

## APPENDIX E

### STANDARD CONSTRUCTION SPECIFICATIONS

**Intent of Specifications:** The specifications are for the purpose of illustrating the general character and extent of the work and are subject to such modifications as may be found necessary or advisable either before or during the prosecution of the work, and the Owner shall conform to and abide by whatever supplementary drawings and explanations may be required by the Authority for the purpose of illustrating the work. Should any incidental work or materials be necessary for the proper carrying out of the intent of the specifications, either directly or indirectly, the Owner agrees to perform all such work and furnish and install all such materials as if the same were fully specified.

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## SECTION 02221 - TRENCHING, BACKFILLING AND COMPACTING

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Trench Excavation.
- B. Bedding and backfilling.
- C. Surface Restoration.

## 1.2 DEFINITIONS

- A. Subgrade: Trench bottom prepared as specified to receive pipe bedding, concrete cradle or concrete encasement or the bottom of excavations prepared to receive pipe line structures.
- B. Bedding: That stone material placed under the pipe.
- C. Haunching: That stone material placed from pipe bottom to the pipe centerline.
- D. Initial Backfill: That stone material from the pipe centerline to twelve (12) inches above top of pipe.

## 1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T99 - Moisture-Density Relations of Soils, Using a 5.5 lb. Rammer and a 12 in. Drop.
  - 2. AASHTO T191 - Standard Method of Test for Density of Soil In-Place by the Sand Cone Method.
- B. The "PennDOT Sections" noted herein refer to sections contained in the Commonwealth of Pennsylvania Department of Transportation Specifications Publication 408 latest version. The references pertain only to materials, construction equipment, methods and labor. The payment provisions do not apply to work to be performed under this Contract.
- C. All workmanship, materials and contractor's responsibility for all work in and adjacent to PennDOT right-of-way shall be in compliance with PennDOT regulations, specifications and requirements. Where information in the specification is contradictory to current PennDOT requirements, PA requirements shall govern. No additional compensation will be considered for claims of misleading or contradictory requirements.

- D. Commonwealth of Pennsylvania Department of Transportation Specifications.
  - 1. PennDOT 408, Section 703 Aggregates.
- E. State Code: Commonwealth of Pennsylvania, Pennsylvania Code, Title 67, Transportation, Department of Transportation, Chapter 459, Occupancy of Highways by Utilities, July 1989 (PennDOT Chapter 459).
- F. State Publication: Commonwealth of Pennsylvania, Pennsylvania Code, Title 67, Transportation, Department of Transportation, Chapter 203, Work Zone Traffic Control (PennDOT Chapter 203).

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Select Backfill: Excavated material free of cinders, ashes, refuse, vegetable or organic material, boulders larger than 6", rocks, stone, or other material which, in the opinion of the Professional, is unsuitable. If the excavated material is found to be unsuitable, the Contractor is required to backfill with suitable material at his expense. The Contractor may use suitable material from other project areas at no additional cost to the Authority.
- B. Aggregate Backfill, Bedding and Haunching: Fine aggregates and coarse aggregates conforming to AASHTO and PennDOT requirements, see plan for dimensions.
- C. Classification of Backfill, Bedding and Haunching Materials:
  - 1. Aggregate Backfill of trench bottoms over-excavated at direction of Professional to correct unstable trench bottom conditions: PennDOT 2A or as directed.
  - 2. Pipe Bedding and Haunching:
    - a. AASHTO M43 Gradation No. 7 or 8.
  - 3. Initial Backfill:
    - a. AASHTO M43 Gradation No. 7 or 8.
  - 4. Final Backfill:
    - a. Select Backfill: Unless otherwise noted on drawings.
- D. Underground Warning Tape:
  - 1. Printed polyethylene tape, three inches minimum width, color coded, one inch minimum lettering, printed with name of utility buried below, and suitable for installation in all soil types.
  - 2. Non-magnetic for ductile iron pipe.
  - 3. Magnetic for PVC and HDPE pipe.
  - 4. Provide for:

- a. Electric Power Lines, Cables, Conduit and Lighting Cables – RED
- b. Gas, Oil, Steam, Petroleum, or Gaseous Materials – YELLOW
- c. Communications, Alarm or Signal Lines, Cables or Conduit – ORANGE
- d. Potable Water – BLUE
- e. Reclaimed Water, irrigation, and Slurry Lines – PURPLE
- f. Sewers and Drain Lines – GREEN
- g. Sludge – BROWN

## PART 3 - EXECUTION

### 3.1 TRENCH PREPARATION AND EXCAVATION

- A. The Contractor shall notify PA One Call (1-800-242-1776) in accordance with the regulations of the Act. For those existing utilities on Authority property, contact the Authority and with their assistance locate the utilities on private property.
- B. General: Excavation of every description and of whatever substances encountered shall be performed to the lines and grades indicated on the drawings and specified herein, or as directed by the Professional.
  1. Excavation shall be made by open cut, unless written permission to tunnel or bore is given by the Professional or is specifically outlined in the Specifications or shown on the Drawings.
  2. Trenches may be excavated and backfilled either by machinery or by hand as the Contractor may elect, provided, however, the Contractor shall use hand excavation where necessary to protect existing structures, utilities, or private or public properties and provided, further, that backfilling shall be done by hand to the extent hereinafter specified.
  3. The Contractor shall have no claim for extra compensation due to the fact that hand excavation, instead of machine excavation, may be made necessary from any cause whatsoever.
- C. Stripping, Storing and Restoring Surface Items: The Contractor shall remove all topsoil, paving, sub-paving, curbing, gutters, brick, paving block, granite curbing, flagging or other similar materials, and grub and clear the surface over the area to be excavated. He shall properly store and preserve such materials that may be required for future use in restoring the surface. The Contractor shall be responsible for any loss or damage to said materials because of careless removal or neglectful or wasteful storage, disposal, or use of the materials. Any excavated materials not required for backfill or restoration shall be disposed of by the Contractor at his expense.
  1. All materials which may be removed, including rock, earth and sand taken from the excavation, shall be stored, if practical, in the roadway or right-of-way or such other suitable place and in such manner as the Professional will approve.
  2. If more materials are removed from any trench than can be backfilled over the completed pipe or stored in the street, leaving space for traffic, the excess materials shall be removed and stored at a suitable site provided by the Contractor.

3. The Contractor shall, at his own expense, bring back as much of the approved materials so removed as may be required to properly refill the trench or excavation.
  4. When directed by the Professional, the Contractor shall furnish such other suitable materials as may be necessary to properly refill the trench at no additional cost to the Authority.
  5. The Contractor shall restore all shrubbery, fences, poles or other property and surface structures, removed or disturbed as a part of the Work, to a condition equal to that before the Work began, furnishing all labor and materials incidental thereto, without any additional cost to the Authority.
  6. The Professional may mark certain trees, shrubs, or other items that are not to be disturbed or damaged. In the event such items are disturbed or damaged, they shall be replaced or compensated for at the Contractor's expense.
  7. Any tree which is approved by the Professional for removal shall be cut into four foot lengths and become the property of the Contractor and shall be removed from the site.
- D. The Contractor must work around existing utilities at no additional cost to the Authority for this work. If the Contractor must repair or replace any damaged utilities, he must do so at his own expense.
- E. Width of Trench: Pipe trenches shall be sufficiently true in alignment to permit the pipe to be laid in the approximate center of the trench. The trench shall be wide enough to provide a free working space on each side of the pipe.
- F. Length of Trench:
1. No trench shall be opened more than 100 feet in advance of the pipe lines laid. Contractor shall provide all safety items such as sheeting, shoring and bracing.
  2. The Contractor shall limit all trench openings to a distance commensurate with all rules of safety and the Erosion and Sedimentation Control Plan.
  3. If the Work is stopped either totally or partially by his own accord or the direction of others, the Contractor shall refill the trench and temporarily repave or restore over the same at his expense and the trench shall not be opened until he is ready to proceed with the construction of the pipeline.
- G. Pumping and Draining: The Contractor shall remove by pumping, draining, or otherwise, any water which may accumulate in the trenches and other excavations and shall build all dams and do all other work necessary to keep the trenches or other excavations as free from water as possible. All pumping operations are subject to Erosion and Sedimentation Control measures.
1. Where it is impractical to completely drain the trench, special pipe of jointing materials may be authorized at no additional expense to the Authority.
  2. While the pipelines are being laid, the Contractor shall have sufficient pumping machinery ready for immediate use.
  3. All surface waters shall be prevented from entering the open ditches or excavations by proper grading of the surface in the vicinity of the excavation.
  4. Sediment laden water will be pumped to an appropriately located "Dirtbag" as shown on Erosion and Sedimentation Control Drawing.
- H. Accommodations of Drainage: The Contractor shall keep gutters, sewers, drains and ditches open at all times so that the flow of storm or other waters shall not be obstructed. If

the material excavated from the trenches must temporarily extend over gutters or other waterways, it shall be the duty of the Contractor to plank or bridge over the gutters, without extra compensation, so that the flow of water is not impeded.

- I. Protection of Utilities, Property and Structures: The existence and location of underground utilities as indicated on the Drawings is presented merely to serve as a notification that such utilities do exist in the general proximity of the work. Any utilities not shown, or not located as shown, shall not be cause of the Contractor to deny responsibility for their protection and/or repair during construction.
  1. The Contractor shall notify all utility companies in advance of construction, to include requesting the companies to establish location of their utilities, in accordance with Pennsylvania Act 287/172, as amended. Cooperate with agents of these companies during the progress of the work. Procedures for emergency action and repairs to utilities shall be established with the utility company prior to commencement of the work. During the course of his work, if the Contractor damages any of the aforementioned utilities, he shall immediately follow the procedure of emergency action and repair as established at their own expense. The Contractor shall determine the location of all utility lines on private property, with the assistance of the utility owner when on private property.
  2. Whenever the Contractor, during the progress of the excavation, shall uncover service pipes or lines, which because of injury or age are in poor condition, he shall immediately notify the proper authority in order that steps may be taken for replacement or repair. Locations of repairs, and the procedures of repairs that have been made shall be recorded by the Contractor.
  3. The Contractor shall, at his own expense, sustain in their places, and protect from direct or indirect injury, all pipes, conduits, existing sewerage systems, septic tanks, tile fields, and other structures or property in the vicinity of his work, whether above or below the ground, or that may appear in the trench. He shall at all times have a sufficient quantity of repair pipe, timber and plank, chains, ropes, etc., on the ground and shall use them as necessary for sheeting his excavations and for sustaining or supporting any structures that are uncovered, undermined, endangered, threatened, or weakened, whether such structures are or are not shown on the Drawings.
  4. Pipes and underground conduits exposed as a result of the Contractor's operations shall be adequately supported along their entire exposed length by timber or planking, installed in such manner that the anchorage of the supporting members will not be disturbed or weakened during the backfilling operation. Backfill of selected material shall be carefully rammed and tamped under and around the supports and all supports shall be left in place as a guard against breakage of the supported structure due to trench settlement. No additional payment will be due to the Contractor for material left in place nor for the labor of installing and maintaining supports.
  5. The cost of all work related to utility protection and repair shall be included in the price of pipe installed. No separate payment will be made for utility relocation or repairs.
- J. Where lines are to be constructed on rights-of-way or easements in open areas, the maximum width of trench at the top specified hereinbefore may be exceeded only if the construction is kept entirely within the limits of the right-of-way or easements and can be carried on without damage to adjoining property. The angle of slope shall be the angle at which the trench bank will stand without sliding.

- K. In locations other than rights-of-way or easements, the Professional may, as warranted by working conditions, and where permitted by the Pennsylvania Department of Labor and Industry requirements, waive the requirements that the maximum width of trench at the top shall not exceed the dimensions specified hereinbefore.

### 3.2 PIPE BEDDING AND TRENCH BACKFILL

- A. Bedding and Haunching: The trench shall be excavated to a depth of six inches below the outside diameter of the pipe barrel, or deeper if so specified. The resultant subgrade shall be undisturbed, or compacted as approved by the Professional if disturbed. The bedding and haunching shall then be prepared by placing thoroughly compacted aggregate, shaped to conform to the bottom portion of the pipe or compacted against the bottom portion of the pipe, to a vertical distance of three inches above the lowest outside surface of the pipe. Contractor is required to properly haunch the pipe before any additional backfilling is allowed.
- B. Special Bedding:
  - 1. Concrete Cradle and Concrete Encasement: if concrete cradle and/or encasement is indicated on the Drawings or required by the Professional, the trench shall be excavated to a depth of twelve inches below the outside of the barrel of pipes. All of this excavation may be done by machine.
  - 2. Unstable Subgrade: Where the bottom of the trench at subgrade is found to be unstable or to include ashes, cinders, any type or refuse, vegetable, or other organic material, or large pieces or fragments of inorganic material, which, in the opinion of the Professional, should be removed, the Contractor shall excavate and remove such unsuitable material to the width and depth recommended by the Professional.
    - a. Before pipe is laid, the subgrade shall be made by backfilling with aggregate material, as directed by the Professional, in six inch (compacted thickness) layers thoroughly tamped and the bedding prepared as hereinbefore specified.
    - b. Aggregate Backfill when used at the direction of the Professional to stabilize trench subgrade will be paid for in accordance with the unit price Bid for Miscellaneous Aggregate Backfill per the actual dimensions of the area backfilled in accordance with Section 02221, exclusive of the pipe bedding.
    - c. Additional excavation required to remove unstable material will be paid for in accordance with the applicable unit price Bid for Miscellaneous Unclassified Excavation.
  - 3. Special Foundations: Where the bottom of the trench at the subgrade is found to consist of material which is unstable to such a degree that, in the opinion of the Professional, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, the Contractor shall construct a foundation for the pipe, consisting of piling, timbers or other materials, in accordance with plans prepared by the Professional. Compensation for such additional work shall be in accordance with the General Conditions.
- C. Backfilling Methods:

1. General: Backfilling shall not be done in freezing weather except by permission of the Professional, and it shall not be done with frozen material. Do not backfill when the material already in the trench is frozen.
    - a. Where Aggregate Backfill is not indicated on the Drawings or specified herein, and in the opinion of the Professional should be used in any part of the Work, the Contractor shall furnish and backfill with aggregate as directed.
    - b. Payment will be made in accordance with the unit price Bid for Miscellaneous Aggregate Backfill in lieu of select backfill.
  2. In or adjacent to state highways all backfill shall be in accordance with PennDOT requirements.
- D. Initial Backfill: Following placement of bedding and haunching material, initial backfill shall be placed to a depth of twelve (12) inches over the crown of the pipe. Compact the initial backfill in maximum twelve (12) inch (compacted thickness) layers. Use vibratory compactors of such size that will not damage the pipe or manual compaction methods as approved by the Professional. Bring the backfill up both sides of the pipe simultaneously to prevent displacement of the pipe.
- E. Aggregate Backfill to Restoration Depth (within State Highway or as directed by the Professional): From six inches above the top of the pipe to Restoration Depth, the trench shall be backfilled by hand or by approved mechanical methods. Backfill in this section of the trench shall be aggregate backfill material subject to limitations specified and consolidated by compacting in six inch layers. Any consolidation method utilizing water such as jetting or puddling will not be permitted. Consolidation shall proceed from the center of the trench to the sides to prevent arching.
- F. Select Backfill to Restoration Depth: From twelve (12) inches above the top of the pipe to restoration depth, the trench shall be backfilled by hand or by approved mechanical methods. Backfill in this section of the trench shall be excavated material subject to limitations specified and consolidated by tamping in eight inch layers or other approved mechanical methods. Any consolidation method utilizing water, such as jetting or puddling will not be permitted. Consolidation shall proceed from the center of the trench to the sides to prevent arching. If the backfill contains too much moisture for optimum compaction, the Contractor shall dry the common backfill or provide aggregate backfill at no additional cost to the Authority.
1. Compacted layers may exceed eight (8) inches provided the Contractor can demonstrate that the compaction results as described in the follow sub-section (Compacting and Compaction Tests) are being obtained throughout the lifts of backfill.
- G. Underground Warning Tape: For the purpose of early warning and identification of buried pipes during future trenching or other excavation, provide continuous identification tapes in trenches. Install in accordance with printed recommendations of the tape manufacturer, and as modified herein. Bury tape at a depth of 12 inches below grade; in pavements, measure 12 inches down from subgrade of pavement. Tape to be installed along all mains, and laterals.
- H. Compacting and Compaction Tests:



1. The Contractor will be required to perform a sample backfilling of a pipe segment early on in the construction, adequately justifying to the Professional that his backfill and compaction operations are adequate to obtain the desired compaction results.
2. Use mechanical tampers to compact backfill materials in trench refill operations to produce a density of backfill in each layer of not less than those specified below as a percentage of maximum standard density determined in accordance with AASHTO T99 or PennDOT requirements.
  - a. Areas subject to vehicular traffic: 100%.
  - b. Grassed areas: 95%.
3. During the course of backfilling and compacting work, the Professional or Authority may, at any location or depth of trench, require the Contractor to make tests to determine whether the Contractor's compaction operations are sufficient to meet specified requirements, at the Contractor's expense. The Contractor will retain the services of an independent agency approved by the Authority for all compaction tests. Contractor will be required to repair all backfill that does not conform to the compaction requirements at no additional cost to the Authority. The Contractor shall provide ample notice to assure all soil testing is done.

### 3.3 RESTORATION AND CLEAN-UP OF SURFACE

#### A. Restoration by Contractor:

1. The Contractor shall restore all driveways, parking lots, sidewalks, curbing, gutters, shrubbery, guiderail, fences, mailboxes, coachlight standards, poles, sod or other property and surface structures removed or disturbed as a part of the Work to a condition equal to that before the Work began, furnishing all labor and materials incidental thereto. Cost of such restoration will be considered part of the price bid and no additional compensation will be made for such work.

#### B. Clean-up and Maintenance of Surfaces:

1. General: During construction, the surfaces of all areas including, but not limited to, roads, streets, and driveways shall be maintained on a daily basis to produce a safe, desirable, and convenient condition. Streets shall be swept and flushed after backfilling, and re-cleaned as dust, mud, stones and debris caused by the Work, or related to the Work again accumulates. Failure of the Contractor to perform this work may be cause for the Authority to order the work by others, and backcharge all costs to the Contractor.
  - a. All surplus materials furnished by the Contractor and temporary structures shall be removed from the site by the Contractor.
  - b. All dirt, rubbish and excess earth from the excavation shall be disposed of by the Contractor in a manner and place acceptable to all governing agencies.
  - c. The construction site shall be left clean at the end of each working day to the satisfaction of the Authority and Professional.
  - d. All surplus materials furnished and delivered by the Contractor will be removed by the Contractor.

2. Repair or Correction of Unsatisfactory Conditions: All unsatisfactory conditions resulting from the work shall be corrected.
  - a. Any hazardous condition caused by the Work, on any surface, shall be repaired or corrected within two hours of observance or notification of its existence. If repairs or corrections are not made within this period, the Authority will have the work completed with the resulting cost subtracted from the Contractor's next monthly Application for Payment. Any such costs shall be deemed a reduction in the total amount due to the Contractor under the Contract and no subsequent reimbursement shall be made to the Contractor by the Authority for these costs.
  - b. There will be no additional payment made for maintenance work.
- C. Restoration of Meadows and Cultivated Fields:
  1. General: Final restoration of all areas shall be performed in accordance with the Specifications for the particular land use as herein defined.

- a. Final restoration shall be performed no later than the start of the next planting season following construction. The planting season shall be as established by the U.S. Agricultural Service for the area of construction for pasture and meadows.
  - b. Topsoil shall be free from subsoil, brush, weeds, or other litter, clay lumps and stones, but may contain decaying vegetable matter as is present in good topsoil.
  - c. Precautions shall be exercised as necessary to conform with laws relating to erosion and sedimentation control.
  - d. Seed shall be labeled for the current growing season. Germination tests of seeds shall be made not more than six months prior to seeding. Seed which has become wet, moldy or otherwise damaged shall not be used.
  - e. All seed mixtures formulas shall be submitted to the Professional for approval prior to seeding.
  - f. The Contractor shall be responsible to produce a stand of grass in all seeded or sodded areas. Erosion, drought, or any other condition encountered shall not relieve the Contractor of this requirement.
2. Lawns: Finish grade and sodding in accordance with applicable sections of these specifications.
  3. Pasture Grass, and Meadow Grass: Prior to construction, the full depth of the existing topsoil, but no less than 12 inches, shall be stripped from all areas anticipated to be disturbed, and shall be stockpiled during construction. Upon completion of the construction, all topsoil removed shall be replaced. As the final class of material is applied, bringing the area to finished grade, the depth of topsoil replaced shall not be less than the depth removed.
    - a. The sod and/or seed mixture shall be as stated in other specification sections.
    - b. If the topsoil thickness is less than twelve (12) inches, the Contractor shall import suitable topsoil so that a good stand of grass can be established at no additional cost to the Authority.

END OF SECTION 02221

## SECTION 02605 - MANHOLES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Precast concrete manholes.

#### 1.2 RELATED SECTIONS

- A. Gravity Wastewater Sewer: Section 02731.
- B. Cast-in-Place Concrete: Section 03300.

#### 1.3 REFERENCES

- A. American Society for Testing and Materials:
  - 1. ASTM A48 - Gray Iron Castings.
  - 2. ASTM A307 - Carbon Steel Externally Threaded Standard Fasteners.
  - 3. ASTM A615 - Deformed and Plain Billet-steel Bars for Concrete Reinforcement.
  - 4. ASTM C139 - Concrete Masonry Units for Construction of Catch Basins and Manholes.
  - 5. ASTM C270 - Mortar for Unit Masonry.
  - 6. ASTM C361 - Reinforced Concrete Low Head Pressure Pipe.
  - 7. ASTM C443 - Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
  - 8. ASTM C478 - Precast Reinforced Concrete Manhole Sections.
  - 9. ASTM C923 - Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
  - 10. ASTM D2146 - Propylene Plastic Molding and Extrusion Materials.
- B. American Association of State Highway and Transportation Officials (AASHTO) Standards as referenced throughout these Specifications.
- C. American Water Works Association:

1. AWWA C302, AWWA Standard for Reinforced Concrete Water Pipe-Noncylinder Type, Not Prestressed.

D. Federal Specifications:

1. FS SS-S-210A, Sealing compound, Preformed Plastic, for Expansion Joints and Pipe Joints (Type 1 Rope Form).

#### 1.4 SUBMITTALS

A. Shop Drawings and Product Data:

1. Manufacturer's published detail drawings, modified to suit design conditions if required, and Contractor prepared drawings as applicable.
2. Manufacturer's descriptive literature and specifications covering the product specified. Include installation information.

B. Certificates:

1. Manufacturer's certification that components and products will be manufactured in accordance with specified reference standards for components and products.

#### 1.5 QUALITY ASSURANCE

A. Shop Inspection:

1. All materials furnished by the Contractor shall be certified by the supplier for compliance with the pertinent specifications. Shop inspections and testing may be required. The cost of shop testing shall be borne by the supplier or the Contractor.

B. Field Inspection:

1. All materials shall be furnished and installed and tested for defects in material and/or workmanship in the manner specified and in the presence of and as approved by the Engineer.

C. Source Quality Control:

1. Maintain uniform quality of products and component compatibility by using the products of one manufacturer in the case of precast reinforced concrete manholes.
2. Obtain certificate of construction compliance with ASTM C478 from the precast reinforced concrete manhole manufacturer. Submit same certificate as part of required submittals.

- D. Initial Manholes: Construct first manhole in the Project to demonstrate the following, and serve as the minimum acceptable conditions of construction through the Project. No additional compensation allowed for initial manhole requirement.
1. Demonstrate manhole base construction methods.
  2. Demonstrate manhole component sealing in the case of precast reinforced concrete manholes.
  3. Demonstrate manhole stop alignment.
  4. Demonstrate pipe opening sealing.
  5. Demonstrate method of adjustment of manhole frame and cover to grade and manhole frame and cover attachment.
  6. Demonstrate successful manhole acceptance test.

#### 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Transport and handle precast reinforced concrete manhole components and other products specified herein in a manner recommended by this respective manufacturers of such to prevent damage and defects. Through-wall lifting holes are not permitted in manhole component construction.
- B. Store precast reinforced concrete manhole components in accordance with manufacturer's recommendations to prevent joint damage and contamination. Exercise such care in storage of other specified products as recommended by the respective manufacturers.

#### 1.7 SITE CONDITIONS

- A. Environmental Requirements: In no instance set or construct manhole base on subgrade containing frost.

### PART 2 - PRODUCTS

#### 2.1 BASIC MATERIALS

- A. Cast-in-Place Concrete: Meet requirements of Section 03300.
- B. Waterproofed Mortar: Material composition meeting requirements of ASTM C270, Type M with waterproofing admixture included.
- C. Concrete Masonry Units for Manholes: Commercially manufactured solid precast segmental concrete masonry units meeting requirements of ASTM C139.

- D. Manhole Steps:
1. Material: Aluminum alloy 6061-T6, with standard mill finish or, polypropylene coated.
  2. Type: Drop-front design with non-slip serrated step surface.
  3. Coating: Coat portion of step which will be embedded in concrete with high-build bituminous paint.
- E. Manhole Frame and Cover: Gray iron castings conforming to ASTM A48, Class No. 30, designed for AASHTO Highway Loading Class HS-20. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion or other defects. Covers to be self-sealing. Frame and cover design, dimensions and weight equal to MHR 701 as manufactured by Quirin.
1. Finish: Bearing surfaces machined to prevent rocking and rattling under traffic. Casting surfaces shotblast cleaned and coated with asphalt paint, non-tacky drying.
  2. Identification: Cast the word DANGER SEWER – DO NOT REMOVE COVER integrally on cover in two inch size raised letters.
  3. Frame hold-down bolts: ASTM A307.
  4. Anchor Bolts: J or L shape with standard coarse thread ends, ASTM A307.
- F. Watertight Manhole Frame and Cover: Gray iron castings conforming to previously specified requirements for Manhole Frame and Cover and equal to MHR 701 I.C. as manufactured by Quirin. The cover shall have a built in O-ring and a non-penetrating pickhole.
- G. Preformed Plastic Sealing Compound: FS SS-S-210A, type 1, Rope Form, of either bitumastic base compound or butyl rubber base compound, and shipped protected in a removable two piece wrapper. Size cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference when joint is completed.
- H. PVC Waterstop for Cast-in-Place Base: Gasket Type waterstop composed of virgin polyvinyl chloride (PVC) such as manufactured by Fernco Joint Sealer Co.; CMA Concrete Manhole Adapter.
- I. Manhole Inserts: HDPE construction as manufactured by Parson.
- J. Heat Shrinkable Wrap: Wrap to cover riser rings and joints in their entirety as equal to wrapid seal as manufactured by CANUSA.

## 2.2 PRECAST REINFORCED CONCRETE MANHOLE COMPONENTS

- A. Materials and Construction: Conforming to requirements specified in ASTM C478 except as follows:
1. Concrete: Composition and compressive strength conforming to ASTM C478 except use Type II or Type III cement in manhole components and increase compressive strength to 4500 psi (at 28 days) in precast bases.
  2. Casting and Curing: Wet cast and steam curing process in accordance with Section 3.6.11 and 3.7.2 of AWWA C302.
  3. Manhole Steps: Factory installed in manhole components, prealigned vertically, spaced on equal centers, and located the minimum distance from ends of risers and top sections as indicated on drawings.
  4. Manhole Component Seals: Manhole component joints factory formed for self-centering concrete to concrete bearing employing either a rubber compression gasket or preformed plastic sealing compound.
    - a. Rubber Compression Gasket: Composition conforming to ASTM C361 or ASTM C443.
    - b. Preformed Plastic Sealing Compound: As specified previously.
    - c. Heat Shrinkable Wrap: Wrap to cover all joints in their entirety as equal to Wrapid Seal as manufactured by CANUSA.
  5. Manhole Component Design: Base, tapered and straight riser section, and top section dimensions and diameters, not consistent with ASTM C478, are as indicated on drawings.
- B. Pipe Openings: Custom preformed during manufacturing in each base and riser section requiring such, to accommodate type of pipe and pipe opening seal provided.
1. Pipe Opening Seals: Resilient gasket type, cast integrally with manhole component conforming to requirements specified in ASTM C923 and of the following acceptable pipe seals:
    - a. A-LOK Products Corporation; A-LOK Manhole Pipe Seal.
    - b. Scales Manufacturing Corporation; RES-SEAL.
    - c. Thunderline Corporation; LOCK-SEAL Modular Wall and Casing Seal.
    - d. Dual Seal Gaskets, Inc.; DUAL SEAL II.



- C. Precast Top Sections: Of materials and construction as specified previously except additional and differing requirements as follows:
1. Hold Down Bolt Inserts: Factory cast in top section no less than two 3/4 inch threaded inserts or slotted inserts to accommodate manhole frame hold down bolts. Threaded inserts of three inches depth. Both insert types designed for an ultimate load in tension of 12,500 pounds. Inserts factory plugged for shipping. Coordinate insert location with manhole component manufacturer to assure proper location in top sections.
  2. Flat Slab Tops: Tops factory formed to properly accept and support required manhole frame and cover and formed to join riser section in a matching joint.
  3. Eccentric Cone Tops: Manufacture to same minimum wall thickness and with same area of circumferential steel reinforcement as riser sections.
- D. Precast Grade Rings: Leveling and adjusting units of three inches or four inches thickness of materials and constructions as specified previously. Factory cast grade rings with hold down bolt holes matching location of same in manhole frame. Design must provide for full bearing of manhole frame.
- E. Coatings:
1. Prepare surfaces to be coated in accordance with the written instructions of the coating manufacturer, including cleaning, sandblasting or acid etching as necessary.
  2. Factory coat entire exterior of precast manhole components with two coats of Pennsbury 32-B-4 PENNOXY-TAR, or equal, to dry film thickness of 7 or 8 mils per coat, coating to be repaired in the field as warranted.

## PART 3 - EXECUTION

### 3.1 LOCATING & INSPECTION

- A. All manholes will be field located and verified for depth and alignment by the Contractor and Engineer. **No manholes shall be ordered until the actual location of such is determined in the field.**
- B. Inspect precast reinforced concrete manhole components in accordance with requirements of ASTM C478 regarding repairable defects and defects subject to rejection by the Engineer.
- C. All material found during the progress of the work, either before or after installation, to have cracks, flaws or other defects will be rejected by the Engineer. All defective materials furnished by the Contractor shall be promptly removed from the site.
- D. Unless noted on the drawings or otherwise directed by the Engineer, all manholes shall be set such that to top of rim is flush with existing or final grade.

### 3.2 PREPARATION

- A. Keep pipe and manhole interiors cleared of debris as construction progresses.

### 3.3 MANHOLE CONSTRUCTION METHODS

- A. Cast-In-Place Concrete Manhole Base (if required)
  - 1. Form and pour concrete in accordance with requirements of Section 03300. Additional requirements as follows:
    - a. Vibrate poured concrete using mechanical vibrator of a type and design approved by Engineer. Use vibrators of type capable of transmitting vibration to concrete in frequencies of not less than five thousand impulses per minute.
    - b. Form and pour joint monolithically in manhole base top to match joint of adjoining precast riser section. Use template as obtained from precast concrete manhole component manufacturer of manhole components used in the Project.
    - c. Do not place precast riser sections on cast-in-place bases for a minimum of 48 hours after pour.
  - 2. Install sewer piping in cast-in-place manhole bases prior to pouring the concrete. Install PVC Waterstop on pipes entering and leaving manhole base prior to pouring concrete. Install PVC Waterstop in accordance with manufacturer's written instructions.
  - 3. Use 4,500 psi concrete as specified in Section 03300.
  - 4. Coat bases in accordance with the requirements for precast manhole components.
- B. Precast Concrete Bases: Install bases on a six inch deep compacted layer of same material used for pipe bedding.
  - 1. When using prefabricated pipe opening seals for connecting pipes into manhole, and such seals create an annular space on interior and exterior of manhole wall after pipe connection is made, fill such annular spaces with preformed plastic sealing compound.
    - a. Tightly caulk sealing compound into annual spaces, completely filling the spaces, and render the installation watertight.
    - b. Following sealing compound installation, trowel compound surface smooth and flush with interior face of manhole.
- C. Concrete Channel Fill: Field pour concrete channel fill for each manhole base or provide and install precast channels:
  - 1. Form inverts directly in concrete channel fill.

2. Accurately shape invert to a semi-circular bottom conforming to inside of connecting pipes, and steel trowel finish to a smooth dense surface.
  3. Make changes in size and grade gradually.
  4. Make changes in direction of entering sewer and branches to a true curve of as large a radius as manhole size will permit.
  5. Make slopes gradual outside the invert channels.
  6. Use 3,000 psi concrete as specified in Section 03300.
- D. Manhole Wall Erection: Provide precast reinforced concrete straight riser, tapered riser and top sections necessary to construct complete manholes. Fit the different manhole components together to permit watertight jointing and true vertical alignment of manhole steps.
1. If rubber compression gaskets are used between sections, install gaskets and join sections in accordance with written instructions of manhole component manufacturer.
  2. Preformed plastic sealing compound must be used between all sections, installed in accordance with manufacturer's recommendations, and join sections also in accordance with written instructions of manhole component manufacturer.
    - a. Prime joint surfaces if required by preformed sealing compound manufacturer.
    - b. If sealing compound is installed in advance of section joining, leave exposed half of two piece protective wrapper in place until just prior to section joining.
    - c. Use preformed sealing compound as the sole element utilized in sealing section joints from internal and external hydrostatic pressure.
    - d. Following manhole section installation, trowel sealing compound surface smooth and flush with interior face of manhole.
    - e. Make pipe connections into manhole walls as specified previously for pipes connecting into manhole bases.
- E. Lifting Hole Sealing: Seal with properly designed tapered rubber plugs. Drive plugs into holes in such a manner to render holes completely water and air tight. Sealing of lifting holes with grout not permitted.
- F. Frame and Cover Installation: Where required, make final adjustment of frame to elevation using the following materials:
1. Precast Grade Rings:

- a. Set precast grade rings in Water-Proof Mortar. Mortar thickness not to exceed 3/4 inch maximum and 3/8 inch minimum. Wet, but do not saturate precast grade rings immediately before laying.
  - b. Pre-set grade rings to proper plane and elevation using wedges or blocks of cementitious material not exceeding one square inch wide on all sides. No more than four wedges or blocks per grade ring permitted. Incorporate wedges or blocks in fresh mortar in a manner to completely encase each. Crown fresh mortar to produce squeeze-out between grade rings. Tool exposed joints with appropriately shaped tool and compact mortar edge into joints. Clean off excess mortar prior to initial mortar set.
2. Concrete Masonry Leveling Units: Lay segmental concrete masonry units to line and in radial course with completely filled mortar joints. Flush cut exposed horizontal and vertical joints on manhole interior and exterior. Leave exterior surface ready for parging.
  3. Use concrete masonry units upon written approval of Engineer. Primary leveling unit shall be precast grade rings.
  4. Parge the outside of finished concrete masonry leveling units with a minimum of 1/2 inch thick waterproof mortar.
  5. Bolt manhole frames in place on manhole top section, or on leveling units if required, after installing 1/2 inch thick preformed plastic sealing compound on bearing surface of manhole frame. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.
  6. Use bolts of sufficient length to properly pass through leveling units, if any, engage full depth of manhole top section inverts and allowing enough threaded end to pass through manhole frame to properly tighten nut and washer. Tighten manhole frame bolts after mortar has cured.
- G. Plugging Pipe Openings: Plug pipe openings in manholes where such openings are required for future pipe connections.
1. Use masonry units and waterproofed mortar laid up to prevent deterioration.
  2. Install such materials to meet exfiltration limits and to allow future removal without damage to manhole.
- H. Manhole Insert: The manhole frame rim shall be clean from all debris. Once insert is installed and manhole cover is re-installed, there shall be a flush surface from frame lip to cover.
1. Adjustments of inserts shall be the Contractor's responsibility.
- I. Heat Shrinkable Wrap: As per manufacturer's instructions.

### 3.4 TESTING MANHOLES

#### A. General

1. Conduct tests in presence of and to complete satisfaction of the Engineer.
2. Should a manhole not satisfactorily pass testing, discontinue manhole construction in the Project until such manhole does test satisfactorily.
3. Provide tools, materials (including water), equipment and instruments necessary to conduct manhole testing specified herein.
  - a. Vacuum Testing Equipment:
    - 1) Use vacuum apparatus equipped with necessary piping, control valves and gauges to control air removal rate from manhole and to monitor vacuum.
    - 2) Provide an extra vacuum gauge of known accuracy to frequently checktest equipment and apparatus.
    - 3) Vacuum testing equipment and associated testing apparatus subject to Engineer's approval.
    - 4) Provide seal plate with vacuum piping connections for
4. Prior to testing clean manholes thoroughly and seal openings, both to the complete satisfaction of the Engineer. Seal openings using properly sized plugs.
5. Perform testing with frames installed. Include the joint between the manhole and manhole frame in the test.
6. The Contractor may elect to make a test for his own purposes prior to backfilling. However, conduct tests of the manholes for acceptance, only after the backfilling has been completed.

#### B. Vacuum Test Procedure:

1. Perform vacuum testing in accordance with the testing equipment manufacturer's written instructions.
2. Draw a vacuum of ten inches of mercury and close the valves.
3. Consider manhole acceptable when vacuum does not drop below nine inches of mercury for the following manhole sizes and times:
  - a. Four foot diameter - 60 seconds
  - b. Five foot diameter - 75 seconds
  - c. Six foot diameter - 90 seconds

C. Exfiltration Test Procedure:

1. Complete fill manhole to top of frame with water.
2. Allow water filled manhole to stand four hours prior to testing to allow absorbing in materials.
3. At commencement of test, fill manhole to top lip of manhole frame.
4. During a consecutive four hour period, keep an accurate record of the amount of water to be added because of exfiltration.
5. Consider manhole acceptable when exfiltration rate does not exceed a rate of 0.038 gallons a day per inch of manhole diameter per vertical foot of manhole.

D. Repair and Retest: Determine source or sources of leaks in manholes failing acceptable limits.

1. Repair or replace defective materials and workmanship, as is the case, before conducting such additional Manhole Acceptance Tests and such subsequent repairs and retesting as required until manholes meet test requirements.
2. Materials and methods used to make manhole repairs must meet with Engineer's approval prior to use.
3. Make repairs, replacements and retests at no additional expense to Owner.

END OF SECTION 02605

## SECTION 02606 - PRE-CAST VAULTS

## PART 1 - GENERAL

## 1.1 RELATED DOCUMENTS

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

## 1.2 STIPULATIONS

- A. The Specifications Sections "General Conditions", "Special Requirements", and "General Requirements" form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

## 1.3 REFERENCES

- A. American Society for Testing and Materials:

- 1. ASTM A307 Carbon Steel Externally Threaded Standard Fasteners
- 2. ASTM A615 Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- 3. ASTM C139 Concrete Masonry Units for Construction of Catch Basins and Manholes
- 4. ASTM C361 Reinforced Concrete Low Head Pressure Pipe
- 5. ASTM C478 Precast Reinforced Concrete Manhole Sections
- 6. ASTM C923 Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes

- B. American Association of State Highway and Transportation Officials (AASHTO) Standards as referenced throughout these Specifications.

- C. Federal Specifications:

- 1. FS SS-S-210A Sealing compound, Preformed Plastic, for Expansion Joints and Pipe Joints (Type 1 Rope Form).

## 1.4 SUBMITTALS

- A. Submit detailed drawings modified to suite site conditions.

## 1.5 QUALITY ASSURANCE

### A. Shop Inspection:

1. All materials furnished by the Contractor shall be certified by the supplier for compliance with the pertinent Specifications. Shop inspections and testing may be required. The cost of shop testing shall be borne by the supplier or the Contractor.

### B. Field Inspection:

1. All materials shall be furnished and installed and tested for defects in material and/or workmanship in the manner specified and in the presence of and as approved by the Engineer.

### C. Source Quality Control:

1. Maintain uniform quality of products and component compatibility by using the products of one manufacturer in the case of precast reinforced concrete valve vaults.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Transport and handle precast reinforced concrete vaults and other products specified herein in a manner recommended by the respective manufacturers of such to prevent damage and defects.

## 1.7 SITE CONDITIONS

- A. Environmental Requirements: In no instance set or construct vaults on subgrade containing frost.

## PART 2 - PRODUCTS

### 2.1 BASIC MATERIALS

- A. Cast-in-Place Concrete: Meet requirements of Section 03300.
- B. Waterproofed Mortar: Material composition meeting requirements of ASTM C270, Type M with waterproofing admixture included.
- C. Concrete Masonry Units for Manholes and Vaults: Commercially manufactured solid precast segmental concrete masonry units meeting requirements of ASTM C139.
- D. Preformed Plastic Sealing Compound: FS SS-S-210A, Type 1, Rope Form, of either bituminastic-base compound or butyl-rubber base compound (CS-102), and shipped protected in a removable two-piece wrapper. Size cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference when joint is completed.



## 2.2 PRECAST REINFORCED CONCRETE VAULT COMPONENTS

- A. Materials and Construction: Conforming to requirements specified in ASTM C478 except as follows:
1. Concrete: Composition and compressive strength conforming to ASTM C478 except use Type II or Type III cement in vault components and increase compressive strength to 4,500 psi (at 28 days) in precast bases.
  2. Casting and Curing: Wet cast and steam curing process in accordance with Section 3.6.11 and 3.7.2 of AWWA C302.
  3. Component Seals: Vault component joints factory formed for self-centering concrete to concrete bearing employing either a rubber compression gasket or preformed plastic sealing compound.
    - a. Rubber Compression Gasket: Composition conforming to ASTM C361 or ASTM C443.
    - b. Preformed Plastic Sealing Compound: As specified previously.
    - c. Heat Shrinkable Wrap: Wrap to cover all joints in their entirety as equal to Wrapid Seal as manufactured by CANUSA.
- B. Pipe Openings: Custom preformed during manufacturing in each base and riser section requiring such, to accommodate type of pipe and pipe opening seal provided.
1. Pipe Opening Seals: Resilient gasket type, cast integrally with manhole component conforming to requirements specified in ASTM C923 and of the following acceptable pipe seals:
    - a. A-LOK Products Corporation; A-LOK Manhole Pipe Seal.
    - b. Scales Manufacturing Corporation; RES-SEAL.
    - c. Thunderline Corporation; LOCK-SEAL Modular Wall and Casing Seal.
    - d. Dual Seal Gaskets, Inc.; DUAL SEAL II.
- C. Vault Coatings:
1. Prepare surfaces to be coated in accordance with the written instructions of the coating manufacturer, including cleaning, sandblasting or acid etching as necessary.
  2. Factory coat entire exterior locate below grade of precast manhole components with 2 coats of Pennsbury 32-B-4 PENNOXY-TAR, or equal, to dry-film thickness of 7- or 8-mils per coat, coating to be repaired in the field as warranted.
- D. Aluminum Access Hatch: 300#/SF loading, 316 stainless steel hardware with spring assist locking hold open arm, 1.5-inch frame drain coupling, and slam lock. Holliday Series W1S.
- E. OSHA Safety Grate: Aluminum "I" bar construction with fusion epoxy orange coating and stainless steel hardware. Haliday Series X
- F. Aluminum Access Ladder: Aluminum construction with slip resistant ribbed rungs, flat wall mounting stand-offs. Haliday Series L1B.

- G. Aluminum Ladder Extension: Aluminum and stainless steel construction with locking pins Haliday Series L1E.
- H. Precast vaults shown with watertight manhole covers shall also meet the frame and cover standards within the "Manholes" section.

## PART 3 - EXECUTION

### 3.1 LOCATING AND INSPECTION

- A. All vaults will be field located by the Contractor and Engineer. No vaults shall be ordered until the actual location of such is determined in the field.
- B. Inspect precast reinforced concrete vault components in accordance with requirements of ASTM C478 regarding repairable defects and defects subject to rejection by the Engineer.
- C. All material found during the progress of the work, either before or after installation, to have cracks, flaws or other defects will be rejected by the Engineer. All defective materials furnished by the Contractor shall be promptly removed from the site.

### 3.2 CONSTRUCTION METHODS

- A. Precast Concrete Bases: Install bases on a 6-inch-deep compacted layer of same material used for pipe bedding.
  - 1. Vault base shall be installed in a level position.
  - 2. When using prefabricated pipe opening seals for connecting pipes into vault, and such seals create an annular space on interior and exterior of vault wall after pipe connection is made, fill such annular spaces with:
    - a. Tightly caulk sealing compound into annual spaces, completely filling the spaces, and render the installation watertight.
    - b. Following sealing compound installation, trowel compound surface smooth and flush with interior face of manhole.
  - 3. Concrete Fill: Field pour concrete floor for each vault base as indicated.
    - a. Accurately shape invert to a semi-circular bottom conforming to inside of connecting pipes, and steel trowel finish to a smooth dense surface.
    - b. Make changes in direction of entering sewer and branches to a true curve of as large a radius as vault size will permit.
    - c. Make slopes gradual outside the invert channels.
    - d. Use 3,000 psi concrete as specified in Section 03300.

- B. Lifting Hole Sealing: Seal with properly designed tapered rubber plugs. Drive plugs into holes in such a manner to render holes completely water and air tight. Sealing of lifting holes with grout not permitted.
- C. Riser Section: Pre-cast or cast-in-place riser sections shall be constructed and/or installed to match the existing grade. The riser section shall include the hatch, ladder or steps, and ladder-up extension device.

END OF SECTION 02606

## SECTION 02731 - GRAVITY WASTEWATER SEWER

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Wastewater Gravity Sewer Pipelines.
- B. Service Connection Piping.
- C. Pipeline Testing.

#### 1.2 RELATED SECTIONS

- A. Trenching, Backfilling, and Compacting: Section 02221.
- B. Cast-in-Place Concrete: Section 03300.

#### 1.3 QUALITY ASSURANCE

- A. Source Quality Control.
  - 1. Shop Tests and Inspection
    - a. All material furnished by the Contractor shall be certified by the Contractor for compliance with the pertinent specifications. Shop inspections and testing may be required. The cost of shop testing shall be borne by the Contractor.
- B. Disposition of Defective Material: All material found during the progress of the work, either before or after installation, to have cracks, flaws or other defects will be rejected by the Engineer. All defective materials furnished by the Contractor shall be promptly removed by him from the site at his own expense.

#### 1.4 REFERENCES

- A. American Society for Testing and Materials.
  - 1. ASTM D2321 - Underground Installation of Flexible Thermoplastic Sewer Pipe.
  - 2. ASTM D3034 - Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  - 3. ASTM D3212 - Joints for drain and sewer plastic pipes using flexible elastomeric seals.
  - 4. ASTM F477 - Elastomeric seals (Gaskets) for joining plastic pipe.

## 1.5 SUBMITTALS

- A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cuts or other data as required to provide a complete description of piping and piping specialties.
- B. Certificates
  - 1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
  - 2. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.

## 1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle and store pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects.

## 1.7 SITE CONDITIONS

- A. Environmental Requirements
  - 1. Keep trenches dewatered until pipe joints have been made and concrete cradle or encasement, if any, have cured.
  - 2. Under no circumstances lay pipe in water or on bedding containing frost.
  - 3. Do not lay pipe when weather conditions are unsuitable, as determined by the Engineer, for pipe laying work.

## PART 2 - PRODUCTS

### 2.1 SEWER PIPE AND FITTINGS

- A. For pipe joints, use rubber gaskets suitable for conveying domestic sewage.
- B. Polyvinyl Chloride Pipe (PVC)
  - 1. Pipe: Type PSM SDR-35, ASTM D3034 unless specified otherwise in the Drawings.
  - 2. Fittings: Conforming to same ASTM standard requirements for pipe.
  - 3. Joints: Push-on with elastomeric gasket, ASTM D3212; and ASTM F477 for gasket specifications.

C. Ductile Iron Pipe (DIP)

1. Pipe: ANSI A21.50 and ANSI A 21.51
2. Wall Thickness Class (Buried): Class 50.
3. Fittings: Gray iron or ductile iron ANSI A21.10.
4. Joints:
  - a. Rubber Gasket Joints (Buried): ANSI A 21.11
    - 1) For buried pipe installation, provide push-on or mechanical joints except where other types of joints are indicated on the Drawings or required by the Specifications.
5. Cement Lining: Ductile Iron pipe and fittings shall be coated inside with double thickness cement mortar lining (1/8") and seal coated, all in conformance with ANSI A21.4 and AWWA C104.
6. Pipe and Fittings Coating: Factory coated inside and out with bituminous material; minimum 1 mil dry thickness. Bituminous material and finished coat conforming to seal coat requirements in ANSI A21.4.

2.2 SERVICE CONNECTION PIPE AND FITTINGS

- A. Polyvinyl Chloride Pipe (PVC): As specified for sewer pipe and fittings; six-inch diameter.
- B. Pipe Plugs: Designed for permanent installation and removable. Obtain plugs from the pipe manufacturer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Earthwork: Perform earthwork for sewer installation as specified in Trenching, Backfilling, and Compacting: Section 02221.

### 3.2 PIPE LAYING

- A. General: All pipe shall be laid to a uniform line and grade between manholes, socket ends upgrade, with a firm and even bearing along the barrel of the pipe, close joints and smooth invert. The spigot end of the pipe is to be centered in, shoved tight and secured against the bell or socket of the previously laid pipe. The interior of each pipe shall be cleaned of all excess joint and foreign material before the next pipe is laid. The pipe shall be laid in the bedding materials as specified in Section 02221. Pipe-laying shall commence at the lowest point and proceed upgrade. At the close of each day's work, and at such other times when pipe is not being laid, the open end of the pipe shall be protected with a close fitting stopper.
- B. Joints: Make joints in strict accordance with manufacturer's installation instructions.
- C. Laying Specified Types of Plastic Pipe: Installation and joint assembly according to ASTM D 2321.
- D. Construction Control
1. The use of laser equipment will be permitted. Cut sheets for all manhole runs as required.
  2. Regardless of control used, the Contractor shall provide alternative verification of grade as work progresses. Pipe not laid to proper line and grade will be removed and reconstructed at the Contractor's expense.
  3. Provide temporary bench marks for grade verification.
- E. Variations: The Engineer reserves the right to vary the line and/or grade from that shown on the drawings for pipe lines and manholes when such changes may be necessary or advantageous. No claims will be allowed for changes in location or grade except as such changes are made after trenching has been done. Payment for all variances shall be in accordance with the unit pricing as indicated in the bid and all excavation shall be unclassified.
- F. Sanitary Sewer near Water Mains. The Engineer may vary the location of sanitary sewers in close proximity to water mains. No variations on location will be permitted without approval of the Engineer.
1. Horizontal Separation - Sewers should be laid at least 10 feet horizontally from any existing or proposed water main. Should local conditions prevent a lateral separation of 10 feet, a sewer main may be laid closer to the 10 feet to a water main if (1) it is laid in a separate trench, or if (2) it is laid in the same trench with the water mains located at one side of the bench of undisturbed earth and if in either case the elevation of the crown of the sewer is at least 18 inches below the invert of the water main.

2. Vertical Separation - Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be varied to meet the above requirement, the water main shall be relocated to provide this separation or reconstruct it with mechanical joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that joints will be as far from the sewer as possible.

When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both the water main and sewer shall be constructed of mechanical joint cast iron pipe or ductile iron pipe and shall be pressure tested to assure water tightness; or, the sewer shall be concrete encased for a distance of 10 feet on either side of the water main in accordance with the details shown on the contract drawings or as ordered by the Engineer.

- G. Handling of Sewer Line Materials into Trench: Proper implements, tools and facilities satisfactory to the Engineer shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, fittings, jointing materials, etc. shall be carefully lowered into the trench piece-by-piece by means of a derrick, ropes, or other suitable tools or equipment, in such a manner as to prevent damage to sewer line materials and/or workmen. Under no circumstances shall such materials be dropped or dumped into the trench.
- H. Pipe Clearance in Rocks: Ledge rock, boulders and large stones shall be removed to provide a clearance of at least six inches below and on each side of all pipe and fittings.
  1. The specified minimum clearances are the minimum clear distances which will be permitted between any part of the pipe and/or fitting being laid and any part, projection or point of such rock, boulder or stone.
- I. Culverts: Sanitary sewer shall be furnished and installed under culverts to the dimensions shown on the drawings.
- J. Concrete Cradle and Encasement:
  1. Preparation: Prior to the formation of cradle or encasement, if any, temporary supports consisting of timber wedges and solid concrete bricks or cap blocks shall be used to support the pipe in place. Temporary supports shall have minimum dimensions and shall support the pipe at not more than two locations, one at the bottom of the barrel of the pipe adjacent to the shoulder of the socket and the other near the spigot end.
  2. Placing: After jointing of the pipe has been completed, concrete shall be uniformly poured beneath and on both sides of the pipe. Placement shall be done by the use of suitable equipment. The concrete shall be wet enough during placement to permit its flow, without excessive prodding, to all required points around the pipe surface. The width of cradle shall be such as to fill completely the trench width. In case of extremely wide trenches, concrete encasement may be confined above the top of the pipe to a narrower width but in no case shall it be less than the width of trench required for the size of pipe being used. Before depositing concrete, the space



within the limits of the pour shall have been cleared of all debris and water. Water shall not be allowed to rise adjacent to, or flow over, concrete deposited for less than 24 hours. Concrete shall be protected from the direct rays of the sun and kept moist, by a method acceptable to the Engineer, for a period of seven days or until backfilling is begun. In no case shall backfilling begin within 24 hours of the time of placing and the Engineer shall have strict control of the rate of backfilling.

3. Concrete: 3000 psi per requirements of Section 03300.

### 3.3 SERVICE CONNECTIONS

- A. Fittings, (Wye branches, risers and bends) and service pipe shall be provided in strict accordance with these specifications and any and all practices and precautions required for the sewer main are equally applicable to the service connections from the sewer to one foot behind the curblin, right-of-way line, or edge of paved surface, or to a location designated by the Engineer. The Contractor shall place a 2" x 2" wooden marker at the end of each sewer lateral. The marker shall be one piece and may not be constructed from two or more smaller pieces. The marker shall extend from the lateral invert to 12" above grade.
- B. Service connections are to be installed at a grade of quarter inch per foot from the main line to the termination of the lateral.
- C. The Contractor shall submit to the Engineer, on a monthly basis, all as-built information which shall include: manhole run, station, length from centerline of sewer, invert elevation at the termination point of lateral and the address or property owner's name for whom the lateral and the address or property owner's name for whom the lateral is provided.
- D. If rock is encountered during the installation of the lateral, the Contractor shall extend the lateral to the required distance as specified elsewhere in these specifications, and he shall provide a minimum "rock-free" distance of one foot beyond the end of the lateral. No lateral shall be "butted" against rock.
- E. Plugs: Close free ends of branches and service connections with a carefully fitted plug. Type of plug used and method of installation shall meet Engineer's approval. Installed plugs shall successfully pass line acceptance tests.
- F. Install warning tape as described in Section 02221.

### 3.4 PIPELINE TESTING PREPARATION

- A. Backfill trenches in accordance with detail on Drawings.
- B. Provide pressure pipeline with concrete reaction support blocking.
- C. Flush pipeline to remove debris. Collect and dispose of flushing water and debris.

- D. Clean pipelines by propelling a snug fitting rubber ball through the pipeline with water from the upstream manhole to the downstream manhole. Investigate and correct any stoppage of the cleaning ball. Collect and dispose of cleaning water and debris.
- E. Lamping:
1. After flushing and cleaning, lamp gravity pipeline in the presence of the Engineer.
  2. Assist the Engineer in the lamping operation by shining a light at one end of each pipeline section between manholes. The Engineer will observe the light at the other end. Pipeline that has not been installed with uniform line and grade will be rejected. Remove and re-lay rejected pipeline sections. Reclean and lamp until pipeline section achieves a uniform line and grade to the satisfaction of the Engineer.
- F. Plug outlets, wye-branches and laterals. Brace plugs to offset thrust.
- G. All testing for pipes and manholes shall be conducted with an Owner representative on site.

### 3.5 TESTING GRAVITY SEWER PIPELINES

- A. Low Pressure Air Test:
1. Test each newly installed section of gravity sewer line between manholes.
  2. Slowly introduce air pressure to approximately 5.0 psig.
  3. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or the increased test pressure as determined below if groundwater is present. Start the test.
  4. Test:
    - a. Determine the test duration for a sewer section with a single pipe size from the table below:

Nominal Pipe Size	T (Time) Min/100 Ft.	
4	.3	3 minutes minimum
6	.7	3 minutes minimum
8	1.2	4 minutes minimum
10	1.5	4 minutes minimum
12	1.8	4 minutes minimum

- b. Record the drop in pressure during the test period. If the air pressure has dropped more than 1.0 psig during the test period, the line is presumed to have failed. If the 1.0 psig air pressure drop has not occurred during the test period, the test shall be discontinued and the line will be accepted
- c. If the line fails, determine the source of the air leakage, make corrections and retest. The Contractor has the option to test the section in incremental stages until the leaks are isolated. After the leaks are repaired, retest the entire section between manholes.

B. Infiltration Test:

1. Use only when gravity pipeline is submerged in groundwater. Obtain prior approval of the Engineer.
2. Maximum Allowable Infiltration: 100-gallons per inch of pipe diameter per mile per day for any one section under test, including the allowances for leakage from manholes.

C. Infiltration:

1. After the air testing described in the preceding paragraph has been completed by the Contractor, regardless of any indications of the test results made by the Engineer or the Owner, the Engineer and the Owner reserve the right to perform field investigations, prior to final written acceptance of each sewer run by the Owner and/or during the one-year correction period specified elsewhere in the Contract Documents, to establish the leakage of groundwater into the sewer and laterals constructed under this contract. The cost of these investigations shall be borne by the Owner.
2. Should the leakage exceed 100 gallons per day per inch diameter per mile of pipe for any section, the Contractor shall, at the direction of the Engineer or Owner, and at no cost to the Owner, perform any additional testing or corrective work required to reduce the infiltration in each manhole run from those lines installed by the Contractor to less than 100 gallons per day per inch diameter per mile of pipe. This leakage applies to each manhole run separately and should not be construed to mean total leakage in the total system. The scope of this corrective work shall include, but not be limited to, cleaning, televising and testing the sewer and laterals to the limits installed by the Contractor, to include testing and grouting of joints, excavation and replacement of faulty or damaged portions of the work, and all final restoration.

### 3.6 DEFLECTION TESTING OF PLASTIC SEWER PIPE

- A. At the direction of the Engineer, perform vertical ring deflection testing on suspect portions of PVC sewer piping, in the presence of the Engineer, after backfilling has been in place for at least 30 days but not longer than 12 months.

- B. The maximum allowable deflection for installed plastic sewer pipe shall be limited to 5% of the original vertical internal diameter.
- C. Perform deflection testing with a deflectometer, calibrated television, or a properly sized "Go, No-Go" mandrel. The mandrel(s) shall be constructed at the Contractor's expense and subject to the approval of the Engineer.
- D. Pipe exceeding the allowable deflection shall be located, excavated, replaced, and retested at the sole expense of the Contractor.

### 3.7 TEST REPORTS

- A. The Contractor shall submit a written, certified report which includes the detailed testing log with times and results for all pipe segments and manholes.

### 3.8 ACCEPTANCE

- A. Observation of successful testing of manholes, sewers or force mains by the Engineer does not constitute acceptance of the system or any portion thereof. Upon completion of any determined portion of a total system, and successful testing thereof, the Engineer may recommend final acceptance to the Owner. Only upon final inspection by the Owner or Engineer, and upon written acceptance for same will the system or portion thereof be considered substantially completed. Upon such acceptance, the one-year correction period as specified for the manholes, sewers or force main will commence.
  - 1. If, during this final inspection, any irregularities are observed, the condition shall be corrected at the Contractor's expense prior to acceptance.

END OF SECTION 02731

## SECTION 02732 - FORCE MAINS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Force Main Pipe and Fittings.
- B. Site Conditions.
- C. Excavation, Bedding & Backfill.
- D. Anchorage.
- E. Tests.
- F. Submittals.
- G. Product Delivery, Storage and Handling.

#### 1.2 RELATED SECTIONS

- A. Trenching, Backfilling, and Compacting, Section 02221.
- B. Cast-in-Place Concrete, Section 03300.

### PART 2 - PRODUCTS

#### 2.1 FORCE MAIN PIPE AND FITTINGS

All work shall be in accordance with UNI-B-3-92 "Recommended Practice for the Installation of Polyvinyl Chloride (PVC) Pressure Pipe.

- A. Polyvinyl Chloride Pipe (PVC)
  - 1. Polyvinyl Chloride (PVC) Pipe for force mains and pressure lines shall be of the bell and spigot type or the coupling type and shall be manufactured in accordance with ASTM D 2241.
  - 2. The pipe shall be made of PVC compounds having a cell classification of 12454-B (or type 1, grade 1 or type 1120) or 12454-C (or type 1, grade 11, or type 1220) as defined in ASTM D 1784.

3. The joint shall be a rubber ring gasket meeting the requirements of ASTM D 1869, C 361 and C 443, and shall provide an adequate compressive force against the bell and spigot or the coupling to affect a positive seal and to provide for expansion and contraction while preventing displacement. The rubber ring gasket shall be the only element depended upon to make the joint flexible and watertight. Solvent cement joints are not acceptable.
4. PVC pipe shall be furnished in standard lengths of 18-22 feet. All pipe shall be marked clearly at intervals of five feet or less with the manufacturer's name, cell classification, SDR rating, and ASTM Designation D 2241.
5. Pipe shall meet the dimensional requirements of SDR 21 with a pressure rating of not less than 200 psi.
6. Fittings for PVC pipe shall be compatible PVC fittings as recommended by the pipe manufacturers, and of same class as the pipe.

B. Ductile Iron Pipe:

1. ANSI A21.51, Ductile Iron Pipe, Thickness Class 51 for underground installation, Class 53 for Flanged piping.
2. Cement lining - double thickness cement mortar lining (1/8") with seal coat, in conformance with ANSI A21.4 and AWWA C104.
3. Exterior Coating:
  - a. bituminous coating, minimum 1.0 mil thickness for underground piping.
  - b. shop prime with primer compatible with finish coat for piping inside structures.
4. Joints:
  - a. Use rubber gasket joints for pipe and fittings installed underground.
    1. Mechanical Joint: ANSI A21.11
    2. Push-on Joint: ANSI A21.11
  - b. Use flanged joints for pipe and fittings installed inside of structures, unless indicated otherwise. Mechanical pipe couplings with self-centering gaskets designed to mechanically engage grooved or shouldered piping and lock in a positive watertight couple may be used in lieu of flanged joints, except where indicated otherwise.
    1. Flanged joint: ANSI A21.15
    2. Mechanical coupling: Victaulic Style 31 or equal.
    3. Gaskets: 1/16 inch thick, one piece cloth insertion rubber gaskets suitable for wastewater service.

## C. Stainless Steel Pipe:

1. Type 304 stainless steel pipe

## PART 3 - EXECUTION

## 3.1 SITE CONDITIONS

## A. Environmental Requirements

1. Keep trenches dewatered until pipe joints have been made and concrete cradle or encasement, if any, have cured.
2. Under no circumstances lay pipe in water or on bedding containing frost.
3. Do not lay pipe when weather conditions are unsuitable, as determined by the Engineer, for pipe laying work.

## 3.2 EXCAVATION, BEDDING &amp; BACKFILL

- A. Non-metallic force mains to be installed with magnetic underground warning tape.
- B. Where force main is benched into a sewer trench, the sewer backfill shall be installed to the elevation of the force main prior to the force main installation and backfill.

## 3.3 ANCHORAGE

- A. Concrete Thrust Blocks: Provide concrete thrust blocks for all fittings, and at all locations where horizontal or vertical deflections are made in the joints of the piping.
  1. Reaction Backing: Concrete of a mix not leaner than 1 cement: 2  $\square$  sand: 5 stone and having a compressive strength of not less than 2,000 psi, at 28 days. Place backing between solid ground and the fitting to be anchored; the area of bearing on the pipe and on the ground in each instance shall be as indicated on the Drawings or directed by the Engineer. Unless otherwise indicated or directed, place backing so that the pipe and fitting joints will be accessible for repair.
  2. Metal Harness: Where indicated, use metal harness of tie rods of adequate strength to prevent movement. Steel rods or clamps shall be galvanized and painted with two coats of asphalt type paint.
- B. Anchorage for Bends: Provide thrust restraint system for all bends deflected 11.25 degrees or more on mains six inches in diameter or greater.
  1. Use only a thrust block system for PVC pipe.
  2. Use metal rods only as indicated on the Drawings or directed by the Engineer.

3. Do not use split retainer flanges on PVC pipe to obtain a restrained joint.

### 3.4 TESTS

- A. Pressure/Leakage Test of Force Mains. Upon completion of the installation and backfilling of each portion of the force main, a formal pressure leakage test will be required of the force mains, valves and fittings in the system constructed (no services 2" in diameter or less). Where any section of a main is provided with concrete thrust blocks, the test shall not be made until at least five (5) days have elapsed after the concrete was installed. If high-early-strength cement is used in the concrete thrust blocks, the test shall not be made until at least two (2) days have elapsed. Prior to the formal test, the main to be tested shall be thoroughly flushed. The force main shall then be tested as per Unibell Standard Test #UNB-3. See standard for leakage requirements.
- B. The Engineer shall be furnished a written report of the results of the hydrostatic test that identifies the specified length of pipe testing, the pressures (minimum 1.5 times working pressure), the duration of the test, and the amount of leakage.
- C. If any test of pipe laid discloses leakage greater than specified in Unibell UNB-3, the Contractor shall at his own expense locate and repair the defective pipe or joints until the leakage is within the specified allowance.
- D. The Contractor shall furnish all labor, materials, tools and equipment necessary for or incidental to satisfactory testing, and shall be responsible for any damage to the pipe line or to adjoining property, due to this work.

### 3.5 SUBMITTALS

- A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cuts or other data as required, to provide a complete description of piping and piping specialties.
- B. Certificates
  1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
  2. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.



3.6 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle and store pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects.

END OF SECTION 02732

## SECTION 02733 – LOW PRESSURE SEWER PIPE (FORCE MAIN)

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

- A. Low Pressure Sewer Pipe and Fittings.
- B. Site Conditions.
- C. Excavation, Bedding & Backfill.
- D. Anchorage.
- E. Tests.
- F. Submittals.
- G. Product Delivery, Storage and Handling.

## 1.2 RELATED SECTIONS

- A. Trenching, Backfilling, and Compacting, Section 02221.
- B. Manholes, Section 2605
- C. Cast-in-Place Concrete, Section 03300.

## PART 2 - PRODUCTS

## 2.1 HIGH DENSITY POLYETHYLENE PIPE (HDPE)

- A. The pipe and fittings shall be made of High Density, Extra High Molecular Weight (EHMW) polyethylene with a standard thermoplastic material designation code of PE3408 and having a cell classification of 345464E per ASTM D3350. The molecular weight category shall be extra high (250,000 to 1,500,000) as per the Gel Permeation Chromatography determination procedure with a typical value of 300,000 to 330,000. The pipe shall be manufactured in accordance with ASTM F714 and/or ASTM D3035.
- B. The manufacturer shall provide certification that the stress regression testing has been performed on the specific product in accordance with ASTM D2837 "Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials". The certification shall also state the specific resin used and its source.

- C. HDPE pipe manufactured from materials meeting the specifications of this section shall have an Environmental Stress Crack Resistance of no failures in 10,000 hrs. (ESCR:  $F_o > 10,000$ ) when tested in accordance with ASTM F1248.
- D. The pipe and fittings shall have product traceability. The manufacturer shall include a printline on the pipe. This shall notate the manufacturer's name, date of manufacture, the lot and supplier of raw material, plant location, and production shift. The ASTM standard shall also appear as ASTM F714 with the material designation as PE3408.
- E. Both pipe and fittings shall carry the same pressure rating. All fittings shall be pressure rated to match the system piping to which they are joined. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall match the outside diameter and minimum wall thickness specifications of ASTM F714 for the same size pipe. Fittings shall be manufactured by the pipe manufacturers or be compatible fittings as recommended by the pipe manufacturers. Elbows, tees, and wyes shall be manufactured by mitered fabrication. All fittings shall be derated according to the manufacturer's written specifications, and clearly labeled on the fitting as such.
- F. Force main and lateral HDPE pipe shall meet the dimensional requirements of SDR 11 and SDR 11.5 with a pressure rating of not less than 160 psi.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Installation shall be in accordance with ANSI/ASTM F585, "Standard Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers."
- B. The system shall be complete, including special equipment for transport and fusion joining of HDPE pipe. The Contractor shall be familiar with the procedures of installation and joining of pipe sections.
- C. Pipe shall be installed in such a way as to not create tension or compression forces in the pipe. Concrete encasement thrust blocking shall be placed at curvatures greater than forty-five degrees, or where pipe movement is likely to occur, at the direction of the Engineer.

### 3.2 SITE CONDITIONS

- A. Environmental Requirements
  - 1. Keep trenches dewatered until pipe joints have been made and concrete cradle or encasement, if any, have cured.
  - 2. Under no circumstances lay pipe in water or on bedding containing frost.
  - 3. Do not lay pipe when weather conditions are unsuitable, as determined by the Engineer, for pipe laying work.

### 3.3 EXCAVATION, BEDDING & BACKFILL

- A. Non-metallic force mains to be installed with magnetic underground warning tape.
- B. Where force main is benched into a sewer trench, the sewer backfill shall be installed to the elevation of the force main prior to the force main installation and backfill.

### 3.4 JOINING

- A. Heat Fusion Joining Systems: Pipe and fittings shall be thermal butt fusion, saddle fusion, or socket fusion according to manufacturer recommended procedures.
- B. The manufacturer shall provide fusion training. The Contactor (actual installers) and the onsite joint inspector shall be trained by the manufacturer or manufacturer's authorized representative.
- C. It will not be permitted to join unlike SDR's to one another. Transition from unlike SDR's shall be accomplished by mechanical couplings capable of identical pressure ratings or machined polyethylene nipples where a thicker wall polyethylene has been matched to the companion pipe wall.
- D. Mechanical Joining Systems: HDPE pipe and fittings shall be connected by means of a polyethylene flange adapter and backup ring. The polyethylene flange adapter will be of the same specifications as the LightView except will be made from black plate stock. This method is also approved to join to another piping system or valves. Mechanical compression couplings or full circle encasement clamps may be used depending on the test specification.
- E. Mechanical couplings shall be installed in accordance with the mechanical coupling manufacturer's recommended procedures.
- F. Equipment: The fusion equipment and operator shall be required to demonstrate successful field experience.

### 3.5 TESTS

- A. Pressure/Leakage Test of Force Mains. Upon completion of the installation and backfilling of each portion of the force main, a formal pressure leakage test will be required of the force mains, valves and fittings in the system constructed. Where any section of a main is provided with concrete thrust blocks, the test shall not be made until at least five (5) days have elapsed after the concrete was installed. If high-early-strength cement is used in the concrete thrust blocks, the test shall not be made until at least two (2) days have elapsed. Prior to the formal test, the main to be tested shall be thoroughly flushed. The force main shall then be tested as per Unibell Standard Test #UNB-3. See standard for leakage requirements.
- B. The Engineer shall be furnished a written report of the results of the hydrostatic test that identifies the specified length of pipe testing, the pressures (minimum 1.5 times working pressure), the duration of the test, and the amount of leakage.

- C. If any test of pipe laid discloses leakage greater than specified in Unibell UNB-3, the Contractor shall at his own expense locate and repair the defective pipe or joints until the leakage is within the specified allowance.
- D. The Contractor shall furnish all labor, materials, tools and equipment necessary for or incidental to satisfactory testing, and shall be responsible for any damage to the pipe line or to adjoining property, due to this work.

### 3.6 WARRANTY

- A. The manufacturer shall provide evidence that their standard Terms and Conditions of Sales for warranty and guarantee have been one year from date of manufacture for a period of at least five years. It will not be permitted for a manufacturer to waive the date for the period of warranty and guarantee for this project to meet this specification. The one year date of manufacture shall be covered under the standard Terms and Conditions of Sale.

### 3.7 SUBMITTALS

- A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, catalog cuts or other data as required, to provide a complete description of piping and piping specialties.
- B. Certificates
  1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
  2. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.

### 3.8 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Transport, handle and store pipe materials and other products specified herein in a manner recommended by the respective manufacturers to prevent damage and defects.

END OF SECTION 02732

## SECTION 02966 – VALVE BOXES

## PART 1 - GENERAL

## 1.1 DESCRIPTION

- A. Refer to details.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Type 1: Roadway Style – 5-1/4” inside diameter, cast iron, asphaltic coated 3-piece adjustable valve box, round head, with the word “**SEWER**” printed on top.
  - 1. Manufacturers: Bringham & Taylor, Mueller or Tyler.
- B. Type 2: Curb Stop Box: 1” inside diameter upper section, asphaltic coated 2-piece cast iron with operating rod and lid with brass head plug.
  - 1. Manufacturer: Ford Model EA2-40-40-24R or Mueller.
- C. Adjustable Pipe Supports: Provide Standon S92 saddle support for 2- and 3-inch pipes and C92 saddle clamp support for 2-inch pipe with ASTM A36 saddle strap, threaded stud, base plate and ASTM A53 collar/base cups with MIG welding and a corrosion resistant galvanized finish.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install Type 1 valve boxes at every distribution valve, blow-off valve, and hydrant isolation valve.
- B. Provide valve box length as required to accommodate valve depth.
- C. Provide Type 2 valve boxes with extended rods for curb stops.
- D. Support valve boxes in accordance with details.
- E. Valve boxes shall be flush with the finish grade.

- F. Locate curb stop valve box in concrete sidewalk. If area does not specify for the installation of sidewalk, provide 4" thick concrete pad a minimum of 12" square as noted on the standard details.

END OF SECTION 02966

## SECTION 02967 – VALVES AND FLUSHING CONNECTION

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. The Contractor shall provide the equipment and materials listed herein as part of Contract.

#### 1.2 SUBMITTALS

- A. Shop drawings and product data.

#### 1.3 RELATED SECTIONS

- A. Precast Concrete Structure, Section 02605.
- B. Valve Boxes, Section 02966.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Sewage Combination Air Valve: Provide APCO Model 443WA.1 (2-inch inlet and 1-inch outlet) air release valve where shown on the drawings. Valves shall be provided with shutoff valve, blowoff valve, flush valve and minimum 5-foot rubber hose with quick disconnect coupling for back flushing.
- B. Ball Valve: Provide Nordstrom poly-water HDPE valves for flushing connections as shown on the Drawings. Valves shall be of drop-light shutoff, multiple elastomeric stem seals, smooth full bore, EPDM seat, flanged ends, and 200 psi rated pressure.
- C. Adjustable Pipe Supports: Provide Standon S92 saddle support for 2- and 3-inch pipes and C92 saddle clamp support for 2-inch pipe with ASTM A36 saddle strap, threaded stud, base plate and ASTM A53 collar/base cups with MIG welding and a corrosion resistant galvanized finish.



- D. Flushing Hydrants: Provide 2" Flushing hydrants for the intermediate and terminal cleanout assemblies. The 2" flushing hydrants are to be hidden underground within a heavy duty precast concrete junction box with cover. Provide a 2-1/2" brass NSFT discharge with cap and chain on top of the pipe riser and is exposed within the junction well box. Also exposed in the well is the top of the valve stem for the integral bronze body ball valve with automatic weep that allow for the hydrant barrel to drain. Basis of design is Gil Industries or an approved equal. Utilize two (2) 45° elbows in lieu of a 90° elbow. Refer to the drawings for more information.

### PART 3 - EXECUTION

#### 3.1 EQUIPMENT

- A. Equipment described in this Section to be installed at the location shown on the drawings, as applicable. Where equipment is not shown, or where equipment is a portable item, deliver to Owner prior to completion of Contract.

END OF SECTION 02967

## SECTION 03300 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

## 1.1 SECTION INCLUDES

## A. Concrete materials and mixes for the following:

1. Concrete Cradle and/or Encasement.
2. Reaction Backing (Thrust Blocks).
3. Manhole Base Channel Fill.
4. Manhole Bases.
5. Anti-Flotation Rings.
6. Concrete Footings, Equipment Foundations, Slabs on Grade.

## 1.2 REFERENCES

## A. American Association of State Highway and Transportation Officials, AASHTO M182 Burlap cloth made from Jute or Kenaf.

## B. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete for Buildings.
2. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
3. ACI 305R - Hot Weather Concreting.
4. ACI 306R - Cold Weather Concreting.
5. ACI 308 - Standard Practice for Curing Concrete.
6. ACI 309 - Standard Practice for Consolidation of Concrete.
7. ACI 318 - Building Code Requirements for Reinforced Concrete.

## C. American Society for Testing and Materials:

1. ASTM C33 - Concrete Aggregates.
2. ASTM C39 - Compressive Strength of Cylindrical Concrete Specimens.
3. ASTM C94 - Ready Mixed Concrete.
4. ASTM C143 - Slump of Portland Cement Concrete.
5. ASTM C150 - Portland Cement.
6. ASTM C171 - Sheet Materials for Curing Concrete.
7. ASTM C171 - Sampling Freshly Mixed Concrete.
8. ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method.
9. ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method.
10. ASTM C260 - Air Entraining Admixtures for Concrete.
11. ASTM C309 - Liquid Membrane - Forming Compounds for Curing Concrete.
12. ASTM C494 - Chemical Admixtures for Concrete.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Portland Cement: ASTM C150 of the following type:
  - 1. For concrete which will be in contact with sewage: Type II, Moderate Sulfate Resistance.
  - 2. For all other uses: Type I, Normal.
- B. Aggregates: Meeting requirements of ASTM C33.
- C. Water: Potable quality, clean and free of injurious amounts of oil, acid, alkali, organic matter, suspended matter, and other deleterious substances.
- D. Concrete Admixtures:
  - 1. Air-Entraining Admixture: Use a product conforming to ASTM C260, certified by manufacturer to be compatible with other required admixtures.
  - 2. Water-Reducing Admixture: ASTM C494, Type A, and containing not more than 0.1 percent chloride ions.
  - 3. High-Range Water-Reducing Admixture (Super Plasticizer): ASTM C494, Type F or Type G and containing not more than 0.1 percent chloride ions.
  - 4. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C494, Type E, and containing not more than 0.1 percent chloride ions.
  - 5. Water-Reducing, Retarding Admixture: ASTM C494, Type D, and containing not more than 0.1 percent chloride ions.
  - 6. Prohibited Admixtures: Calcium chloride thyocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.
- E. Moisture-Retaining Cover: One of the following, complying with ASTM C171.
  - 1. Waterproof paper.
  - 2. Polyethylene film.
  - 3. Polyethylene-coated burlap.
- F. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ASTM C309, type I, Class A. Moisture loss not more than 0.055 gr/sq cm when applied at 200 sq ft/gal.
  - 1. Acceptable Manufacturers:
    - a. Masterseal; Master Builders.
    - b. L&M Cure; L&M Construction Chemicals.
    - c. Substitutions: Under provisions of Section 01600.

## 2.2 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.
- B. Compressive Strength:
1. Provide concrete with 28 day compressive strength as specified in other Specification Sections.
  2. Where no compressive strength is specified, use 3,000 psi concrete.

C. Admixtures:

1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.
2. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50°F.
3. Use high-range water-reducing admixture in pumped concrete, concrete required to be watertight, and concrete with water/cement ratios below 0.50.
4. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or-minus 1-1/2 percent within following limits:
  - a. Concrete exposed to freezing and thawing, deicer chemicals, or subjected to hydraulic pressure:

Maximum Aggregate Size (inches)	Air Content (% by Volume)
1/2	5-9
3/4	4-8
1	3.5-6.5
1-1/2	3-6
2	2.5-5.5
3	1.5-4.5

- D. Water-Cement Ratio: Provide concrete for following conditions with maximum water-cement (W.C.) ratios as follows:
1. Concrete with 28 day compressive strength required to be 3,000 or higher: 0.58 maximum (non air-entrained), 0.40 maximum (air-entrained).
- E. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
1. Slump: Not less than 1" nor more than 4", except when super plasticizer is used, slump may be as high as eight inches.

## 2.3 CONCRETE MIXES

- A. Job-Site Mixing: Not Allowed.
- B. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as herein specified.
  - 1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required.
  - 2. When air temperature is between 85°F and 90°F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes, and when air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 CONCRETE PLACEMENT

- A. General: comply with ACI 304 "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete", and as herein specified.
- B. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.
- C. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305.

### 3.2 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
  - 1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than seven days.
  - 2. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least seven days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing, and by combinations thereof, in accordance with ACI 308.

### 3.3 FINISHES

- A. Provide a steel troweled floor finish on the floors of the generator stations.

### 3.4 QUALITY CONTROL

- A. Sampling and testing for quality control during placement of concrete may include the following, as directed by Engineer.
1. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
  2. Slump: ASTM C143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
  3. Air Content: ASTM C173, volumetric method; ASTM C231 pressure method; one for each day's pour of each type of air-entrained concrete.
  4. Concrete Temperature; Test hourly when air temperature is 40° F and below, and when 80°F and above; and each time a set of compression test specimens made.
  5. Compressive Strength Tests: ASTM C39; one set for each day's pour exceeding 5 cubic yards plus additional sets for each 50 cubic yards over and above the first 25 cubic yards of each concrete class placed in any one day; one specimen tested at seven days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required. The average compressive strength for the two 28 day specimens will be used to determine compliance with the compressive strength requirements.

END OF SECTION 03300

## SECTION 11100 - SEWAGE PUMPING STATIONS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Concrete Wet Well.
- B. Valve Chamber
- C. Submersible Pumps
  - a. Pump Motor
  - b. Motor Starter
  - c. Pump Controls
- D. Sewage Grinder
- E. Emergency Generator

#### 1.2 RELATED SECTIONS

- A. Trenching, Backfilling, and Compacting, Section 02221.
- B. Force Mains, Section 2732
- C. Valves and Flushing Connections, Section 02967
- D. Cast-in-Place Concrete, Section 03300.

#### 1.3 GENERAL GUIDELINES

- A. The intent of this section of the specifications is to provide the Developer / Contractor with **General Guidelines** for the design and construction of sewage pumping stations. Each pumping station is unique and will need to be designed and constructed as such.
- B. Nothing in these specifications shall preclude the Developer / Contractor from conformance with the PADEP Domestic Wastewater Facilities Manual. Where conflicts occur the more stringent requirement shall govern.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Pressure ratings of sewage pumps and discharge piping components shall be at least 150% of the sewage pump discharge pressure but not less than 150 psig.
- B. Force main velocities shall be a minimum of 2 ft/sec with 3 to 3.5 ft/sec preferred. Maximum velocity shall be 6 ft/sec.

## 1.5 SUBMITTALS

### A. Shop Drawings and Product Data:

1. Manufacturer's published detail drawings showing the wiring diagrams, pipe, joints, fittings, connection details, equipment, materials, procedures for fabrication and erection, adapters, appurtenances, procedures for earthwork, shoring, bracing, procedure of dewatering, methods of installation and testing, and other relevant details of the complete installation, modified to suit design conditions if required, and Contractor prepared drawings as applicable.
2. Manufacturer's descriptive literature and specifications covering the product specified. Include installation information.

### B. Certificates:

1. Submit test certificates for each consignment or shipment to indicate all materials and equipment required by the Specifications are satisfactorily tested by the manufacturer and found to comply with specified requirements.

### B. Design Engineer's Report:

1. Design Engineer's report listed pump capacities and detailing pump selection method and calculations. Manufacturer's data on pumps shall include pump characteristic curves showing head, capacity, efficiency, and brake horsepower.

### B. Operation and Maintenance Manual:

1. The Developer / Contractor shall furnish for submission with each unit or set of identical mechanical units copies of printed instruction books. These books shall include operation, maintenance and repair information, location and telephone number where spare parts may be ordered, plus a parts list. The parts list shall indicate the various parts by their name, number, and diagram.

## 1.3 QUALITY ASSURANCE

### A. Workmanship and Guarantee

1. The manufacturer of the pumping station shall have a minimum of five years experience in the design and manufacture of submersible pumping stations and shall guarantee the structure and all equipment to be free from defects in materials and workmanship for a period of up to one year from date of start-up.
2. Warranties and guarantees by the suppliers of various components in lieu of a single-source responsibility by the manufacturer will not be accepted. The manufacturer shall be solely responsible for the guarantee of the station and all components, with the exception of the flow metering and remote monitoring system. These shall be warranted by their respective manufacturers.
3. In the event a component fails to perform as specified or is proven defective in service during the guarantee period, the manufacturer shall provide a replacement



part without cost to the Owner. Manufacturer shall further provide, without cost, such labor as may be required to replace, repair, or modify major components such as the pumps, pump motors, and sewage piping manifold.

C. Factory Tests

1. All components of the pumping station shall be given an operational test of all equipment at the factory to check for excessive vibration, for leaks in all piping or seals, for correct operation of the control systems and all auxiliary equipment. Pumps shall take suction in a manner to simulate actual service conditions. The control panel shall undergo a full operational test with all systems operating.
2. Each pump shall be factory tested by the manufacturer for capacity, power requirements, and efficiency at the specified minimum operating head, rated head, shut-off head, and at three points as necessary to provide a certified pump performance curves. Certified curves will be provided for each serial number pump being supplied to the project and be performed to Hydraulic Institute test level A standards for engineer's review prior to shipment.

1.3 PRODUCT STORAGE AND HANDLING

A. General

1. The Contractor shall at all time take necessary steps to protect and preserve all materials, supplies, equipment and all work which has been performed.
2. Should work be suspended temporarily because of inclement weather or other causes, the Contractor shall take such steps as are necessary to protect materials, supplies, equipment and work performed against damage and injury. Any damaged materials, supplies, equipment, or work performed shall be removed and replaced at the expense of the Contractor.

B. Storage and Handling

1. In all cases, equipment and materials shall be stored per manufacturer instructions so that equipment and materials shall remain undamaged and in suitable condition for installation. Damaged equipment and materials shall be replaced at the expense of the Contractor.
2. All materials shall be so handled that the coating and/or linings shall not be damaged. If any part of the coating or lining is damaged, it shall be repaired or replaced by the Contractor at no cost to the Owner.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION OF EQUIPMENT

- A. The Contractor shall furnish and install a pumping station within a concrete wet well and valve chamber. Each pump shall be capable of handling raw, unscreened domestic sewage consisting of water, fibrous materials, and 3"inch diameter spherical solids. The pump (s) shall be capable of handling liquids with temperatures to 104 degrees F continuous, 160 degrees F intermittent, and shall be capable of running dry for extended periods.
- B. The station will be provided with a portable hoist rated to lift the pumps within the station, and remove them from the wet well.

### 2.2 SEWAGE PUMPS AND MOTOR

#### A. Pumps General:

1. Furnish and install a minimum of two submersible non clog or grinder type pumps, ITT Flygt Corporation or approved equal, to meet specified operating conditions with at least one pump fitted with the ITT Flygt mix flush valve assembly and the other pump fitted with the mix flush valve adapter only.
2. The pump(s) shall be manufactured by a company regularly engaged in the manufacture and assembly of similar units for a minimum of five (5) years.
3. Pumps, mechanical seals and motor units provided shall be from the same manufacturer in order to achieve standardization of operation, maintenance, spare parts, service and warranty.

#### B. Pump Construction:

1. Furnish and install a minimum of two submersible non clog or grinder type pumps, ITT Flygt Corporation or approved equal, to meet specified operating conditions with at least one pump fitted with the ITT Flygt mix flush valve assembly and the other pump fitted with the mix flush valve adapter only.
2. The volute, seal plates, impeller and motor housing shall be constructed of high quality ASTM A-48 class 30 cast iron. Pump (s) shall be painted with a water based air dry enamel of 2.0 mil minimum thickness. All exposed hardware shall be 300 series stainless steel. The pump construction shall contain no points of critical clearance nor require periodic adjustment or replacement to maintain operating efficiency. Discharge connection shall be a standard 125 pound 4" inch flange. All gaskets shall be of the compression square ring type eliminating critical slip fits and the possibility of damage during service associated with sliding o-ring sealing arrangements.
3. The impeller shall be of the non-clog design with pump out vanes on the back side. The impeller shall be dynamically balanced to ISO G6.3 specifications. The double mechanical shaft seal shall be of the single spring design operating in an oil-filled

seal cavity. Pump-out vanes in the back of the impeller shroud shall develop a radially increasing pressure differential from the impeller hub outward. This pressure differential shall be transmitted by means of a Buna-N elastomer diaphragm to the oil in the seal cavity, thus producing a higher pressure inside the seal cavity than immediately adjacent to the seal face in the pump case forcing the oil in the seal cavity to be the seal face lubricant. The materials of construction shall be silicon carbide for the rotating faces and silicon carbide for the stationary faces, lapped and polished to a tolerance of one light band, 300 series stainless steel hardware, and all elastomer parts to be of Buna-N.

4. The seal shall be commercially available and not a manufacturer's proprietary design. A moisture sensor detection system consisting of two probes utilized as a positive/negative pole shall be integrated within the oil-filled seal chamber. Units utilizing one probe and grounding through the pump case or a float device are not acceptable.

C. Electric Motor:

1. The motor shall be designed to be non-overloading throughout the entire intended hydraulic operating range. The pump and motor shall be UL Listed with Underwriters Laboratories as Class I, Division I, Groups C & D, explosion proof, for installation in water and sewage. All electrical parts shall be housed in an air filled, cast iron, watertight enclosure. The enclosure shall be sealed by the use of o-rings and shall have rabbit joints with a large overlap. The motor shaft extension and all external hardware shall be stainless steel. The motor windings shall have class F insulation system minimum and a 1.15 service factor. The shaft seals shall be a tandem design and operate in an oil filled enclosure. The shaft sealing system shall run in an oil bath. The lower, primary seal shall consist of one stationary silicone carbide ring and one positively driven (rotating) silicon carbide ring; while the upper seal between the motor and the oil housing shall consist of one stationary stainless steel ring and one positively driven rotating carbon ring. Each interface shall be held in place by its own independent spring system. The seal shall be commercially available and not a manufacturer's proprietary design.

Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with a thermal switch embedded in the end coil of the stator winding. This shall be used in conjunction with and supplemental to external motor overload protection and wired to the control panel.

The pump shall be equipped with type 6/4 SOW-A power cable and sensor cable type 18/5 SOW. The cable entry design shall be such that it precludes specific torque requirements to insure a watertight and submersible seal. All incoming lead wires shall be spliced in the motor terminal housing. After splicing, the terminal housing shall be filled with epoxy to seal the outer cable jacket and the individual strands to prevent water from entering the motor housing. A secondary rubber pressure grommet shall be provided as an additional sealing point and strain relief at the point of cable entry. Cable entry designs utilizing terminal boards to connect power cord leads with motor leads shall not be acceptable. The pump cord(s) shall be equipped with a properly sized metric fitting to connect to pump disconnect box.

2.3 PUMP DISCONNECT PANEL AND STAND

- A. An appropriately rated stainless steel junction box shall be provided and mounted on the top slab of the system. The enclosure shall be lockable single door and carry an IP rating of 66 minimum. The disconnect panel shall be mounted on a stainless steel pedestal with stainless steel mesh that provides atmospheric separation per NEC requirements. The wires shall be surrounded by stainless steel wire mesh of which one side can be removed to access the wiring. Meltric fitting sized for pump amperage shall be installed for quick removal and replacement of pump units. The precast concrete slab shall include an aluminum cable trough with bolt down cover to allow pump control wires to reach into disconnect box without any splicing.

## 2.4 SWITCH RATED PLUGS AND RECEPTACLES

- A. Meltric DSN Decontactor Series switch rated plugs and receptacles should be used for connecting the pump power cords into the bottom of the junction box. Hazardous location models suitable for Class 1, Division 2, Group D location shall be provided. The plugs and receptacles shall include the following features.

1. Features:

- a. Spring-Loaded Butt Contacts – Butt style contacts ensure a very positive and consistent connection. The spring loading of these contacts, which is accomplished with coil springs, provides a desirably high contact force that remains constant over thousands of operations. In addition, it should automatically compensate for any wear and/or deviations in contact length resulting from manufacturing tolerances.
- b. Silver-Nickel Contact Material – Solid silver-nickel (85%/15%) contacts should be used. Brass contacts will not be considered acceptable. The silver-nickel combination is used for the excellent electrical and mechanical properties.
- c. Dead Front Construction – When used in submersible pump applications the dead front construction should be used to enhance safety by eliminating unintended access to live parts. Dead front should be able to be opened only by an appropriate mating plug.
- d. Enclosed Arc Chambers – The contacts should make and break within enclosed arc chambers. By containing arcing in the chamber, safety is greatly enhanced.
- e. Push Button Load Breaking – To disconnect the switch the user needs to depress the pawl, which will cause the circuit to be disconnected and the plug to be ejected to its off position.
- f. Automatic Watertightness – The DSN contactor shall have a NEMA 4X rating, while the DS and DB models shall have a NEMA 3R rating.
- g. Spring Assisted Terminals – A spring ring shall surround the conductor terminal, which applies constant pressure as the terminal screw is tightened.
- h. Stainless Steel Springs & Screws – All hardware shall be made of stainless steel.
- i. The DS, DSN, and DB product lines shall be UL, CSA, and IEC switch rated plugs and receptacles.
- j. Optional Auxiliary Contacts – Integral pilot contacts shall be an option. These pilot contacts shall be able to control auxiliary equipment, monitor parameters, or communicate alarms through the same plug as the power

supply.

- B. Pump Retrieval Chain Sling for Each Pump - Stainless steel chain attaches to pump lifting handle and smarty lift grasps chain for pump lifting and installation.

## 2.5 CORD STRAIN RELIEF

- A. Each pump cord shall be fitted with a stainless steel Kellems cord grip to help support the weight of the pump power and control cables. Kellems support grips are used to hold the weight of electrical cable as it hangs in a vertical, sloping or horizontal position. Electrical cable must be supported, or its dead weight can cause excessive strain or pullout at the connections resulting in pump failure.

## 2.6 WET WELL

- A. The wet well shall be as indicated on the drawings with a monolithically poured base and riser section. The unit shall have minimum 8" thick walls and a flotation collar and precast hopper bottom, 4,000 PSI reinforced concrete conforming to ASTM specific C-478. All joints shall be sealed with Ram-Nek sealant. The top cover slab shall be a minimum of 8" thick concrete with a U.S.F. Fabrication lockable aluminum cover inserted to size written in the specifications below. The junction box shall be mounted to a stainless steel frame, and the wires shall be surrounded by stainless steel wire mesh of which one side can be removed to access the wiring. The entire structure shall be mounted to the concrete wet well slab to allow maintenance personnel to disconnect wiring without entering or reaching into the wet well.

1. Manufacturer: AC Miller Concrete Products or approved equal.

- B. Piping in the station shall be minimum 4" cement lined ductile iron with threaded flanges. No "uniflanges", slip on flanges, or flexible couplings will be allowed in the pumping station. The station shall also be equipped with an inlet gasket, minimum 2.00" stainless steel guide rails, and a stainless steel level control switch-mounting bracket with a compression grommet that allows for level setting adjustment. A galvanized vent with bird screen of size shown shall be mounted through the top slab of the wet well. The vent shall have a confined space warning sign attached with stainless steel U-bolts.

- C. The station shall also be equipped with an inlet gasket(s) as per the station drawing, stainless steel guide rails, pump and control and a level control switch mounting bracket for floats and transducer and a cable rack to hang pump cords with stainless steel Kellems cord support grips.

- D. A white epoxy coating shall be applied to the entire interior concrete surface of the wet well. The coating shall consist of minimum two (2) coats, each six (6) mils thick, applied as recommended by the manufacturer under controlled conditions at concrete manufacturer's plant.

1. Manufacturer: Penn-Chem Coating #54-W-23 by MAB Coatings or approved equal.

- E. Bitumastic coating shall be applied to the below grade exterior concrete surface of the wet well.

## F. Pipe Gaskets:

1. All pipe penetrations in the manhole shall be sealed watertight using flexible rubber gaskets conforming to ASTM C923 specifications. The use of caulking or epoxy type liner systems at the pipe penetrations shall not be acceptable.
  - a. Manufacturer: Kor-N-Seal as manufactured by NPC, or approved equal.

## 2.8 VALVES

## A. Air Cushioned Swing Check Valve:

1. Horizontal swing check valves, sized as shown on the plans shall be installed in the discharge piping. The swing check valve shall be constructed with heavy cast iron or cast steel body with a bronze or stainless steel seat ring, a non-corrosive shaft for attachment of weight and lever, and complete non-corrosive trim cushion chamber. It shall absolutely prevent the return of water, oil or gas back through the valve when the inlet pressure decreases below the deliver pressure. The valve must be tight seating, and must be cushioned in operation. The seat ring must be renewable. The cushion chamber shall be attached to the side of the valve body externally and so constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The cushion chamber shall be arranged that the closing will be adjustable to meet the service requirements. The valve disc shall be convex and of cast iron or cast steel and shall be suspended from a non-corrosive shaft which will pass through a stuffing box and be connected to the cushion chamber on the outside of the valve. All material and workmanship shall be first class throughout and the purchaser reserves the right to inspect this valve before shipment. The valve shall be the GA Industries, Inc. Fig. No. 250-D, or APCO Series 6004 or approved equal.

## B. Resilient Seat Gate Valves:

1. Resilient Seat Gate Valves 12 Inches and Under for Buried Service Installation: Resilient wedge, iron body, bronze trim, resilient seat for zero leakage, mechanical joint ends, non-rising stem, O-Ring packing, 2-inch operating nut, epoxy coating inside and outside applied before valve assembly. Valves shall meet or exceed AWWA Standard C504, C509 and C550 (current edition). Valves shall be rated for 200 psi minimum with no leakage. Valves shall be line size in accordance with the diameters shown on the drawings. Manufacturer: Mueller A-2360, US Metroseal or equal.

## C. Valve Chamber:

1. Provide a separate concrete valve chamber for discharge, gate valves and swing check valves. Valve chambers shall be constructed of concrete as specified for pump station with minimum 6" walls and 10" bottom, white epoxy coating interior, bitumastic coating exterior (below grade only). The top cover slab shall be concrete with a U.S.F. Fabrication lockable aluminum cover inserted to size written in the specifications below. Piping shall be sealed with boot gaskets and waterstops where it penetrates the wall. Aluminum ladder with safety extension shall be provided in the chamber. The valve chamber floor shall be sloped toward the drain line to provide sufficient drainage. A 2 "

PVC drain line sloped at 3% with flap valve or Tide Flex valve shall be installed from valve chamber to wet well. The valve chamber shall incorporate precast concrete piers with stainless steel straps or "Standon" pipe supports to support and stabilize piping.

2. Manufacturer: AC Miller Concrete Products or approved equal.

D. Piping and Valves:

1. The station sewage piping shall be class 53 ductile iron pipe that will extend down through the common base plate terminating in plain ends exterior to the pump chamber. Steel or PVC pipe will not be accepted as an "or equal" substitute to the ductile iron pipe specified. The pipes shall be sealed where they penetrate the concrete with link seal or a gasket to form a gas tight seal between the pump valve chamber and wet well. Each discharge line shall be fitted with a gate valve and check valve as specified herein and sized as shown on the plans. All piping shall be field coated with two coats of gray epoxy to a DFT of 10 – 12 mils. Valve vault piping shall also include an emergency bypass connection.

## 2.9 PRESSURE GAUGES

- A. Provide a filled sleeve pressure sensor assembly on each of the pump discharge lines. Provide ample space for gauge assembly, valve operation and process sampling. Each pressure gauge shall be an all welded assembly. The diaphragm shall be recessed within the all-welded body, and the pressure gauge is back-welded to the seal upper housing to eliminate another potential leak path. No threaded seal fill port should be included to ensure tamper resistant design.
1. Suitable Pressure Ranges: 0 psi to 100 psi
  2. Operating Temperature: 0°F to 200°F
  3. Ambient Temperature: -40°F to 150°F
  4. Dial Size: 2 1/2" process gauge
  5. Process Connection: 1/4" NPT female
  6. Process materials: Carbon steel body; Class 150 flanges; Neoprene sleeve; ethylene glycol and water fill fluid
  7. Manufacturer: Red Valve Series 40 or approved equivalent

## 2.10 WET WELL HATCH

- A. The hatch shall have a clear opening as indicated on the Drawings. Door leaf shall be 1/4 inch thick aluminum diamond plate reinforced for a 300 p.s.f. live load. The frame shall be extruded aluminum channel section with an integral anchor flange on all four (4) sides. The frame shall include an EPDM odor reduction gasket that reduces the amount of odor that escapes from below the door and a 1-1/2 inch threaded drain coupling. The floor access door shall be equipped with a flush drop handle that does not protrude above the cover, and a stainless steel hold open arm with red vinyl grip that automatically locks the cover in the 90 degree open position. The door shall have stainless steel hinges and stainless steel tamper resistant bolts/locknuts. A staple for a padlock shall be supplied for security. All stainless steel components shall be type 316 alloy. An adhesive backed vinyl material that protects the product during shipping and installation shall cover the entire top of the frame and cover. Installation shall be in accordance with the manufacturer's attached instructions. The door

shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of ten (10) years.

B. Additional Features:

1. Bituminous Coating – A bituminous coating shall be applied to any part of the aluminum frame that comes in contact with the concrete.
2. Slamlock – The hatch shall be equipped with a watertight stainless steel slamlock with threaded plug, removable outside key, and fixed inside handle. The slamlock must latch onto a stainless steel catch that is bolted to the frame.
3. Hinged on Opposite Short Sides – The doors of the hatch shall be hinged on opposing short sides.
4. Hinged Aluminum Safety Gate – The hatch shall have a fall through prevention system capable of withstanding a load of 300 pounds per square foot. The hatch should not rely on the safety gate to achieve its 300 pounds per square foot. Instead both the hatch and safety gate should independently achieve a rating of 300 pounds per square foot. It will consist of an aluminum grate with 5" x 5" openings that rotates on hinges that are welded to the hatch frame. When the grate is lifted to its open position, it will lock in place and serve as a barrier. The door cannot be closed until the Hinged Aluminum Safety Gate is completely closed. (Will reduce clear opening.)

- D. Manufacturer: The floor access door shall be Model TPD as manufactured by U.S.F. Fabrication, Inc. or approved equal.

## 2.11 VALVE CHAMBER HATCH

- A. The hatch shall be as indicated on the Drawings. Door leaf shall be ¼-inch thick aluminum diamond plate reinforced for a 300 p.s.f. live load. The frame shall be extruded aluminum channel section with an integral anchor flange on all four (4) sides. The frame shall include an EPDM odor reduction gasket that reduces the amount of odor that escapes from below the door and a 1-1/2 inch threaded drain coupling. The floor access door shall be equipped with a flush drop handle that does not protrude above the cover, and a stainless steel hold open arm with red vinyl grip that automatically locks the cover in the 90 degree open position. The door shall have stainless steel hinges and stainless steel tamper resistant bolts/locknuts. A staple for a padlock shall be supplied for security. All stainless steel components shall be type 316 alloy. An adhesive backed vinyl material that protects the product during shipping and installation shall cover the entire top of the frame and cover. Installation shall be in accordance with the manufacturer's attached instructions. The door shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of ten (10) years.
- B. Additional Features:
1. Bituminous Coating – A bituminous coating shall be applied to any part of the aluminum frame that comes in contact with the concrete.



3. Slamlock – The hatch shall be equipped with a watertight stainless steel slamlock with threaded plug, removable outside key, and fixed inside handle. The slamlock must latch onto a stainless steel catch that is bolted to the frame.

- C. Manufacturer: Model TPS as manufactured by U.S.F. Fabrication, Inc. or approved equal.

## 2.12 PORTABLE HOIST

- A. A portable adjustable stainless steel hoist which has an integral base that is mounted to the top slab shall be provided. The hoist shall have a 2000 lb. maximum capacity and shall be capable of lifting the pumps without entering the wet well. The portable hoist shall be manufactured by Thern or approved equal. The hoist base shall be mounted so the hoist can reach both pumps.

## 2.13 APPURTENANCES

- A. Pump Guide Rails: Non-sparking stainless steel.
- B. Pump Mounting Plates and Guide Rail Braces: Stainless steel.
- C. Guide Rail Supports: Stainless steel.
- D. Pump Lifting Cable: Stainless steel (stainless steel lift cable shall incorporate enough length to reach into portable hoist assembly).
- E. Fasteners and Hardware: Stainless steel.
- F. Pump/Control Cable: Cable shall be supplied by the manufacturer for the entire circuit, starting at the pumps and terminating in the pump control panel. Provide junction boxes and conduit seals as required.
- G. Vent Pipes: Provide 4" galvanized iron vents with return bends and No. 8 bronze mesh insect between two flanges. Confined space warning sign should be affixed to wet well vent pipe.

## 2.14 ELECTRICAL

- A. Wiring:
  1. All wiring shall be minimum 600 volt (UL) type MTW or AWM and have a current carrying capacity of not less than 125% of the full load current.
  2. The conductors shall be in complete conformity with the National Electric Code, state, local and NEMA electrical standards.
  3. To ensure the safety of all personnel working with this equipment, as well as providing a simple means of tracing wires when troubleshooting, all wiring shall be color coded in strict accordance with the wiring diagrams furnished by the equipment supplier.

## B. UL Approval:

1. The control panel shall be constructed in compliance with Underwriter's Laboratories Industrial Control Panels listing and follow-up service, utilizing UL listed recognized components where applicable.

## C. Enclosure:

1. The described equipment shall be housed in appropriate stainless steel enclosure as shown on the drawings. Controls should be mounted on a deadfront door of the enclosure for easy access by operators.
2. All major components and sub-assemblies shall be identified as to function with laminated, engraved Bakelite nameplates or similar approved means.
3. The following described equipment shall be furnished as the control systems required and matched to the specific pumping station equipment.

## D. Power Supply and Metering:

1. Main Circuit Breaker: A properly sized molded case circuit breaker shall be provided as the main power disconnecting device for the control panel. The circuit breaker must have a minimum ampere interrupting capacity of 25,000 @ 480 volt symmetrical RMS amps.

## E. Lightning Arrestor:

1. A lightning arrestor shall be supplied in the control and connected to each line of the incoming side of the power input terminals. The arrestor shall protect the control against damage due to lightning strikes on the incoming power line.

## F. Phase Monitor:

1. A solid state, phase sequence/failure and under voltage release relay shall be provided to ensure additional running protection for the pump motors. The relay shall be complete with an LED to indicate proper phase sequence, all phases in operation and voltage within limits. The relay shall also include an adjustable voltage monitor, be UL and CSA certified and be complete with automatic reset feature.

## G. Pump Circuit Breaker:

1. A thermal magnetic circuit breaker shall be supplied as branch circuit protection for each pump motor. The circuit breaker must have a minimum ampere interrupting capacity of 10,000 @ 480 volt symmetrical RMS amps. The circuit breakers shall be operable through the operator's door of the enclosure and include provision for padlocking in open position.
2. The circuit breaker shall be properly sized to protect the control circuit conductors, motor starter and the motor against overcurrent due to short circuit or grounds.

## H. MOTOR STARTERS (Reduced Voltage Soft Starter)

Provide a microprocessor-controlled starter for three-phase induction motors. As manufactured by Benshaw type RediStart Digital motor starter. An equivalent design by an alternate manufacturer will be considered.

1. Starter shall include the following :
  - NEMA (National Electrical Manufacturers Association) specified frame size.
  - Solid state design.
  - Current limited reduced voltage starting.
  - Closed-loop motor current control.
  - Programmable motor protection.
  - Programmable operating parameters.
  - Programmable metering options.
  - Variable voltage control.
  - 120 VAC Control Voltage
2. Starter shall operate within applied voltage and frequency values of 480VAC and 60Hz.
3. The starter shall be programmed for a motor FLA and the motor service factor. The starter shall continually monitor the amount of current being delivered to the motor.
4. Starter shall include the following standard features:
  - Adjustable ramp time (0 - 120s)
  - Adjustable initial current
  - Adjustable maximum current
  - Adjustable full-voltage kick start (0.1 to 5 seconds or Off)
  - Selectable motor deceleration control for Pumps (0 - 60s)
  - Variable voltage control input (0 to 5 volts, 0 to 10 volts, 4 to 20mA)
  - Extreme current imbalance/line phase loss detection
  - Adjustable line current imbalance protection (5 - 40%)
  - General fault, motor power and up to speed form "C" contacts
  - Line phase sequence sensitivity or insensitivity
  - Phase loss and phase reversal protection
  - Selectable solid state overload class (10, 20, 30, or None)
  - Negative sequence overload biasing.
  - Adjustable motor full load amps (1 - 1600A)
  - Adjustable motor service factor (1.00 - 1.40)
  - Adjustable current transformer ratio
  - Adjustable stalled motor detection (0 - 210s)
  - Line frequency tracking (23Hz through 72Hz)
  - 120VAC external trip input (fault detection active on start or UTS)
  - 800% FLA instantaneous overcurrent detection
  - Overcurrent (jam) protection (50 - 400%, 1 to 15 seconds or disabled)
  - Undercurrent protection (25 - 100%, 1 to 15 seconds or disabled)
  - Shorted SCR detection and SCR condition indication
  - 3-digit 7-segment LED Display
  - Programmable metering

5. LED Display - A three character, alphanumeric LED display located on the control card shall display:
  - Starter status information.
  - Operating parameters.
  - Condition codes.
  - Fault codes.
  - Thermal Overload Content.
  - Metering.
  - Remote display active.

6. LED indicators - Each starter shall have indicating LEDs for:
  - Power On.
  - SCR Condition.

7. Control Relays

The starter shall have four control relays as follows:

- Start/Stop input relay: (This contact shall energize whenever the SCRs are conducting as a direct command from the starter).
- Fault output relay: (The relay shall energize any motor or starter fault is detected)
- UTS (up to speed) output relay. (The contact shall engage when a true motor Up to Speed condition is achieved)
- Motor power output relay.

Each relay shall provide three Form "C" relay contacts capable of 250VAC, 16A Resistive and 8A Inductive. The fault contact shall be only capable of 125VAC 2A Resistive, 1A Inductive.

- I. Receptacle: An inner door mounted ground fault interrupter (GFI) type convenience receptacle rated at 15 amperes shall be supplied for the operating of trouble lights, drill, etc. It shall be protected by a separate 15 ampere trip rated circuit breaker.
- J. Condensation Protective Heater: A thermostatically controlled, fan driven heater shall be supplied in the control panel to maintain a stable temperature and protect the electrical and electronic equipment from the harmful effects of condensation, corrosion and low temperatures.
- K. Motor Ground Fault: Motor Ground fault protection will be provided for each pump motor to ensure the integrity of the submersible pump cords.
- L. Control Breaker – Door Mounted: The panel shall be supplied with a properly sized control power circuit breaker. The breaker shall be operator door mounted and shall supply power to all control wiring within the enclosure.
- M. USEMCO "Sentry" or approved equivalent Pump Controller:
  1. The control system shall utilize standard "off the shelf" equipment. Job specific, "one-of-a-kind" customized software and hardware components will not be accepted

2. The equipment shall be protected from transient voltages and surges induced into the signal lines. The contractor shall provide a permanent earth ground connection to the panel ground lug in order to insure proper operation of transient protectors.
3. A microprocessor-based automatic pump and alarm control system shall be provided for the pump station incorporating an industrial-grade, 16-bit CMOS microcomputer and associated elements suitable for achieving performance as hereinafter described. The controller shall incorporate the following:
  - Internal diagnostics.
  - Real time clock calendar.
  - Floating-point math.
  - Battery back up.
  - Non-proprietary RTU communication.
  - (4) PID loops.
4. The system shall incorporate UL 508 Industrial Control Panel approved elements as required of all components of the panel and shall be furnished with all necessary hardware and software to accomplish level-responsive pump and alarm operation with software specifically suited to this project.
5. All of the discrete I/O circuitry of the computer-based system shall be built to the IEEE 472 (1974) Surge Withstand Capability Standards. The automatic pump and alarm control system computer shall be the standard product of the control system manufacturer and specifically suited for this type of industrial control panel service. All job connections shall be a UL recognized clamp type barriered screw terminals.
6. The constant speed drive equipment shall be programmed to respond to variations in the wetwell in a manner wherein the hydraulic requirement will be accommodated in the pumping program using simple menu-related operator interface routines.
7. Upon power-up, the Controller shall go through a timing routine, which allows the analog signal and display to stabilize before any control, or alarm outputs are enabled. After the stabilization period, the control circuits of the Controller shall be sequentially enabled on a time-step arrangement. In addition to the time delay upon power-up, the differential-level control circuits shall each be forced to an off condition upon power up so that a level excursion will need to go past their turn-on elevation for them to operate.

8. An alternator shall operate the pumps in a First-on/First-off (FOFO) sequence and can be configured to sequence the pumps every start, every 24 hours, on the lowest run time or manually. The alternator shall be capable of accepting pump failure and/or advance inputs and shall automatically transfer to the next pump sequence when failure condition input is sensed. The alternator shall provide automatic transposing of the operating sequence of the control relays for the pumps on successive starts. The FOFO alternator sequencing shall operate such that the next load turned on is always the one that has had the longest opportunity to rest since its last operation.
9. Microprocessor based, programmable controller and operator interface shall provide all of the above controls and operations. A redundant back up float system shall be incorporated into the controller along with programmable automatic operation. Operator interface shall be a minimum of 3" x 4" LCD.
10. The automatic pump and alarm control shall employ an operator interface having a 240 x 80 pixel STN monochrome liquid crystal display. The operator interface shall have an IEC standard IP65F sealed housing. The display shall be rated for 50,000 hours and include an adjustable sleep mode to increase life. The unit shall support four levels of password protection.
11. The Operations Manual shall be included for the pump controller.

N. Controller Configuration:

1. The pump controller shall operate on a 4-20mA input via a submersible transducer, and shall be capable of being configured at the factory or jobsite to perform operating functions as described below. All configurations shall be password protected and shall be provided as a minimum as follows:

Duplex Pump Operation.

- Clock hours (0-23) and minutes (0-59).
- Calendar day of week (0-6 for Monday - Sunday).
- Wetwell transducer rating (1.0-15.0 PSI).
- Wetwell transducer offset.
- Wetwell cross sectional area for Flow Monitor
- Lag pump disable for non-additive systems.
- Pump Alternation method.
- Shut down, Alarm only or Lag pump designation upon Seal fail.
- On board or Redundant float back up with weekly test feature.
- Selectable pump fault for Low oil or Bearing overtemperature

The pump controller shall include the field adjustable delay timers. All timer settings shall be password protected and shall be provided as follows:

- Pump 1 start fail delay (0-99 seconds).
- Pump 2 start fail delay (0-99 seconds).
- Lead pump start delay (0-99 seconds).
- Lag pump start delay (0-99 seconds).
- Lead pump stop delay (0-99 seconds).
- Lag pump stop delay (0-99 seconds).
- High Level alarm delay (0-99 seconds).
- Low Level alarm delay (0-99 seconds).
- Delay between calls (0.1-9.9 minutes).

- Back up float pump down timer (1-5 minutes).
- Back up float lag call timer (0-99 seconds).

The pump controller shall include the field adjustable set points. Set points shall be password protected and provided as follows:

- Lead pump start.
- Lead pump stop.
- Lag pump start.
- Lag pump stop.
- High Level Alarm.
- Low Level Alarm.
- Back up high float.

The menu driven screen shall display the following:

- Wetwell Level.
- Pump Run time values scaled to hours and tenths.
- Pump Start counters.
- Flow Rates.
- Pumping Rates.
- Alarm Messages.

#### O. Alarm Messages

In the event of an alarm condition the operator interface shall display an alarm message. The following list of alarms shall be provided:

- Low Level.
- High Level.
- Pump 1 Fail.
- Pump 2 Fail.
- Transducer Fail.
- Seal 1 Fail.
- Seal 2 Fail.
- Motor 1 Overtemp.
- Motor 2 Overtemp.
- Pump 1 Fail (Configurable from external device).
- Pump 2 Fail (Configurable from external device).
- Backup Float Test Fail.

P. Flow Monitoring

A flow-monitoring algorithm shall be included in the controller to measure influent flow. This algorithm shall calculate the incoming flow rate during periods of pump inactivity, detecting the change in level and using the configured wetwell area. Pumping rates shall be calculated during periods of pump activity, detecting the change in level and using the configured wetwell area and average incoming flow rate. The controller shall display incoming flow and totalized flow in gallons per minute. It also shall display each pump's rate in gallons per minute.

Q. Pump Seal Fail

A seal failure relay specifically designed to interface with a contact closure from each of the specified pumps shall be included. A Seal Fail alarm message shall be displayed on the controller. In addition the controller should be configured to shut down the pump or designate it to the lag position until the condition is corrected.

R. Over Temperature Pump Protection

Over temperature protection relays shall be provided in the control panels to operate in conjunction with the over temperature switch in each pump motor. The controller shall provide an Overtemp Fail alarm message and pump lockout of operation upon occurrence of high temperature. The circuitry shall also include a reset push button on the controller for manual reset capability.

S. Ammeters

A 3½" ammeter shall be provided for each pump motor. Each meter shall be connected to a current transformer. The meter and current transformer shall be sized such as to provide half scale readings when the pump motors are running at designed conditions. The ammeter shall meet ANSI specifications C-39.1. The ammeter shall be mounted on the operator's door of the control panel.

T. Selector Switches

A 22 mm oil tight, three-position, "Hand-Off-Automatic" selector switch shall be flush-mounted on the operator's door of the control panel for the operation of each motor starter. This selector switch shall operate the starter when it is in either the "Hand" position or the "Automatic" position, and the automatic control system is calling for the operation of the equipment in the manner as herein described.

U. Status Indicators

A 22 mm oil tight green "Pump Running" push-to-test pilot light shall be flush-mounted on the operator's door of the control panel. This pilot light shall be operated from a respective starter auxiliary contact. The pilot light shall have a replaceable bulb.



## V. Weather Proof Alarm Light

A weatherproof high water, 100-watt alarm light assembly including a high impact resistant lexan red lens and wire guard with mounting bracket shall be included, for panel or remote mounting. The alarm light will glow at half brilliance during normal operation. During alarm conditions, a solid-state flasher shall be included to strobe the alarm light from full brilliance to off 90 times per minute for any of the specified alarm conditions.

## W. Power Fail Alarm

A 120-Volt DPDT control relay powered from the load side of the control power circuit breaker shall be included.

## X. Telemetry Contacts

Dry contacts rated 10 amps shall be provided, and wired to a numbered terminal strip inside the panel, to interface with remote telemetry or dialing equipment for the following:

- Motor Heat Sensor(s)
- High Level Alarm
- Low Level Alarm
- Moisture Sensor(s)
- Power Fail
- Pump(s) Run
- Pump Fail
- Transducer Fail

## 2.15 SUBMERSIBLE WET WELL LEVEL SENSING TRANSDUCER

- A. The submersible transducer shall be a piezoresistive type with optional ranges of 0-100 INWC to 0-100 psi. The device shall require a 10-30 VDC low voltage power supply. The response time of the transducer shall be less than one millisecond. Accuracy of the equipment should be #0.25% of the entire range and the repeatability shall be #0.05% of the entire range. The transducer shall be capable of being used in media from +15°F to +122°F, and the storage temperature for the unit shall be -22°F to 176°F. Shock resistance per IEC 770 for mechanical shock should be 1000g, and the vibration resistance per IEC 770 for vibration under resonance conditions should be 50g. Protection against reverse polarity, short circuit, and overvoltage should be included in the transducer. The transducer shall carry an IP68 (NEMA 6) rating and shall be submersible up to 350 ft. All wetted parts shall be 316 SS. The transducer shall have a vented polyurethane cable with a tensile strength of 220 lbs.

1. Manufacturer: WIKA model LS-10 or equal.

- B. An optional anti-clog attachment shall be included for the above referenced submersible transducer. The anti-clog attachment shall be made of all 316 SS, and shall be silicone liquid filled. The anti-clog attachment shall also include a 2" diaphragm for performance. In case of transducer failure, the anti-clog attachment should be able to be removed and used with a new transducer. Transducers with anti-clog attachments that cannot be removed shall not be acceptable. The anti-clog attachment shall be able to be used with all models of WIKA transducers.
  - 1. Manufacturer: WIKA LS-10 with a LevelGuard™ or equal.

## 2.16 WET WELL LEVEL SENSING FLOAT SWITCHES

- A. The floats shall have a molded polyethylene body, internal redundant polyurethane foam floatation, potted switch/cable connections and fine stranded AWG #18 cable with heavy-duty synthetic rubber jacket in lengths as required to run unspliced to the control panel.
- B. The contractor shall furnish, install and wire the float switches as shown on the drawings. The float switches shall be individually suspended in the wetwell with weight kits. The float switch cables shall be suspended from a cable rack mounted to the top of the wetwell.
- C. The redundant back-up float controller shall connect to the float switch level sensors through an intrinsically safe module. The module shall provide an intrinsically safe interface for the sensors located in a hazardous area rated Class 1, Group D. The module shall contain an LED indicator providing visible indication of sensor actuation. The intrinsic safety barrier shall be UL listed.

## 2.17 ALARM DIALER

- A. The automatic dialing alarm system shall be microprocessor based and have the capability to monitor from 4-48 dry contact or digital inputs, 8 to 48 analog inputs or energize from 4 to 24 relays in any combination. The dialer shall be field upgradeable to allow for future conditions. Each of these inputs shall monitor a set of dry contacts (normally-closed or normally-open). In addition, the dialer shall monitor the AC power and battery voltage continuously. Upon detecting an alarm on any of its inputs, a low battery condition or detecting loss of its AC power, the dialer shall begin dialing the first of up to 16 user programmed telephone numbers.
- B. The dialer shall speak user-recorded messages to the called party describing its location and the alarm conditions that are present. The dialer shall then verbally request that an acknowledgment be given. The called party shall acknowledge the call by momentarily depressing the '8', '9' or '\*' key on their telephone keypad. If the dialer is not acknowledged during the call, it shall hang up, wait from 1 to 3600 seconds and then dial the next number in its phone list. If a successful acknowledgment occurs, the dialer shall give a sign-off message, hang up and then wait a user-programmed period of time for the alarm conditions to be corrected. If this period of time elapses and the alarm condition(s) still exist, the dialer shall begin the alarm notification cycle again. The dialer shall have relay outputs that shall remain energized as long as the dialer has any unacknowledged alarms.

This output shall be available to allow for wiring to an external horn, buzzer, light or other

local alarm device. Alternatively, the user shall be able to program the dialer to allow remote activation of this relay from a telephone keypad.

C. Construction:

1. Enclosure: Minimum rating should be NEMA 4X
2. Power Requirements: 115 VAC 10% 60 Hz; 25 watts
3. Printer Port: Centronics parallel – DB25 (female)
4. Serial Port: 38.4Kbaud – DB9 (male)
5. Electrical Protection: Transient voltage/surge protection shall be provided on power line, telephone and all input channels. Solid state surge protection provided on digital input, analog input, serial port, parallel port, telephone and AC power circuitry.
6. The alarm dialer shall be mounted in its own enclosure within the pump control panel. Alarm dialer shall have its own surge protection separate from any panel surge protection.
  - a. Manufacturer: Antx Elite or RACO Verbatim or Equal

2.18 MAGNETIC FLOWMETER AND TRANSMITTER

- A. A 4-inch magnetic flow tube with remote transmitter shall be provided. The flow tube shall be flanged and placed in the valve vault discharge piping. The transmitter shall be mounted remotely in the control building. Provide optional indicator, keypad and configure for totalizing flow.
- B. Flow tube: ptfе liner; 316 ss electrodes; Foxboro 9300A.
- C. Flow transmitter: Foxboro IMT25, remote mounted.

2.19 PERMANENT AUXILLIARY POWER GENERATOR

- A. Generator shall be sized to adequately supply starting current and continuous operation for all connected loads. Generator to be located in a separate room within the control building, having adequate ventilation as required by the manufacturer. Engine shall have protective equipment capable of shutting down the unit and activate an alarm under conditions which may damage the engine. Supplier shall recommend amount and type of vibration isolation and anchor bolt necessary to mount the generator to the generator slab. With one pump running and all other loads on, the voltage drop, upon starting the second pump, shall not exceed 35%. Emergency generator shall be manufactured by Cummins/Onan. Generator shall be supplied with natural gas feed from gas distribution system within development, if available. Otherwise, generator to be diesel powered.
- B. Automatic Transfer switch (ATS): ATS shall be provided to automatically start the emergency generator when power failures are detected and to switch back over

when power is restored. ATS shall be fully rated to protect all types of loads, inductive and resistive, from loss of continuity in power. Adjustable solid state time delays for starting, transfer, retransfer, and stopping the generator shall be provided. A seven day exerciser clock and standard indicating lights shall be provided. ATS shall be manufactured by Cummins/Onan and shall come integral with level 1 power command control with exerciser clock and programmed transition. ATS shall also contain a 2A (integral) battery charger mounted and wired within the ATS.

## 2.20 CONTROL BUILDING

- A. Structure: Building to be of masonry construction and sized to house electric and control panels, emergency generator, and chemical treatment (if needed), all in separate rooms.
- B. Chemical treatment Odor Control:
  - 1. Hydrogen Peroxide - Provide the following:
    - a. Chemical Metering Pump: one (1) peristaltic chemical metering pump, 3 RPM, gear motor, powered by 120V electrical. Metering pump shall be capable of pumping in a range of 1/z gpm and 5 gpm, or as specified. Chemical metering pump and shall be model SP10, manufactured by Watson/Marlow or approved equal.
    - b. Polypropylene shelf for pump with stainless steel mounting hardware.
    - c. Hose and fittings capable of handling chemical.
    - d. 30 gallon plastic day tank for holding chemical solution
    - e. Two (2) stainless steel ejectors one on discharge side of each pump's discharge header.
    - f. 24-hour timer with 15-minute interval pre-timed control of chemical feed pump.
  - 2. Other suitable methods of odor control shall be considered on a case by case basis.
- C. Accessories:
  - 1. Lighting: Provide adequate lighting for each room in the control building.
  - 2. Control Building Space Heater: Provide a unit space heater capable of maintaining the control building at an ambient temperature of 65°F. The space heater shall be ceiling or wall mounted with integral thermostat capable of controlling between 60°F and 90°F, and be manufactured by Chromalox, or approved equal.
  - 3. Ventilation: (In all rooms except the emergency generator room) Exhaust fan shall be manufactured by New York Blower Company, or approved equal, and shall include 8" diameter fan with motor capable of producing 400 CFM of flow at 0" S.P. Fan shall include gravity louvers and shall mount directly in wall. Louvers shall be shielded on the exterior with an insect/bird

screen. NOTE: Ventilation for the emergency generator room shall be installed exactly as specified by Cummins/Onan to be adequate for the generator to be used.

4. Hose Bibs: All hose bibs must have backflow protection and must be frost-proof.
5. Hose: Contractor shall furnish a 50-foot length of 3/4" heavy duty rubber hose for connection to the 2" yard hydrant.

## 2.21 SITE IMPROVEMENTS

- A. Chain Link Fence: Nominal 8-foot height with 12-foot wide double section gate. Framework shall be constructed of schedule 40 steel, standard weight, one piece without joints. Fabric shall be 2-inch diamond mesh steel wire, interwoven 9 gage thick, top selvage twisted tight, bottom selvage knuckle end closed.
- B. Access Drive: Driveway to be bituminous, minimum 10-foot wide providing access directly adjacent to the wet well, valve vault, and control building. Provide vehicle turnaround and parking area for one vehicle.
- C. Exterior Lighting: A single exterior light shall be mounted 12' above ground on an aluminum pole set on a concrete base. Floodlight shall be a heavy-duty aluminum fixture with motion detector and manual override activation switches, impact resistant glass and a 500-watt quartz lamp, Light shall be equipped with manually operated toggle switch to override the motion detector.
- C. Freeze-Proof Yard Hydrant: Provide a two-inch automatic draining hydrant with schedule 40 stainless steel casing and operating rod, bury depth of three feet with locking feature. All buried fittings must be constructed of brass. Hydrant shall be equipped with backflow protection. Hydrant seat must be repairable without excavation, manufactured by Woodford Manufacturing Company, or approved equal.

## PART 3 – INSTALLATION

### 3.1 FABRICATION, INSTALLATION, AND FIELD TESTING

- A. General: Fabrication and installation of all equipment and materials required for the sewage lift stations and Pumping stations shall be performed by the Contractor as per manufacturer's instructions, drawings, cut sheets, and the Specifications and Drawings. Testing of all equipment and materials after installation shall be considered an integral portion of the construction process. The Contractor shall repair any item not meeting testing criteria at his own expense. The Contractor shall also furnish all necessary labor, equipment, and materials for testing and shall bear all the costs thereof.
- B. Fabrication and Installation:
  1. All anchorage steel required for the equipment shall be supplied by the equipment manufacturer. The Contractor shall install the anchorages in the concrete structures

in accordance with drawings and instructions furnished by the equipment manufacturer. Foundation anchor steel shall be grouted as shown on the plans.

2. The Contractor shall furnish and install all sleeves and adapters in the wall required for process piping. The Contractor shall install all piping and fittings and shall make all joints and connections, including wall sleeves, watertight by means acceptable to the Engineer.

C. Start-Up

1. Prior to the start-up of any piece of mechanical equipment, the Contractor shall have submitted to the Engineer four copies of printed instructions as specified herein.
2. Start-up of all mechanical equipment shall be conducted by the Contractor, under the direction of the manufacturer's representative, and in the presence of the Engineer. Unless otherwise allowed by the Engineer, in writing, the manufacturer's representative shall be present during the start-up of the equipment.
4. As part of the start-up, the manufacturer's representative shall instruct the operating personnel of the Owner on the proper operation and maintenance of the equipment. Eight (8) hours and two (2) separate visits shall be included in the bid price.
4. The manufacturer's representative shall issue a written start-up report to the Engineer, the Contractor, and the manufacturer containing the following information:
  - a. A list of each piece of mechanical equipment which was started up.
  - b. The manufacturer of the equipment.
  - c. The date of the start-up.
  - d. A list of persons present during the start-up.
  - e. A list of persons present during the operation and maintenance instructions given by the manufacturer's representative.
  - f. Any problems noted during the start-up.
  - g. Any recommendations which would improve the operation.
  - h. A statement that the equipment is or is not operating properly and why.
  - i. The name of the person directing the start-up and the company the person represents.

- D. The Contractor shall be responsible for coordinating and making the necessary arrangements to schedule the start-up of the equipment. The Contractor shall include all costs relating to equipment start-up in the bid price for the installation of the equipment.

END OF SECTION 11100