet in any direction if not indicated on the Drawing unless authorized by the Engineer.
- B. Waterstops. Provide waterstops in construction and control joints as indicated. Install waterstops to form continuous diaphragm in each joint in strict accordance with manufacturer's instructions. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions.
- C. Isolation Joints in Slabs-on-Ground for Floors of Buildings, Sidewalks, and Driveways. Construct isolation joints in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated. Construct isolation joints using preformed joint filler board.
- D. Contraction Joints in Slabs-on-Ground for Floors of Buildings, Sidewalks, and Driveways. Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use saw cuts 1/8 inch wide by 1/4 of slab depth or inserts 1/4 inch wide by 1/4 of slab depth, unless otherwise indicated.
1. Form contraction joints by inserting premolded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. Tool slab edges round on each side of insert. After concrete has cured, remove inserts and clean groove of loose debris.
 2. Begin saw cutting of contraction joints in floor slabs as soon as possible after slab finishing as may be safely done without dislodging aggregate. Saw cutting must be completed within 8 hours following slab placement.
 3. If joint pattern is not shown, provide joints not exceeding 15 feet in either direction and locate to conform to bay spacing wherever possible (at column centerlines, half bays, third bays).

3.6 INSTALLATION OF EMBEDDED ITEMS

- A. General. Set and build into work anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached thereto.
- B. Forms for Slabs. Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting-type screeds.

3.7 PREPARATION OF FORM SURFACES

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

3.8 CONCRETE PLACEMENT

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

1. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.
 2. One operable, back-up, mechanical vibrator shall be on site prior to beginning concrete placement.
 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.
- E. Placing Concrete Slabs. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
 3. Maintain reinforcing in proper position during concrete placement.
- F. Cold-Weather Placing. If permitted by the Engineer, comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When air temperature has fallen or is expected to fall below 40°F (4 C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F (10°C) and not more than 80°F (27°C) at point of placement.
 3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 4. Do not place concrete on or against any formwork that has an accumulation of ice or snow. Remove ice or snow by manual means and by melting with heat. Do not melt snow or ice by the application of melting agents or chemicals.

5. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators unless authorized by the Engineer.
 6. Provide adequate means for maintaining the temperature of the air surrounding the concrete at 70°F for three days, or 50°F for five days, or for as long as is necessary to ensure proper curing of the concrete. Rapid cooling of the concrete shall be prevented. Housing, covering, or other protection used in connection with heating shall remain in place and intact at least 24 hours after the artificial heat is discontinued.
- G. Hot-Weather Placing. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 85°F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water. Use of liquid nitrogen to cool concrete is Contractor's option.
 2. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
 3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
 4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, when acceptable to The Engineer.

3.9 FINISH OF FORMED SURFACES

- A. Coordinate finish requirements with surface preparation requirements for concrete to be coated in accordance with Section 09900, Painting.
- B. Provide rough form finish for formed concrete surfaces not exposed to view in the finish work or concealed by other construction. This is the concrete surface having texture imparted by form-facing material, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.
- C. Provide smooth form finish for formed concrete surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing,

veneer plaster, painting, or other similar system. This is an as-cast concrete surface obtained with selected form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

- D. Grout-Cleaned Finish. Provide grout-cleaned finish as follows to concrete surfaces that have received smooth form finish treatment not to be coated with paint, waterproofing, dampproofing, or other similar system.
1. Combine one part portland cement to 1-1/2 parts fine sand by volume, and a 50:50 mixture of acrylic-based bonding admixture and water to consistency of thick paint. Blend standard portland cement and white portland cement, amounts determined by trial patches, so that final color of dry grout will match adjacent surfaces.
 2. Thoroughly wet concrete surfaces, apply grout to coat surfaces, and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.
- E. Related Unformed Surfaces. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 MONOLITHIC SLAB FINISHES

- A. Coordinate finish requirements with surface preparation requirements for concrete to be coated in accordance with Section 09900, Painting.
- B. Float Finish. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified; slab surfaces to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo; and as otherwise indicated.
1. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating, using float blades or float shoes only, when surface water has disappeared, when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance of plus or minus 1/4-inch as measured from a 10-foot straight edge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

- C. Trowel Finish. Apply trowel finish to monolithic slab surfaces to be exposed to view and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
- D. Trowel and Fine Broom Finish. Where ceramic or quarry tile is to be installed with thin-set mortar, apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
- E. Nonslip Broom Finish. Apply nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen concrete surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with The Engineer before application.

3.11 CONCRETE CURING AND PROTECTION

- A. General. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation-control material. Apply in accordance with manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- B. Initial Curing. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.
- C. Curing Methods. Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified. Select curing method appropriate for subsequent coating and finishing requirements. Coordinate curing methods with Section 09900, Painting, for concrete to be painted.
 - 1. Provide moisture curing by either of the following methods or combination thereof, maintaining concrete surface moisture for seven days:
 - a. Keep concrete surface continuously wet by covering with water.
 - b. Use continuous water-fog spray.
 - c. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
 - 2. Moisture-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or

adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape. Maintain concrete surface moisture for seven days.

2. Curing and sealing compound, when utilized, shall be applied as follows:
 - a. Flatwork: Apply curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - b. Use membrane curing compounds that will not affect surfaces to be covered with finish materials applied directly to concrete.
 - c. Formed Surfaces: Apply curing and sealing compound upon removal of form work.
4. Curing Formed Surfaces. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces, by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.
5. Curing Unformed Surfaces. Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces, by application of appropriate curing method.
 - a. Cure concrete surfaces to receive liquid floor hardener or other finish by use of moisture-retaining cover, unless otherwise directed.

3.12 REMOVAL OF FORMS

- A. General. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50°F (10°C) for 72 hours after placing concrete, provided curing and protection operations are maintained.
- B. Formwork supporting weight of concrete, such as beams, soffits, joists, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained at least 75 percent of design minimum compressive strength at 28 days. Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.

- C. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.

3.13 REUSE OF FORMS

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

3.14 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In. Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.
- B. Curbs. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations. Provide machine and equipment bases and foundations, as shown on Drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment. Anchor bolts set into existing concrete shall utilize EPCON C-6 ceramic epoxy.
- D. Reinforced Masonry. Provide concrete grout for reinforced masonry lintels and bond beams where indicated on Drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.
- E. Concrete Embedment and Encasement of Pipe. Install concrete for embedment and encasement where indicated on the Drawings and at such locations where installation conditions require such pipe support as determined by the Engineer. Embedment and encasement of pipe shall be preceded by the following preliminary steps:

1. Remove all loose material from the trench prior to placing concrete. All concrete shall have a continuous contact with undisturbed soil on sides and bottom of trench.
2. Accurately place a base course of concrete to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of the base course.
3. Restrain each length of pipe to maintain alignment and prevent floatation in a manner acceptable to the Engineer.

3.15 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas. Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to The Engineer.
 1. Cut out honeycomb, rock pockets, voids over 1/4-inch in any dimension, and holes left by tie rods and bolts, down to solid concrete but in no case to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar before bonding compound has dried.
 2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.
- B. Repair of Formed Surfaces. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of The Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry-pack mortar, or precast cement cone plugs secured in place with bonding agent.
 1. All tie holes shall be filled with non-shrink grout a minimum of 1.5 inches in depth from each surface.
 2. Tie holes from tie systems using through-the-wall bolts shall be plugged using rubber plugs manufactured for use with form tie systems. Plugs shall be set in place as instructed by the manufacturer. After setting plugs, fill hole with epoxy grout to within 1.5 inches of the formed surface on each side of the plug.

3. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.
- C. Repair of Unformed Surfaces. Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope.
1. Repair finished unformed surfaces that contain defects that affect durability of concrete. Surface defects, as such, include crazing and cracks in excess of 0.01-inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
 2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
 3. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound. Finish repaired areas to blend into adjacent concrete.
 4. Repair defective areas, except random cracks and single holes not exceeding 1-inch-diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- D. Repair isolated random cracks and single holes not over 1-inch-diameter by dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry-pack before bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.
- E. Perform structural repairs with prior approval of The Engineer for method and procedure, using specified epoxy adhesive and mortar.

- F. Repair methods not specified above may be used, subject to acceptance of The Engineer.

3.16 QUALITY CONTROL TESTING DURING CONSTRUCTION

- A. General. The Owner will employ a testing laboratory to perform tests and to submit test reports.

- B. Field Sampling and Testing. During concreting operations, the Engineer will periodically require additional field inspection, sampling, and testing of cement, aggregate, and/or concrete by an independent testing laboratory in order to determine if the requirements of this specification section are being satisfied.

- 1. Field sampling and testing of cement, aggregate, and concrete will be performed according to the following ASTM standards at a frequency determined by the Engineer:

- a. Aggregate
 - 1) Sampling ASTM D 75
 - 2) Testing Any test specified in ASTM C 33

- b. Cement
 - 1) Sampling ASTM C 183
 - 2) Testing Any test specified in ASTM C 150

- c. Concrete
 - 1) Sampling ASTM C 172
 - 2) Slump Test ASTM C 143
 - 3) Air Content Test ASTM C 231
 - 4) Making and Curing Test Cylinders ASTM C 31
 - 5) Compression Strength Tests ASTM C 39

- 2. Compressive strength testing will consist of making, curing, and testing cylinders of concrete. A total of six test cylinders will be prepared from each sample of concrete to be tested. Two test cylinders will be broken at an age of 7 days, three test cylinders will be broken at an age of 28 days, and the remaining test cylinders will be held in reserve. The minimum number of samples and test cylinders to be taken is as follows:

Total Size of Pour (CY)	Number of Samples	Number of Cylinders
1 – 100	1	6
101 – 200	2	12
201 - 300	3	18
Over 300	1/100 CY	6/100 Cy

3. Test cylinders will normally be laboratory-cured. However, the Engineer may require tests on field-cured specimens to check the adequacy of curing operations.
 4. A slump test and an air content test will be performed on each sample of concrete tested for compressive strength.
 5. Cement and aggregate will be subject to inspection, sampling, and field testing at the batching plant. Concrete will be subject to inspection, sampling, and field testing at the place of concrete placement.
 6. All field sampling, field testing, making and curing of field test cylinders, and laboratory testing performed during concreting operations for the purpose of determining if the requirements of this specification section are being satisfied shall be conducted by an independent testing laboratory selected by the Owner and paid for directly by the Owner and not as a part of this Contract.
 7. Furnish the testing laboratory representative satisfactory samples of cement, aggregate, and concrete for inspection and testing purposes. The Contractor shall furnish any barrows, shovels, mixing boards, shaded area for preparing test cylinders, and similar equipment required by the testing laboratory representative for securing samples, making test cylinders, and conducting field tests.
- C. Test results will be reported in writing to The Engineer, Ready-Mix Producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. Nondestructive Testing. Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- E. Additional Tests. The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by The Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for any and all such tests.

3.17 LOADS APPLIED TO NEW CONCRETE

- A. Loads including, but not limited to, earth loads, loads exerted from bracing or shoring, wind loads, hydrostatic or hydraulic loads, equipment or vehicle loads, or loads exerted by stacked materials, shall not be applied to fresh concrete until the concrete has reached its specified 28-day strength.
- B. Concrete which has cracked due to overloading, loading before required strength has developed, or otherwise damaged shall be repaired or replaced as determined by the Engineer.

3.18 INSTALLATION OF EPOXY ANCHORS AND DOWELS

- A. Verify number, size, depth, and location of anchors or dowels to be installed.
- B. Drill holes in concrete to the depth specified on the Drawings using methods as instructed by the epoxy manufacturer. The diameter of holes shall be as instructed by the epoxy manufacturer for the anchor or dowel being installed. Clean holes as instructed by the epoxy manufacturer.
- C. Install epoxy in strict accordance with the manufacturer's instructions using guns with self-mixing nozzles provided by the manufacturer. Verify epoxy is mixed prior to placement into the hole using methods per manufacturer's instructions. Insert dowel or anchor into the hole and hold steady as instructed by the manufacturer.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes the following metal fabrications:

1. Ladders.
2. Ladder safety cages.
3. Loose bearing and leveling plates.
4. Loose steel lintels.
5. Miscellaneous structural steel framing and supports.
 - a. Applications where framing and supports are not specified in other sections.
6. Miscellaneous steel trim.
7. Metal bar gratings.
8. Floor plate and supports.
9. Pipe railings.
10. Metal stairs.
11. Pipe bollards.
12. Expansion (epoxy-set) anchors.
13. Bird Screen.
14. Metal Castings – trench frames and grated covers.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions or General Provisions and Supplementary Specifications

1.3 DEFINITIONS

- A. Definitions in ASTM E 985 for railing-related terms apply to this section.

1.4 SYSTEM PERFORMANCE REQUIREMENTS

- A. Structural Performance. Design, engineer, fabricate, and install the following metal fabrications to withstand the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each respective component of each metal fabrication.

1. Top Rail of Handrail Systems: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 300 pounds applied at any point nonconcurrently, vertically downward, or horizontally.
 - b. Uniform load of 100 pounds per linear foot applied vertically and concurrently with a uniform load of 50 lbs/ft applied horizontally.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
2. Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:
 - a. Concentrated load of 200 pounds applied at any point nonconcurrently, vertically downward, or horizontally.
 - b. Uniform load of 50 pounds per linear foot applied nonconcurrently, vertically downward, or horizontally.
 - c. Concentrated and uniform loads above need not be assumed to act concurrently.
3. Stair Treads: Capable of withstanding a concentrated load of 300 pounds on front 5 inches of tread at the center of the tread length and a deflection of no greater than 1/240 of length.

4. Stair Platforms: Capable of withstanding a uniform load of 100 pounds per square foot.
5. Floor Gratings: Capable of withstanding a uniform load of 250 pounds per square foot or a concentrated load of 300 pounds per foot of grating width, whichever produces the greater stress. No grating shall be installed which deflects more than $\frac{1}{4}$ inch under a uniform load of 100 pounds per square foot.

1.5 SUBMITTALS

- A. Submit the following in accordance with Conditions of Contract and Supplemental Specifications.
- B. Product data for products used in miscellaneous metal fabrications, including paint products and grout.
- C. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.
 1. Where installed metal fabrications are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis that has been signed and sealed by the qualified professional engineer who was responsible for their preparation.
- D. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" article.

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications. Firm experienced in successfully producing metal fabrications similar to that indicated for this Project, with sufficient production capacity to produce required units without causing delay in the work.
- B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel," D1.3 "Structural Welding Code - Sheet Steel," and D1.2 "Structural Welding Code - Aluminum."
 1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.
- C. Engineer Qualifications. Professional engineer licensed to practice in jurisdiction where Project is located and experienced in providing engineering services of the

kind indicated that have resulted in the successful installation of metal fabrications similar in material, design, and extent to that indicated for this Project.

1.7 PROJECT CONDITIONS

- A. Field Measurements. Where possible, check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.
 - 1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

1.8 SEQUENCING AND SCHEDULING

- A. Sequence and coordinate installation of wall handrails as follows:
 - 1. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

1.9 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment will be allowed for this work. Payment for all work performed under this section shall be included in other items of work.

PART 2 - PRODUCTS

2.1 FERROUS METALS

- A. Metal Surfaces, General. For metal fabrications exposed to view upon completion of the Work, provide materials selected for their surface flatness, smoothness, and freedom from surface blemishes. Do not use materials whose exposed surfaces exhibit pitting, seam marks, roller marks, rolled trade names, roughness, and, for steel sheet, variations in flatness exceeding those permitted by reference standards for stretcher-leveled sheet.
- B. Steel Plates, Shapes, and Bars.
 - 1) W Shapes. ASTM A 992.
 - 2) C and S Shapes. ASTM A 36.

- 3) CEE and ZEE (purlins and girts). ASTM A 570 Grade 33 (min).
- 4) Steel Plates, Angles, and Bars. ASTM A 36

- C. Rolled Steel Floor Plates. ASTM A 786.
- D. Steel Bars for Gratings. ASTM A 569 or ASTM A 36.
- E. Wire Rod for Grating Cross Bars. ASTM A 510.
- F. Cold-Formed Steel Tubing. ASTM A 500; Grade B, unless otherwise indicated or required for design loading.
- G. Galvanized Steel Sheet. ASTM A 446; Grade A, unless another grade required for design loading, and G90 coating designation unless otherwise indicated.
- H. Steel Pipe. ASTM A 53; finish, type, and weight class as follows:
 1. Galvanized finish for exterior installations and where indicated.
 2. Type S, Grade B, standard weight (Schedule 40), unless otherwise indicated, or another weight required by structural loads.
- I. Gray Iron Castings. ASTM A 48, Class 25 or better.
- J. Welding Rods and Bare Electrodes. Select in accordance with AWS specifications for the metal alloy to be welded.

2.2 STAINLESS STEEL

- A. Bar Stock and Shapes. ASTM A 276, Type 304 or 316.
- B. Plate. ASTM A 240, Type 304 or 316.
- C. Bolts and Nuts. ASTM F 593 and ASTM F 594, Type 304 or 316.
- D. Pipe. ASTM A376, Type 304 or 316, Seamless Schedule 40, unless otherwise indicated on the Drawings.
- E. Bird Screen. Type 304, stainless steel wire cloth, minimum wire diameter 0.063 inch, No. 2 mesh.

2.3 ALUMINUM

- A. Extruded Bars and Shapes. ASTM B 221, alloys as follows:

1. 6061-T6 or 6063-T6 for bearing bars of gratings and shapes.
 2. 6061-T1 for grating cross bars.
- B. Aluminum-Alloy Floor (Tread) Plate. ASTM B 632, Alloy 6061-T6.
- C. Aluminum Sheet. ASTM B 209, Alloy 6061-T6.
- D. Fasteners for Aluminum Gratings. Use fasteners made of same basic metal as fastened metal or stainless steel fasteners. Do not use metals that are corrosive or incompatible with metals joined.
- E. Rolled Sections. ASTM B 308, Alloy 6061-T6.
- F. Pipe. ASTM B 429, Alloy 6061-T6 or 6063-T6.
- G. Castings. ASTM B 26 or B 85.
- H. Handrail. ASTM B 221, Alloy 6105-T5.

2.4 GROUT

- A. Nonshrink Nonmetallic Grout. Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with CE CRD-C 621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.
- B. Available Products. Subject to compliance with requirements, non-shrink nonmetallic grouts that may be incorporated in the work include but are not limited to the following:
1. "Bonsal Construction Grout;" W. R. Bonsal Co.
 2. "Diamond-Crete Grout;" Concrete Service Materials Co.
 3. "Euco N-S Grout;" Euclid Chemical Co.
 4. "Kemset;" Chem-Masters Corp.
 5. "Crystex;" L&M Construction Chemicals, Inc.
 6. "Masterflow 713;" Master Builders.
 7. "Sealtight 588 Grout;" W. R. Meadows, Inc.
 8. "SonogROUT;" Soneeborn Building Products Div., Rexnord Chemical Products, Inc.
 9. "Stonecrete NM1;" Stonhard, Inc.
 10. "Five Star Grout;" U. S. Grout Corp.
 11. "Vibropruf #11;" Lambert Corp.

2.5 FASTENERS

- A. General. Provide zinc-coated steel fasteners unless otherwise indicated. Select fasteners for the type, grade, and class required.
- B. Connectors and Accessories
 - 1. High Strength Bolts: ASTM A 325.
 - 2. Unfinished Bolts: ASTM A 307, Grade B, cadmium plated.
 - 3. Self-Locking Nuts: Prevailing torque type; IFI-100, Grade A.
 - 4. Flat Washers: ANSI B 27.2.
 - 5. Lock Washers: Spring type, ANSI B 27.1.
 - 6. Beveled Washers: Table 1 of "Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts," AISC Steel Construction Manual.
- C. Connection Requirements
 - 1. Make connections not specifically detailed on Drawings using Tables I and III, Framed Beam Connections, in the latest edition of the AISC manual. The shop fabricated portion of structural connections may be bolted, welded, or riveted. Except for connections detailed on the Drawings or specified otherwise, make all field connections with ASTM A 325 high-strength bolts.
 - 2. Connections for miscellaneous metal work not included in the AISC definition of structural steel may be made with unfinished bolts. All unfinished bolts shall be equipped with self-locking nuts or lock washers.
 - 3. Install high-strength bolts using turn-of-nut tightening as described in "Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts" as set forth in the AISC manual. Beveled washers shall be used when the bearing faces of bolted parts have a slope of 1:20 or greater with respect to a plane perpendicular to the bolt axis. Provide a platform or other means of access at each field connection until the connection has been inspected by the Engineer.
 - 4. Field welded connections will not be acceptable for structural steel unless shown on the Drawings or specifically permitted by the Engineer. Where structural or miscellaneous steel connections are welded, all butt and miter welds shall be continuous and where exposed to view shall be ground smooth. In addition, intermittent welds shall have an effective

length of at least 2 inches and shall be spaced not more than 6 inches apart.

2.6 PAINT AND GALVANIZING

- A. Shop surface preparation and painting of elements not shown to be galvanized shall comply with applicable requirements of Section 09910, Painting.
- B. Steel members, fabrications, and assemblies shown to be galvanized after fabrication shall be treated as follows:
 - 1. Hot dip galvanize in accordance with ASTM A 123.
 - 2. Zinc used for galvanizing shall conform with ASTM B 6.
 - 3. Weight of zinc coating to conform to requirements specified under "Weight of Coating" in ASTM A 123.
 - 4. Safeguard against steel embrittlement in conformance with ASTM A 143.
 - 5. Safeguard against warpage or distortion of steel members in conformance with ASTM A 384. Notify Engineer of potential warpage problems which may require modification in design before proceeding with fabrication or treating.
 - 6. Finish and uniformity of zinc coating and adherence of coating to comply with ASTM A 123.
 - 7. Give a passivating treatment to galvanized elements which are not to be further coated or which may be stored in open, exterior locations for long periods prior to erection. Do not use chromate passivation on items to be painted after erection.
 - 8. Do not treat galvanized or passivated surfaces which are to be painted with oils or other chemicals which might interfere with coating adhesion.
- C. Protection of Aluminum in Contact with Other Materials
 - 1. Coat aluminum surfaces to be placed in contact with other metals, except stainless steel, or concrete with two coats of a high-build coal tar coating.
 - 2. Coating to be Tnemec "46-465 H.B. Tnemecol," Corchem Corporation "Corchem 146 High Build Coal Tar," or approved equal.
 - 3. Solvent clean and otherwise prepare all surfaces in accordance with the coating manufacturer's recommendations prior to application.

4. Each coat to provide a dry film thickness of at least 10 mils.

2.7 LADDERS

- A. General. Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.
- B. Side Rails. Continuous channel or similar extruded shape, with eased edges, spaced 18 inches apart unless a specific spacing is shown on the Drawings.
- C. Bar Rungs. Round solid bars or tubes, 3/4-inch diameter, spaced 12 inches on center.
- D. Fit rungs in centerline of side rails, weld and grind smooth on outer rail faces.
- E. Support each ladder at top and bottom and at intermediate points spaced not more than 12'-0" on center, or as shown on Drawings.
 - 1. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.
 - 2. Extend side rails and rungs at least 42 inches above top access level. Where "step-through" access is indicated, extend side rail 42 inches. Goose-neck the extended rails back to the structure to provide secure ladder access.
- F. Provide non-slip surface on top of each rung, either by coating the rung with aluminum oxide granules set in epoxy resin adhesive, or by using a "flat top" rung with an abrasive top surface.

2.8 LADDER SAFETY CAGES

- A. General. For ladders more than 20 feet in height, fabricate ladder safety cages to comply with ANSI A14.3; assemble by welding or riveting.
- B. Primary Hoops. Aluminum bars, 5/16 inch x 4 inches, for top, bottom, and for cages longer than 20 feet, intermediate hoops spaced not more than 20'-0" on center.
- C. Secondary Intermediate Hoops. Aluminum bars, 5/16 inch x 2 inches, hoops spaced not more than 4'-0" on center between primary hoops.
- D. Vertical Bars. Aluminum bars, 5/16 inch x 2 inches, secured to each hoop, spaced approximately 9 inches on center.

- E. Fasten assembled safety cage to ladder rails and adjacent construction as indicated.

2.9 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

2.10 LOOSE STEEL LINTELS

- A. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels for equal bearing of one inch per foot of clear span but not less than 8 inches bearing at each side of openings, unless otherwise indicated.
- D. Galvanize loose steel lintels located in exterior walls.
- E. Provide stainless steel shims for movement.

2.11 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General. Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.
- B. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plates, and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
 - a. Except as otherwise indicated, space anchors 24 inches on center and provide minimum anchor units in the form of steel straps 1¼ inches wide x ¼ inch x 8 inches long.

2.12 METAL BAR GRATINGS

- A. General. Produce metal bar gratings of description indicated per metal bar grating standard "Standard Specifications for Metal Bar Grating and Metal Bar Grating Treads" published in ANSI/NAAMM MBG 531-00 "Metal Bar Grating Manual."
- B. Fabricate welded steel and stainless steel gratings to comply with requirements indicated below:
 - 1. Mark/Size: Unless otherwise indicated on the Drawings, W-19-4 (welded with bearing bars 1-3/16 inch on center and cross bars 4 inches on center).
- C. Fabricate pressure-locked rectangular bar aluminum gratings to comply with requirements indicated below:
 - 1. Mark/Size: Unless otherwise indicated on the Drawings, P-19-4 (pressure-locked with bearing bars 1-3/16 inch on center and cross bars 4 inches on center)/rectangular bearing bar or I-bar sizes as indicated.
- D. Steel Finish: Hot-dip galvanized with a coating weight of not less than 1.8 oz. per sq. ft. of coated surface.
- E. Aluminum Finish: Mill.
- F. Fabricate removable grating sections with trim banding. Include anchors and stainless steel fasteners for attachment to supports.
- G. Fabricate cutouts in grating sections for penetrations indicated. Arrange layout of cutouts to permit grating removal without disturbing items penetrating gratings.
 - 1. Edge band openings in grating that interrupt 2 or more bearing bars with bars of same size and material as bearing bars.
 - 2. Do not notch bearing bars at supports to maintain elevation.
- H. Available Manufacturers. Subject to compliance with requirements, manufacturers offering metal bar gratings that may be incorporated in the Work include, but are not limited to, the following:
 - 1. Alabama Metal Industries Corp.
 - 2. Barnett/Bates Corp.
 - 3. Blaw-Knox Grating Div., Blaw-Knox Corp.

4. IKG Industries.
5. Klemp Corp.
6. Ohio Gratings, Inc.
7. Reliance Steel Products, Inc.
8. Seidelhuber Metal Products, Inc.
9. Truweld, Inc.

2.13 PREFABRICATED GRATING TREADS

- A. Fabricate from 1½-inch aluminum I-bar grating to provide a tread width as shown on the Drawings within a tolerance of ±¼-inch.
- B. Tread length to be as shown on the Drawings.
- C. Tread to incorporate a non-slip (grit) nosing.
- D. Mount treads to stringers with stainless steel bolts sized in accordance with the tread manufacturer's recommendations.

2.14 STEEL FLOOR PLATE

- A. Fabricate raised pattern steel floor plates from rolled steel plate ¼-inch in thickness and in pattern as indicated; if not indicated, as selected from manufacturer's standard patterns.
- B. Include steel angle stiffeners and fixed and removable sections as indicated.
 1. Provide two steel bar drop handles for lifting plates, one at each end of each removable section.

2.15 ALUMINUM FLOOR (TREAD) PLATE

- A. Fabricate raised pattern tread plates from aluminum-alloy rolled tread plate in pattern 1 of ¼-inch thickness.
- B. Include aluminum angle stiffeners and fixed and removable sections as indicated.
 1. Provide two (2) aluminum bar drop handles for lifting plates, one at each end of each removable section.

2.16 ALUMINUM PIPE RAILINGS AND HANDRAILS

- A. General. Fabricate pipe railings and handrails to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of pipe, post spacings, and anchorage, but not less than that required to support structural loads.
- B. Aluminum Finish. Class I clear anodized finish, unless otherwise indicated.
- C. Interconnect railing and handrail members by butt-welding, welding with internal connectors, or assembling with flush type fittings using concealed or non-projecting pins and fasteners, at fabricator's option, unless otherwise indicated.
- D. Provide slip joints to facilitate removal of pipe railing at all intersections, changes in direction, or at intervals not to exceed 25 feet in straight runs of railing. The slip joint shall be designed and constructed to provide strength equivalent to a straight section of pipe.
- E. Form changes in direction of railing members as follows:
 - 1. By insertion of prefabricated elbow fittings.
 - 2. By mitering at elbow bends.
 - 3. By bending.
 - 4. By any method indicated above, applicable to change of direction involved.
- F. Form simple and compound curves by bending pipe in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross-section of pipe throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of pipe.
- G. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated.
- H. Close exposed ends of pipe by welding 3/16-inch-thick aluminum plate in place or by use of prefabricated fittings, except where clearance of end of pipe and adjoining wall surface is $\frac{1}{4}$ inch or less.
- I. Toe Boards. Where indicated, provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated, or if not indicated, use 4 inches high x $\frac{1}{2}$ inch aluminum plate welded to, and centered between, each railing post.

- J. Brackets, Flanges, Fittings, and Anchors. Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnections of pipe and attachment of railings and handrails to other work. Furnish inserts and other anchorage devices for connecting railings and handrails to concrete or masonry work.
1. For railing posts set in concrete, fabricate sleeves from steel pipe not less than 6 inches long and with an inside diameter not less than $\frac{1}{2}$ inch greater than the outside diameter of post, with steel plate closure welded to bottom of sleeve.
 2. For surface mounted railing posts, provide prefabricated aluminum mounting brackets with stainless steel anchors. Coat aluminum surfaces in contact with concrete with bituminous coating.
 3. For removable railing posts, fabricate slip-fit sockets from aluminum pipe whose inside diameter is sized for a close fit with posts and to limit deflection of post without lateral load, measured at top, to not more than $\frac{1}{12}$ of post height. Provide socket covers designed and fabricated to resist accidental dislodgement. Coat exterior surfaces of sleeves with bituminous coating.
- K. Provide guard chains across all pipe railing openings where shown, specified, or required. Chain links shall be $\frac{1}{4}$ -inch stainless steel of welded construction, 12 links to the foot. One end shall be connected to a $\frac{1}{4}$ -inch stainless steel eye bolt in the stanchion and the other end shall be connected by means of a heavy, stainless steel swivel eye, snap hook to a similar eye bolt in the opposite stanchion.

2.17 STEEL FRAMED STAIRS

- A. General. Construct stairs to conform to sizes and arrangements indicated. Join pieces together by bolting, unless otherwise indicated. Provide complete stair assemblies, including metal framing, hangers, columns, railings, newels, balusters, struts, clips, brackets, bearing plates, and other components necessary for the support of stairs and platforms, and as required to anchor and contain the stairs on the supporting structure.
1. Fabricate treads and platforms of exterior stairs to accommodate slopes to drain in finished traffic surfaces.
- B. Stair Framing. Fabricate stringers of structural steel channels as indicated. Provide closures for exposed ends of stringers. Construct platforms of structural steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to strings, newels, and framing members to strings and headers; fabricate and join so that bolts, if used, do not appear on finish surfaces.

- C. Floor Grating Treads and Platforms. Provide patterns, spacing, and bar sizes indicated; fabricate to comply with NAAMM "Metal Bar Grating Manual."
- D. Fabricate grating treads with nosing on one edge and with angle or plate carrier at each end for stringer connections. Secure treads to stringers with stainless steel bolts.
- E. Fabricate grating platforms with nosing matching that on grating treads at all landings. Provide toe plates at open-sided edges of grating platform. Secure grating to platform frame with stainless steel clips and bolts.
- F. Stair Railings and Handrails. Comply with applicable requirements specified elsewhere in this section for pipe railings and handrails.

2.18 PIPE BOLLARDS

- A. Fabricate pipe bollards from Schedule 40 steel pipe. Cap bollards with ¼- inch minimum thickness steel base plate.
- B. Fabricate sleeves for bollard anchorage from steel pipe with ¼-inch-thick steel plate welded to bottom of sleeve.
- C. Fill bollards with Class A concrete as specified in Section 03300, Cast-In- Place Concrete.

2.19 EXPANSION (EPOXY-SET) ANCHORS

- A. Provide adhesive type anchors consisting of an "all-thread" rod or reinforcing bar set in a drilled hole completely filled with an epoxy-based filler.
- B. Materials
 - 1. "All-thread" rod, nuts, and washers shall be AISI 304 stainless steel meeting the requirements of ASTM F593.
 - 2. Reinforcing bars shall comply with all applicable requirements of Section 03300, Cast-In-Place Concrete.
 - 3. Epoxy filler/adhesive shall be a two component, high strength, low deflection, ceramic filled epoxy equivalent to EPCON Ceramic 6 by ITW Ramset/Red Head or equal. Epoxy fillers shipped and installed in glass capsules are NOT acceptable under this specification.

2.20 TRENCH FRAMES AND GRATED COVERS

A. Manufacturers

1. Neenah Foundry Company, Cat. No. R-4990, Heavy Duty, with Type A grate openings.
2. East Jordan Iron Works, 6950 Series, Heavy Duty, with Type M2 Grate.
3. Or as approved.

B. Trench drain assemblies shall include appropriate frames and end pieces.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.
- B. Center nosings on tread widths with noses flush with riser faces and tread surfaces.
- C. Set sleeves in concrete with tops flush with finish surface elevations; protect sleeves from water and concrete entry.

3.2 FABRICATION, GENERAL

- A. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than that needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- B. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges.
- C. Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication, and installation of installed metal assemblies to prevent buckling, opening up of joints, and overstressing of welds and fasteners. Base design calculations on actual surface temperatures of metals due to both solar heat gain and nighttime sky heat loss.
 1. Temperature Change (Range): 100 degrees F (55.5 degrees C).

- D. Shear and punch metals cleanly and accurately. Remove burrs.
- E. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- F. Remove sharp or rough areas on exposed traffic surfaces.
- G. Weld corners and seams continuously to 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.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.
- I. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- J. Shop Assembly: Preassemble items 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.
- K. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.
- L. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

3.3 INSTALLATION, GENERAL

- A. Fastening to In-Place Construction. Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place

construction; include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors as required.

- B. Cutting, Fitting, and Placement. Perform cutting, drilling, and fitting required for installation of miscellaneous metal fabrications. Set metal fabrication accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- D. Fit exposed connections accurately together to form hairline joints. Weld or bolt, as indicated, 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 which have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- E. Field Welding. Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, 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.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface matches those adjacent.
- F. 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.
- G. Expansion Anchors. Comply with anchor adhesive manufacturer's recommendations for:
 - 1. Location, spacing, depth of embedment, and installation of anchor.
 - 2. Drilling, cleaning, and preparation of holes to receive anchors.

3.4 SETTING LOOSE PLATES

- A. Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- B. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
 - 1. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.5 INSTALLATION OF METAL BAR GRATINGS

- A. General. Install gratings to comply with recommendations of NAAMM grating standard referenced under Part 2 that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.
- B. Secure units to supporting members with stainless steel clips and fasteners.

3.6 INSTALLATION OF PIPE RAILINGS AND HANDRAILS

- A. Adjust railings prior to anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated, or if not indicated, as required by design loadings. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
 - 1. Anchor posts in concrete by means of pipe sleeves preset and anchored into concrete. After posts have been inserted into sleeves, fill annular space between post and sleeve solid with non-reactive setting cement, mixed and placed to comply with anchoring material manufacturer's directions.
 - 2. Install removable railing sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.
- B. Secure handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1½-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. Secure wall brackets and wall return fittings to building construction as follows:
 - 1. Use type of bracket with pre-drilled hole for exposed bolt anchorage.
 - 2. For concrete and masonry anchorage, use stainless steel epoxy set anchors.

3.7 INSTALLATION OF BOLLARDS

- A. Anchor bollards in concrete by means of pipe sleeves preset and anchored into concrete. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solid with nonshrink, nonmetallic grout, mixed and placed to comply with grout manufacturer's directions.

3.8 INSTALLATION OF BIRD SCREENS

- A. Fasten bird screens to openings with collars or frame designed for screen. Provide stainless steel bolts, nuts, and washers for fasteners.
- B. At pipe vent openings, fasten bird screen between fittings or flange plate.
- C. Prior to installation, clean openings to remove dirt and prepare surface for bird screen.

3.9 ADJUSTING AND CLEANING

- A. Touch-Up Painting. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and recoat exposed areas in accordance with Section 09900, Painting.

END OF SECTION

SECTION 15010

MECHANICAL GENERAL PROVISIONS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The intent is to obtain a complete installation to which end the Contractor shall furnish all material, equipment, labor, etc. specified and any other accessory items which may not be specified, but which normally are furnished or can be reasonably implied from the specifications and plans. The Contractor shall furnish all freight, drayage, rigging, etc. required for his work.

- 1.2 In this section, the word “Contractor” or “This Contractor” means the Contractor who is engaged to execute that portion of the work under which the word is shown.

- 1.3 The word “Provide” means to furnish, install, and connect.

1.4 CODES, LAWS AND ORDINANCES

- A. Contractor shall comply with all laws, codes and ordinances, etc, having jurisdiction over the work involved, except where the requirements called for in Drawings and Specifications are in excess of those called for in said laws, codes, etc.

- B. Perform work in accordance with the standards listed below, except where Federal, State, or Local Codes are more stringent, in which case follow same:

1.	American Society of Testing Materials	ASTM
2.	National Fire Protection Association	NFPA
3.	Sheet Metal & Air Conditioning Contractor's Association	SMACNA
4.	Standard Building Code	SBCCI
5.	Standard Mechanical Code	SBCCI
6.	Standard Plumbing Code	SBCCI
7.	Standard Gas Code	SBCCI

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|-----|--|------|
| 8. | Underwriters Laboratories | UL |
| 9. | National Sanitation Foundation
Testing Laboratory | NSF |
| 10. | American National Standards Institute | ANSI |

- C. Any changes necessary in order that the work comply with all such codes, laws, ordinances, etc., shall be made by the Contractor, with the approval of the Engineer, and without additional cost to the Owner.
- D. The Contractor shall obtain permits, inspection certificates, etc., required and give them to the Owner upon request before final payment.

1.5 PLANS AND SPECIFICATIONS

- A. While Drawings are to scale, they are diagrammatic. Equipment, piping, outlets, etc. are not exactly positioned, therefore the Contractor shall refer to architectural Drawings for actual building dimensions and work by other trades. Do not scale Drawings having 1/4" or smaller scale.
- B. The right is reserved to move any outlet, equipment, and related ducts, controls, piping, etc., as much as five (5) feet at no increase in cost provided the Contractor is notified of the change before work on the detail in question is started.
- C. It shall be the responsibility of this Contractor that the equipment he installs fits the space available, leaving reasonable space for maintenance and servicing of equipment. If, after the installation of any equipment, piping, etc., it is determined that the space requirements have not been met, the Contractor shall rearrange the work at no extra cost to the Owner.
- D. Existing Conditions. The Contractor is to visit site PRIOR TO BID to become completely familiar with existing systems, conditions and location of work affected by the plans and specifications. Failure to observe existing conditions shall not relieve the Contractor from providing a complete and properly operating system or from providing offsets, fittings, accessories, etc. which may be required for new and existing systems.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. All materials and equipment shall be new and the best grade and shall conform to all standards and requirements governing the work. Equipment and materials damaged during the installation shall be replaced immediately at no extra cost to the Owner.
- B. Manufacturer's names, catalog numbers, etc. used herein are to denote design, workmanship, and quality desired. Materials and equipment of other Manufacturers, when conforming to the specifications, and when proved to be equal to the material specified, will be approved. This paragraph shall be considered as applying throughout.

2.2 SHOP DRAWINGS

- A. The Contractor shall submit, for approval by the Engineer, six (6) sets of brochures describing each item required. Description shall include rated capacities, dimensions, and characteristics. This information shall be submitted before procurement. Mark sheets with model numbers and options being proposed, identified with same designation as used on plans.
- B. ALL BROCHURES AND DRAWINGS SHALL BE SUBMITTED AT ONE TIME: Items not approved shall be resubmitted with the necessary corrections made and shall be resubmitted until final approval is obtained.
- C. On request from the Engineer, the Contractor shall submit samples of material and equipment.
- D. Equipment substitutions which affect structural, architectural, electrical or other trades will be the sole responsibility of the Contractor. Any additional work required by other trades for proper installation shall become the responsibility of the Contractor whose work was substituted. Shop drawing approval shall not relieve the Contractor from compliance.

PART 3 – EXECUTION

- 3.1 All work shall be carried out in a neat and orderly manner by experience mechanics, and under constant supervision of a competent mechanic, trained and licensed in this field, who shall represent this Contractor at all times in connection with the work.
- 3.2 When materials or work is rejected by the Engineer, the Contractor shall remove all rejected work and/or material at no extra cost to the Owner.
- 3.3 When this work damages other material, equipment, etc. this Contractor shall make all needed repairs which shall be equal to that damaged, in quality, strength, and appearance.

- 3.4 This Contractor shall, in every way, cooperate with the other contractors in the job. Where several trades are involved in any space, area, or pipe chase, all shall cooperate and install their own work to utilize the space between them as their individual trades require. In general, the ductwork shall be given preference except where grading of a pipe becomes impossible. Attention is called to space required by lighting fixtures.

END OF SECTION

SECTION 15050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 REFERENCE: Requirements stated in General and Special Provisions apply to all work in this Section. Alternates, Addenda and Division I are a part of this Specification. Contractors and Sub-contractors shall examine same as well as other Divisions of the Specifications which affect work under this Division.

1.2 WORK INCLUDES

1. Pipe and Fittings
2. Valves
3. Floor, Ceiling and Wall Plates
4. Sleeves
5. Inserts, Hangers and Supports
6. Roof Flashings
7. Vibration Control
8. General Piping
9. Excavation and Backfill

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 15: Plumbing
- B. Division 15: Heating and Ventilating

1.4 SUBMITTALS: Submit data for all products proposed for this project.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. Underground:
 1. Sanitary Drains to 5'0" from Building: Schedule 40 PVC with drainage pattern fittings and solvent welded joints.

2. Domestic Water Underground: Schedule 80 PVC pressure pipe fittings with solvent welded joints.

B. Above Ground:

1. Soil, Waste and Vent Piping: Schedule 40 PVC with drainage pattern fittings and solvent welded joints.
2. Domestic Water: Schedule 40 PVC pressure pipe fittings with solvent welded joints.
3. Gas: ASTM-A53 Schedule 40 black steel pipe with screwed malleable iron fittings.

2.2 VALVES

- A. Valves shall be of the same manufacture where possible as manufactured by Nibco, Appolo or approved equal and rated to withstand minimum 125 lbs. steam working pressure.
- B. Valves in water piping 2" and smaller: Ball valves with bronze body and screwed ends.
- C. Other valves or valve requirements shall be as described hereinafter in the Sections covering the Specification of the various systems.

2.3 FLOOR, CEILING AND WALL PLATES: Fit all pipe passing through walls, floors or ceilings in finished rooms with PVC escutcheons.

2.4 SLEEVES

- A. Where pipes pass through masonry or concrete partitions, or rated fire partitions other than masonry, set machine cut steel pipe sleeves 1" larger than outside diameter of pipe, with ends of sleeves flush with partition faces.
- B. Where pipes pass through floors, set Schedule 40 PVC pipe sleeves 1" larger than outside diameter of pipe. Top of sleeve to be 4" above finished floor in machine rooms and wet floor locations.
- C. Set sleeves true to line, grade; position and plumb or level and so maintain throughout construction period.
- D. Where concrete or masonry floors and walls are core drilled for pipe passage steel sleeves are not required.
- E. Seal opening between pipe and sleeve or opening as required to maintain the integrity of the fire rating of all walls and floors.

2.5 INSERTS, HANGERS AND SUPPORTS

- A. Provide all inserts, hangers, anchors, guides and supports to properly support and retain piping, ductwork and conduits; to control expansion, contraction, anchorage, drainage and prevent sway and vibration. Piping shall be so supported as not to place a strain on valves or equipment.
- B. Support individual piping from hangers as manufactured by Anvil, PHD Manufacturing, National Pipe Hanger Corporation or approved equal.
 - 1. PVC Pipe - Anvil Figure 65 carbon steel clevis coated with Scotchcote 134 epoxy coating on hanger rods and clevis hanger.
- C. Hanger Spacing (steel pipe):

<u>PIPE SIZE</u>	<u>MAXIMUM SPACING</u>
Up to 1"	6'
1-1/4"	8'
1-1/2", 2"	10'
2-1/2", 3"	12'
4"	14'

Provide additional hanger support within two feet of each elbow and at valves, strainers and other equipment in pipe lines.

- D. PVC water pipe shall be supported at intervals of not over four feet. Additional supports shall be provided where necessary to maintain proper alignment.
- E. Plastic soil pipe hung from building construction shall be supported at intervals of not over four feet next to hub. Additional supports shall be provided where necessary to maintain proper alignment and grade.
- F. Do not suspend a pipe from another pipe or ductwork. Do not support ceiling framing or lighting from piping or ductwork.

2.6 VIBRATION CONTROL

- A. Vibration or noise created in any part of the building by the operation of any equipment furnished and/or installed under this contract will be prohibited and this Contractor shall take all precautions by isolating the various items of equipment from the building structure.
- B. Flexible connections shall be used between ductwork and air handling equipment and the ductwork attached rigidly to the structure.
- C. Isolators shall be manufactured by Mason Industries, Consolidated Kinetics or Amber Booth.

PART 3 – EXECUTION

3.1 GENERAL PIPING

- A. Provide shut-off valves at all branch connections to main, at each piece of apparatus and in mains to sectionalize the systems and elsewhere as indicated on plans.
- B. Install valves with stems at or above horizontal position.
- C. Provide hose end drain valves at all low points, trapped sections and on equipment side of all branch valves to permit draining of all parts of liquid piping systems. Install valves at high points of equipment and piping to allow venting.
- D. Pipe equipment drip bases to nearest drain.
- E. Make piping connections to equipment indicated.
- F. Plug open ends of pipe or equipment at all times during installation to keep dirt and foreign material out of system.
- G. Arrange and install all pipes, valves, cleanouts, access openings and equipment so as to be accessible for service. Locate equipment to maintain clearances for tube, coil pulling, periodic servicing.
- H. Make reductions in piping lines with reducing coupling.
- I. Where underfloor PVC drainage pipes connect to floor drains, support the first section of pipe with hangers, from the floor slab.

3.2 JOINTS

- A. All pipe must be reamed and cleaned before assembly. Apply Teflon tape to male end of threaded joints.

3.3 EXPANSION

- A. Install all piping throughout the project with adequate allowance for expansion to prevent damage to the building, equipment and piping.

3.4 EXCAVATION AND BACKFILL

- A. Provide all excavation and backfilling necessary for installation of work.
- B. Dig trenches to exact grade and depth with only sufficient dirt removed at holes to provide working space. Bell holes shall be dug to insure pipe resting for its entire length upon bottom of trench. Refill trenches dug below required depth to proper depth with sand. Dig trenches not more than 18" wider than external diameter of pipe and sides practically perpendicular. Shore or sheet pile trenches if necessary to prevent caving. Do not endanger work of other contractors or existing structures. Contractor will be held solely responsible for damage.
- C. In event that rock is encountered during excavation, notify Engineer at once. In event that shale is encountered or any condition such that it is not possible to provide a flat even grade depth to properly support sewer.
- D. After installation and testing of piping has been completed and approved for backfill, refill all excavation inside of building and under paved areas outside of building with grits or bank run sand or the previously excavated material if this excavated material is determined by the Engineer to be suitable for reuse. Backfill shall be made and tamped in six-inch layers.
- E. Remove, dispose of any material not used for backfill as outlined in Division 2.
- F. Provide, operate pumping equipment as necessary to keep trenches, other excavations, free of water. No piping shall be installed in trenches until trenches have been pumped and bottom dried-out sufficiently to receive piping.

END OF SECTION

SECTION 15061

FIBERGLASS REINFORCED POLYMER MORTAR PIPE SEWERS

PART 1 - GENERAL

1.1 SCOPE

- A. The work included in this section includes furnishing all labor, equipment, and materials required to install, test, and inspect fiberglass reinforced polymer mortar (CCFRPM) pipe for direct bury sewers including all plugs, fittings, and bedding as shown on the Drawings and/or specified herein.

1.2 QUALITY ASSURANCE

- A. Each joint of pipe, each fitting and special shall be inspected by an independent commercial testing laboratory acceptable to the Engineer prior to delivery. Each piece of pipe shall be stenciled or otherwise clearly and legibly marked with the laboratory's mark of acceptance.
- B. Each pipe shall be clearly marked as required by the governing ASTM standard specifications to show its class, date of manufacture, and the name of trademark of the manufacturer.
- C. Any pipe or specials which have been broken, cracked or otherwise damaged before or after delivery or which have failed to meet the required tests, shall be removed from the site of the work and shall not be used therein. All pipe interiors shall be completely free from voids and defects. Any pipe section which fails any test after installation shall be removed and replaced at no additional cost to the Owner.
- D. Pipe shall be designed for the anticipated external dead and live loads. Unless otherwise shown or specified, pipe and fittings shall be designed for a working pressure of 25 psi, a minimum pipe stiffness of 72 psi; also, pipe shall be designed for maximum loads due to soil, vehicles, hydrostatic (500-year flood), flotation, etc. Unless otherwise shown or specified, bedding shall be as shown on the Drawings. Pipe located under roads or driveways shall be designed for AASHTO H20 wheel loading.

1.3 REFERENCES

- A. ASTM D3262 -Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
- B. ASTM D4161 -Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced

Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.

- C. ASTM D2412 -Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- D. ASTM D3681 – Standard Test Method for Chemical Resistance of “Fiberglass” Pipe in a deflected Condition.

E. ASTM D638 – Test Method for Tensile Properties of Plastics.

F. CITY OF CANTON SUPPLEMENTAL SPECIFICATIONS

1.4 GUARANTEE

- A. Provide a guarantee against defective materials and workmanship.

1.5 SUBMITTALS

A. SHOP DRAWINGS AND ENGINEERING DATA

1. Submit complete shop drawings to the Engineer in accordance with the requirements of the Supplemental Specifications.
2. Submit complete engineering data to the Engineer in accordance with the requirements of the Supplemental Specifications.

1.6 MEASUREMENT AND PAYMENT

- A. Payment for this work will include all equipment, materials and labor necessary to perform the work under this specification as shown on the Drawings and specified herein and included in the Contract. The payment for this work shall be included in the unit price for Fiberglass Reinforced Polymer Mortar Pipe for Sanitary Sewer.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe and special fittings shall be furnished in sizes, types, and classes at the locations shown on the Drawings, and/or specified herein.
1. Pipes: Manufacture pipe by the centrifugal casting or filament wound process to result in a dense, nonporous, corrosion-resistant, consistent composite structure. The interior surface of the pipes exposed to sewer flow shall be manufactured using a resin with a 50% elongation (minimum) when tested in accordance with D638. The interior surface shall provide crack resistance and abrasion resistance. The exterior surface of the pipes shall be comprised of a sand and resin layer which provides UV protection to the exterior. Pipes shall be Type 1, Liner 2, Grade 3 or Type 1 Liner 1 Grade 1 per ASTM D3262. Minimum pipe stiffness (SN) when tested in accordance with ASTM D2412 shall be 72 psi. Minimum pipe class (PN) shall be 25 psi. The extrapolated 50year strain corrosion value shall not be less than the required values determined in accordance with ASTM D3681 and ASTM D3262.
 2. Joints: Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint watertightness. The joints must meet the performance requirements of ASTM D4161. Joints at tie-ins, when needed, may utilize gasket-sealed closure couplings.
 3. Fittings: Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy-coated steel and stainless steel fittings may also be used.
- B. All pipe and specials shall be new materials which have not been previously used.
- C. Packaging, handling, and shipping shall be performed in accordance with the manufacturer's instructions.

2.2 MANUFACTURERS

- A. The design has been based on pipe provided by the following manufacturers:
1. HOBAS Pipe USA.
 2. U.S. Composite Pipe South – Flowtite Pipe.

3. Or approved pipe meeting this specification

2.3 BEDDING

- A. Bedding for FRPM pipe shall be provided as recommended by the pipe manufacturer as shown on the Drawings to fit the depth of trench, type and size of pipe, width of trench, and bearing value of subgrade.
- B. Bedding shall consist of compacted sand as classified by ASTM D2487 or other approved granular materials as shown on the Drawings to fully support the pipe along its entire length. Placement of this material shall be done carefully. Material shall be thoroughly compacted by to SPD of 95%.
- C. Bedding minimum depth shall be equal to 25% of the nominal diameter or 6 inches, whichever is less as shown on the Drawings.
- D. The determination of the bedding class shall be from actual width of trench. If Contractor increases width of trench for his convenience or due to collapse of trench walls so that a higher class of bedding is required, the increased cost of same shall be borne by the Contractor. If the bearing value of the subgrade is determined by the Engineer to be inadequate for a particular class of bedding, substitute a higher class of bedding as directed by the Engineer.
- E. Bedding shall be in accordance with the schedule and dimensions shown on the Drawings and the pipe manufacturer's requirements.
- F. Sand bedding shall conform to ODOT Type 2 bedding 703.11B.

2.4 FIBERGLASS REINFORCED POLYMER MORTAR PIPE MATERIALS

- A. Resin Systems: The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
- B. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
- C. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.
- D. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.

- E. Elastomeric Gaskets: Gaskets shall meet ASTM F477 and be supplied by qualified gasket manufacturers and be suitable for the service intended.

2.5 FIBERGLASS REINFORCED POLYMER MORTAR PIPE DIMENSIONS

- A. Diameters: The actual outside diameter (18" to 48") of the pipes shall be in accordance with ASTM D3262. For other diameters, OD's shall be per manufacturer's literature.
- B. Lengths: Pipe shall be supplied in nominal lengths of 20 feet to 25 feet. Actual laying length shall be nominal +1, -4 inches. At least 90% of the total footage of each size and class of pipe, excluding special order lengths, shall be furnished in nominal length sections.
- C. Wall Thickness: The minimum wall thickness shall be the stated design thickness.
- D. End Squareness: Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/8".

PART 3 - EXECUTION

3.1 PIPE LAYING

- A. Before sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared and bracing and sheeting installed where required. A mason's line, supported at intervals not exceeding 50 feet, shall be stretched tightly above ground level at a grade parallel to and directly above the axis line of the pipe. Each pipe shall be accurately placed to the exact line and grade called for on the Drawings by measuring down from this line to the invert of the pipe in place. Furnish all labor and materials necessary for erecting banner boards and establishing lines and grades therefore.
- B. Use the laser beam method of setting a line and grade for the sewer by using the laser beam coaxially through the center of the sewer being laid. The laser beam projector is to be rigidly mounted to its support platforms, with a two-point suspension, or equivalent, assuring that all ground and equipment vibrations are kept to an absolute minimum. Furnish all equipment including equipment necessary to control atmospheric conditions in the pipe to keep line and grade to acceptable standards of accuracy. The laser beam system must be operated by competent experienced men who have been properly trained to operate the equipment used.

- C. Stake check pegs at all manholes throughout the job. Provide check pegs midway between manholes and any other check points deemed necessary to assure accuracy of the equipment.
- D. Each piece of pipe and special fitting shall be carefully inspected before it is placed and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill. No pipe shall be laid except in the presence of an inspector representing the Engineer. Trench booms found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade with approved compacted materials.
- E. Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completely set or before the trench has been backfilled. The Contractor at no time shall open up more trench than his available pumping facilities are able to dewater. Where sewer pipelines are located in or across stream beds or drainage ditches, divert the stream flow and dewater each section as the work progresses.
- F. No joints shall be made where pipe or joint materials have been soiled by earth in handling until such soiled surfaces are thoroughly cleaned by wire brushing and wiping until all traces of the earth are removed.
- G. The interior of all pipe shall be kept thoroughly clean as the work progresses. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior. A filled bag or other approved type of follower shall be pulled through the line immediately after each joint is made in order to remove any debris which may be left on the inside of the pipe.
- H. Backfilling of trenches shall be started immediately after the pipe in place has been inspected and approved by the Engineer and backfill shall be deposited and compacted as provided under Section 02200, Earthwork.
- I. Haunching material shall be placed and consolidated under the pipe while avoiding both vertical and lateral displacement of the pipe from proper grade and alignment.

3.2 JOINT CONSTRUCTION

- A. Clean ends of pipe and coupling components.
- B. Apply joint lubricant to pipe ends and elastomeric seals of the coupling. Use only lubricants approved by the pipe manufacturer.
- C. Use suitable equipment and end protection to push or pull the pipes together.
- D. Do not exceed forces recommended by the pipe manufacturer for coupling pipe.

- E. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed the deflection permitted by the pipe manufacturer.
- F. After joining pipes, assure that all bell holes are filled with the appropriate embedment materials and compacted as specified.

3.4 CONNECTIONS

- A. If the work consists of the construction of sewer that is to replace an existing sewer, all of the existing service lines shall be kept in operation and connected to the new line.
- B. Connections shall be made to all existing sewer lines in the vicinity of the work by removing a section of the sewer from the existing line and inserting in the space a tee branch of proper size, or by the construction of a manhole, regulator chamber or other structure as shown on the Drawings.
- C. Connections to manholes, inlets, or pipe where no plugged stubs exist shall be made by coring a hole at the required location. The hole shall be cored at a diameter to allow for the installation of a resilient connector such as Kor-N-Seal rubber boot or equal in the cored opening. The resilient connector shall meet the requirements set forth in ASTM C 923 (latest edition). Connections using mortar or other rigid materials will not be acceptable. On connections to manholes, the bottom of the manhole shall be shaped to fit the invert of the sewer pipe as specified under Section 02560, Precast Manholes and Covers.
- D. Connections to building services shall be made in a neat and workmanlike manner. Cleanout plugs shall be installed, wherever feasible, by making the connection with a standard wye or tee.

3.5 EXISTING UTILITIES

- A. Carefully protect from damage at all times all existing sewers, water lines, gas lines, underground conduits, telephone lines, sidewalks, curbs, gutters, pavements, electric lines, or other utilities or structures in the vicinity of the work. Where it is necessary for the proper accomplishment of the work to repair, remove and/or replace any such utility, the work shall be done under the provisions set forth in the General Conditions. No separate payment shall be made for removing and replacing and/or repairing damaged existing sewers, water, gas, electric, telephone lines or conduits or other utilities, culverts, drains or conduits of similar existing services or structures. The removal, replacement and/or repair of these items shall be paid for in the lump sum price bid by the Contractor. Similar repair and replacement of sidewalks, curbs, gutters and pavements are provided elsewhere in these Specifications.

3.6 INSPECTION AND TESTING

- A. After completion of any section of sewerage, the grades, joints, and alignment shall be true to line and grade. Joint surfaces shall be smooth. There shall be no visual leakage and the sewer shall be completely free from any cracks and from protruding joint materials, deposits of sand, mortar or other materials on the inside.
- B. All pipe installed in this contract shall be subjected to a hydrostatic exfiltration test by filling the pipe and manholes with water, pumping to 10 psig for 2 hours continuous and a maximum leakage rate of 25 gallons per inch diameter per mile of sewer per 24 hours. All pipe not passing this maximum allowance shall be removed and replaced at no additional cost to the Owner. Furnish all supplies, materials, labor, services, etc., needed to make infiltration or exfiltration tests including water. No separate payment will be made for equipment, supplies, material, water, or services.
- C. Correct any leakage, including active seepage, by removal and replacement of pipe or joint where such leakage exists until the pipelines meet the requirements of the allowable leakage specifications.
- D. The sewers installed under this contract shall be subject to deflection testing by the Contractor in accordance with City of Canton Supplemental Specification 02-00 Testing for Excessive Deflection for Non-pressure Thermoplastic Sewer Pipe. The maximum allowable deflection at 30 days after installation is 4.0%. Maximum allowable long-term deflection is 5% of the initial diameter.
- E. The sewers installed under this contract shall be subject to television inspection by the Contractor in accordance with City of Canton Supplemental Specification 05-01 Sanitary Sewer Television Inspection and Documentation Procedure.
- F. All sewer pipe shall be tested using low pressure air testing in accordance with the procedures and standards listed below:
 - 1. Clean pipe to be tested by propelling snug-fitting inflated rubber ball through pipe with water.
 - 2. Plug all pipe outlets with suitable test plugs. Brace each plug securely to prevent blowouts. As a safety precaution, pressurizing equipment shall include a regulator set at slightly above test pressure to avoid overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manhole during testing.
 - 3. During manhole fabrication, a ½-inch-diameter threaded pipe nipple shall be cast through the manhole wall directly on top of one of the sewer pipes entering the manhole. The threaded end of the nipple shall extend no more than two inches on the inside of the manhole. The total length of the nipple shall exceed the manhole wall thickness by no less than four inches. The pipe nipple shall be non-corrosive and resistant to chemicals common in

domestic sewage. Special attention shall be given to providing a permanent, watertight seal around the pipe nipple at the manhole wall. The pipe nipple shall be sealed with a threaded ½-inch cap or plug. Every manhole need not have a pipe nipple, but 20 percent of all manholes on each line shall have an installed nipple. The Engineer shall assist the Contractor in selecting appropriate locations for manholes with pipe nipples installed.

4. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any groundwater above the pipe (0.43 psi per foot of groundwater above the pipe invert), but not greater than 9.0 psig.
5. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
6. When pressure decreases to 3.5 psig, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 3.0 psig. Minimum permissible pressure holding times for runs of single pipe diameter are indicated in the table in seconds. No separate allowance shall be given for laterals. Times for other sizes and lengths shall be calculated as described in ASTM C 828 using the formula $t = K D^2 L/Q$.

TIME REQUIRED FOR A 0.5 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED											
Pipe Dia. (in)	Min. Time (min:sec)	Length for Min. time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)							
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft
15	7:05	159		7:05	8:54	11:08	13:21	15:35			
18	8:30	133		8:30	9:37	12:49	16:01	19:14	22:26	25:38	
	9:55	114		9:55	13:05	17:27	21:49	26:11	30:32	34:54	
24	11:20	99	6.837xL	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17

27	12:4 5	88	8.653x L	14:2 5	21:3 8	28:5 1	36:04	43:1 6	50:3 0	57:4 2	64:5 4
30	14:1 0	80	10.683 xL	17:4 8	26:4 3	35:3 7	44:31	53:2 5	62:1 9	71:1 3	80:0 7
33	15:3 5	72	12.926 xL	21:3 3	32:1 9	43:5 6	53:52	64:3 8	75:2 4	86:1 0	96:5 7
36	17:0 0	66	15.384 xL	25:3 9	38:2 8	51:1 7	64:06	76:5 5	89:4 4	102: 34	115: 23
42	19:7 4	57	20.942 xL	34:5 4	52:2 1	69:4 9	87:15	104: 42	122: 10	139: 37	157: 04
48	22:6 7	50	27.352 xL	45:3 5	68:2 3	91:1 1	113:5 8	136: 46	159: 33	182: 21	205: 09

3.7 CLEANUP

- A. After completing each section of the sewer line, remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean and neat condition. Unless otherwise called for on the drawings, restore all disturbed areas to as close to its original condition as possible. Restoration shall include but not be limited to grassing, replacing shrubbery, trees, fences and other improvements which have been disturbed.
- B. Cleanup and restoration shall be completed within 60 calendar days after each section of sewer line is installed. Should the Contractor fail to do the cleanup within 60 calendar days, payment made for pipe sewers and service lines for that section of the sewer not cleaned up shall be removed from the periodic estimate until the cleanup work is completed.

END OF SECTION

SECTION 15090

PIPE COUPLINGS AND EXPANSION JOINTS

PART 1 - GENERAL

1.1 SCOPE

- A. The work covered by this section includes furnishing all labor, equipment, and materials required to furnish and install pipe couplings and expansion joints, including grooved couplings, flanged adaptors, expansion couplings, and rubber expansion joints, as shown on the Drawings, specified herein, and/or required for proper installation of piping and equipment.

1.2 SHOP DRAWINGS AND ENGINEERING DATA

- A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of the Supplemental Specifications

1.3 STORAGE AND PROTECTION

- A. Equipment and products stored outdoors shall be supported above the ground on suitable wooden blocks or braces arranged to prevent excessive deflection or bending between supports. Items such as pipe, structural steel, and sheet construction products shall be stored with one end elevated to facilitate drainage.

1.4 SHOP PAINTING

- A. Clean, shop prime, and shop paint all pipe couplings as specified herein.

1.5 GUARANTEE

- A. Provide a guarantee against defective materials and workmanship.

1.6 MEASUREMENT AND PAYMENT

- A. No separate measurement or payment will be allowed for this work. Payment for all work performed under this section shall be included in other items of work.

PART 2 - PRODUCTS

2.1 EXPANSION COUPLINGS

- A. Unless otherwise shown or specified, expansion couplings shall be of a gasketed, short sleeve type, with a diameter to fit the pipe properly. Expansion couplings shall have a working pressure of not less than 150 psig.
- B. Each short sleeve coupling for joining ductile iron or steel pipe shall consist of one cylindrical steel middle ring without pipe stop, two steel follower rings, two rubber-compound, wedge section gaskets, and a sufficient number of track head, electroplated steel bolts to compress the gaskets properly. Steel couplings shall be Dresser Style 38, Rockwell Style 411, or equal.
- C. Where expansion couplings are required for joining ductile iron pipe to steel pipe of the same nominal size, steel transition couplings, Dresser Style 62, Rockwell Style 413, or equal, shall be used.
- D. Rubber gaskets shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.

2.2 GROOVED COUPLINGS

- A. Grooved couplings for ductile iron pipe shall consist of two or more ductile iron housing clamps, a single rubber-compound gasket and electroplated oval-neck track bolts with heavy hex nuts. Housing shall be ribbed for strength and self-centering. Rubber gasket shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.
- B. Grooved couplings shall provide for a pipe end separation of not less than 3/32-inch and a deflection of not less than 0.45'.
- C. Grooved couplings shall engage two circumferential grooves cut at the ends of the pipe sections to be joined. The grooves shall provide a positive mechanical grip that locks the pipe ends together such that they cannot blow apart under pressure, vibration, or sag. Grooves shall be cut with a radius at the inside corners of the grooves.
- D. Grooved couplings for joining ductile iron pipe shall be Vitaulic Style 31, Gustin-Bacon Gruvajoint No. 500, or equal.

2.3 FLANGED ADAPTORS

- A. Flanged adaptors shall be used for joining plain end ductile iron pipe to flanged valves, pumps, and fittings. Flanged adaptors shall be suitable for working pressures to 150 psig.
- B. Flanged adaptors in sizes 12-inch and smaller shall consist of an ASTM A 126, Class B cast iron flanged body drilled to mate with a 125-pound cast iron flange per ANSI B16.1, a cast iron follower ring, a rubber-compound, wedge section gasket, and a sufficient number of track head, electroplated steel bolts to compress the gasket properly.
- C. Flanged adaptors in sizes 14-inch and larger shall consist of a high strength steel flanged body drilled to mate with a 125-pound cast iron flange per ANSI B16.1, a high strength steel follower ring, a rubber-compound, wedge section gasket, and a sufficient number of electroplated steel bolts to compress the gasket properly.
- D. Rubber gasket shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil and grease.

2.4 FLANGED RUBBER EXPANSION JOINTS

- A. Flanged rubber expansion joints shall be standard spool-type single or multiple arch expansion joints constructed of abrasion-resistant rubber reinforced with high tensile strength synthetic fabric and steel rings.
- B. Ends of the expansion joint shall be integral with the body and shall be full faced and drilled per ANSI B16.1 for 125-pound flanges. Beveled and split, galvanized steel retaining rings shall be provided to prevent damage to flanges and to distribute bolting stresses during assembly.
- C. Tube, body, and flanges shall be constructed using Buna-N for wastewater, natural rubber for clean water, and Buna-N or neoprene for air. For working temperatures in excess of 180 F or for chemical service, tube, body, and flanges shall be constructed of Viton. The exterior of the expansion joint shall be coated with Hypalon to resist weathering.
- D. When used to convey slurries, raw water, or untreated wastewater in horizontal piping, arches shall be filled with a special soft rubber compound integrally cured in the arches.
- E. In unrestrained piping systems or pipe systems subject to excessive longitudinal deflection, joints shall be furnished with two plated steel control rods fitted with nuts to limit compression and extension and prevent damage to the joint.

- F. Rubber expansion joints shall be "Redflex," as manufactured by Red Valve Company, "Invincible Expansion Joint," as manufactured by Mercer Rubber Company, or equal, subject to the requirements of this section.

2.5 SLIP-ON RUBBER EXPANSION JOINTS

- A. Slip-on rubber expansion joints for low pressure applications (less than 15 psig) up through 6-inch diameter in size shall be sleeve-type, single-arch expansion joints constructed of abrasion resistant rubber reinforced with high tensile strength synthetic fabric.
- B. Ends of the joint shall be designed to slip over pipe ends and shall be secured in place with adjustable stainless steel clamps. Two (2) clamps shall be provided on each end of the joint.
- C. Joint shall be constructed of Buna-N for wastewater and Buna-N or neoprene for air at working temperatures up to 180 F.

2.6 SHOP COATINGS

- A. Couplings and adaptors shall have finish as follows:

<u>Material</u>	<u>Location</u>	<u>Primer</u>	<u>Finish</u>
Ductile Iron	Buried, Submerged, or Exposed	Epoxy Primer Interior	Epoxy
Ductile Iron	Buried, Submerged, or Exposed	Epoxy Primer (Exterior)	Epoxy
Steel	Buried, Submerged, or Exposed	Epoxy Primer Interior	Epoxy Finish
Steel	Buried, Submerged, or Exposed	Epoxy Primer (Exterior)	Coal Tar Epoxy

- B. Coatings used for couplings and adaptors in potable water shall be approved for use with potable water.

2.7 SPARE PARTS

- A. Furnish 2 spare gasket sets and 2 spare track head bolt sets for each size and type of coupling.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Pipe couplings and expansion joints shall be installed where shown on the Drawings, required, or directed by the Engineer. Couplings and joints shall be installed in strict conformance with the manufacturer's instructions.
- B. Pipe ends shall be cleaned, brushed, or filed to produce a mating surface for the gasket that is free from dirt, rust, chuck marks, mill scores, dents, burrs or other foreign substances that would impede proper gasket seating.
- C. Grooves for grooved couplings shall be accurately located and cut with a suitable grooving tool.
- D. A lubricant recommended by the coupling manufacturer shall be used in seating all gaskets.
- E. On expansion couplings and flanged adaptors, bolts shall be tightened diametrically opposite each other and in progression so that the inner rims project an equal distance over the flares of the middle ring at all points. Bolts shall be tightened sufficiently to ensure a watertight joint but shall not be tightened beyond the point of stretching.
- F. On grooved couplings, bolts shall be tightened alternately and uniformly so the housing clamps come together evenly and the gasket is not pinched. Bolts shall be tightened until the housing clamps meet.
- G. Couplings shall be field painted, following installation and testing, in accordance with the requirements listed previously in this section. Rubber expansion joints shall not be painted.

END OF SECTION