

## SECTION 02732

### FORCE MAINS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Wastewater Sewer Force Main Piping.
- B. Valves.
- C. Air Release, Valve and Cleanout Manholes.
- D. Thrust Restraint.
- E. Force Main Testing.

##### 1.02 RELATED SECTIONS

- A. Trenching, Backfilling and Compacting: Section 02221.
- B. Manholes: Section 02601.
- C. Gravity Wastewater Sewer: Section 02731.
- D. Division 3 - Concrete.

##### 1.03 REFERENCES

- A. American National Standards Institute (ANSI):
  1. ANSI A21.10 - Gray-Iron and Ductile-Iron Fittings, 2 inches through 48 inches, for Water and Other Liquids.
  2. ANSI A21.15 - Flanged Cast-iron and Ductile-Iron Pipe with Threaded Flanges.
  3. ANSI A21.50 - Thickness Design of Ductile-Iron Pipe.
  4. ANSI B16.1 - Cast-iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
  5. ANSI A21.11 - Rubber Gasket Joints for Cast Iron and Ductile Pressure Pipe and Fittings.
- B. American Society for Testing and Materials (ASTM):
  1. ASTM A48 - Gray Iron Castings.
  2. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, Spec. for.
  3. ASTM A616 - Rail-Steel Deformed and Plain Bars for Concrete Reinforcement, Spec. for.
  4. ASTM C39 - Compressive Strength of Cylindrical Concrete Specimens, Test for.
  5. ASTM C94 - Ready-Mixed Concrete, Spec. for.
  6. ASTM C150 - Portland Cement, Spec. for.
  7. ASTM C206 - Finishing Hydrated Lime, Spec. for.
  8. ASTM C478 - Precast Reinforced Concrete Manhole Sections, Spec. for.

9. ASTM D4 – Bitumen Content, Spec. for.
10. ASTM D2241 – Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR), Spec. for.
11. ASTM D3139 – Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals, Spec. for.
12. ASTM D3350 – Polyethylene Plastic Pipe and Fittings Materials, Spec. for.

C. American Water Works Association (AWWA):

1. AWWA C104 – Cement-Mortar Linings for Ductile-Iron and Gray Iron Pipe and Fittings for Water.
2. AWWA C110 – Ductile-Iron and Gray-Iron Fittings, 3-in. through 48-in. for Water and Other Liquids.
3. AWWA C111 – Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
4. AWWA C150 – Thickness Design of Ductile-Iron Pipe.
5. AWWA C151 – Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
6. AWWA C500 – Gate Valves, 3-in. through 48-in. NPS, for Water and Sewer Systems.

#### 1.04 SUBMITTALS

- A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, cuts or other data as required to provide a complete description of piping, piping specialties, restraint systems and valves.
- 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.

#### 1.05 QUALITY ASSURANCE

- A. Source Quality Control:
  1. Shop Tests and Inspection: 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. 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.

#### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Replacement of Damaged Material: The Contractor shall replace, at his own expense, all material furnished by him and found defective in manufacture or damaged in handling after delivery by the manufacturer. This shall include the furnishing of all materials and labor required for replacement of installed material.

1. Material furnished by the Owner that becomes damaged after acceptance by the Contractor shall be replaced by the Contractor at his own expense.
- B. Responsibility for Safe Storage: The Contractor shall be responsible for the safe storage of material furnished by or to him, and accepted by him, and intended for the work, until it has been incorporated in the completed project. The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter, at all times. All equipment and materials subject to damage from freezing shall be drained and stored in a manner which will protect them.
- C. Hauling: All materials furnished by the Contractor shall be delivered and distributed at the site by the Contractor.
  1. Pipe, fittings, items of equipment, and other materials of construction shall be loaded and unloaded by lifting with hoists or skidding so as to avoid shock or damage. Under no circumstances shall such materials be dropped.
  2. Materials handled on skidways shall not be skidded or rolled against materials already on the ground.
- D. At Site of Work: In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in the trench, or as otherwise directed by the Engineer. Under no circumstances should lawns, grass plots or other private property be used for this purpose without the consent of the property owner.
- E. Care of Pipe Lining: Pipe shall be handled so the lining will not be damaged. If, however, any part of the lining is damaged, the repair shall be made by the Contractor at his expense in a manner satisfactory to the Engineer.

## 1.07 SITE CONDITIONS

- A. Environmental Requirements:
  1. Keep trenches dewatered until pipe joints have been made and concrete cradle, thrust blocks and 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

### 2.01 PIPE AND PIPE FITTINGS

- A. Cement Lined Ductile Iron Pipe: Ductile iron pipe conforming to ANSI Specification A21.51 or AWWA Specifications C151, Latest Editions, for the material class or pressure designated and ANSI Specification A21.50 or AWWA Specification C150. Latest Editions, for wall thickness.
  1. Minimum Thickness: Class 52 unless indicated otherwise on the Drawings or as may be required for flanged pipe or restrained joints.
  2. Cement Mortar Linings: Conforming to ANSI Specification A21.4 or AWWA C104, Latest Edition, except the thickness of linings should not be less than 1/8-inch.

3. Fittings: Ductile or gray iron in accordance with the standard specification set forth in the ANSI A21.10 or AWWA Specification C110.
    - a. All fittings shall be minimum Class 250 with cement lining and joints as required for pipe restraint.
    - b. Iron fittings to be enclosed by valve and cleanout manholes shall be of the short body flanged type in order to minimize the size of the manholes.
  4. Joints: Push-on type or mechanical joint type in accordance with ANSI A21.11 or AWWA C111 Specifications, for all pipe except at changes in alignment, valves, tees, caps and plugs not restrained with thrust blocking.
    - a. Joints requiring pipe restraint and not restrained with thrust blocking shall be Lok-Type or TR Flex as manufactured by U.S. Pipe; Super-Lock as manufactured by Clow; Lok-Fast as manufactured by American Pipe; Snap-Lok or Locked Mechanical joint as manufactured by Griffin; Locked mechanical joint as manufactured by Atlantic State; or approved equal.
    - b. In addition to restrained joints, adequate tie rods must be provided to develop full joint restraint and must extend to the adjacent fitting or joint as approved by the Engineer.
    - c. Mechanical joint retainer glands shall not be used.
    - d. Prior to construction, joint restraint systems shall be submitted for Engineer's review and approval.
- B. Polyvinyl Chloride Pipe and Fittings (PVC):
1. 4-inches and Greater Diameter: PVC pipe conforming to AWWA C 900 for working pressure of 200 psi.
    - a. Fittings: As specified for Cement Lined Ductile Iron Pipe.
  2. Fittings: Ductile or gray iron in accordance with the standard specification set forth in the ANSI A21.10 or AWWA Specification C110.
    - a. All fittings shall be minimum Class 250 with cement lining and joints as required for pipe restraint.
    - b. Iron fittings to be enclosed by valve and cleanout manholes shall be of the short body flanged type in order to minimize the size of the manholes.
    - c. Acceptable Manufacturer:
      - (1) Certain-Teed; Vinyl Iron Pipe, DR 14.
      - (2) Or Equal.
  3. Less than 4-inches Diameter: PVC pipe conforming to ASTM D2241, SDR-21 except 1.5-inch pipe shall be SDR-26.
    - a. Fittings: Compatible PVC fittings as recommended by pipe manufacturers, and of same Class as the pipe.
    - b. Acceptable Manufacturer:
      - (1) Certain-Teed; Fluid-Tite with Integral Bell.
      - (2) Or Equal.
  4. Joints: Push-on type conforming to ASTM D3139.
    - a. Solvent weld joints permitted only for special situations as approved by Engineer (e.g. bored service line highway crossings).
    - b. PVC pipe joints shall be restrained at changes in alignment, valves, tees, caps, and plugs with thrust blocking.
    - c. Split retainer flanges shall not be used in place of thrust blocks.
    - d. Proposed joint restraint system shall be submitted for Engineer's review and approval.

## 2.02 SEWAGE VALVE

- A. Sewage Air Release Valve: Designed to automatically release air, gas or vapor under pressure during system operation. Valve design shall feature long body and float stem components so that the operating mechanism is kept free from contact with sewage during operation. Valve construction as follows:
1. Valve Body and Cover: Cast iron, ASTM A48, Class 35.
  2. Maximum Working Pressure: 150 psi.
  3. Vent Orifice: 3/16-inch for 150 psi.
  4. Discharge Orifice Seat, Mechanism and Valve Stem: Stainless Steel.
  5. Orifice Button: Stainless steel and Buna-N, Nitrile Rubber ASTM SB 800.
  6. Mechanism Lever Pins and Float: High strength stainless steel, ASTM A240.
  7. Backflushing and Cleaning Accessories: Factory assembled to the valve and consisting of a shut-off valve at bottom inlet, a blow-off valve near the bottom of the valve body, quick disconnect couplings and shut-off valve at top of valve. and a 5-foot section of rubber hose with quick disconnect coupling.
  8. Acceptable Manufacturers:
    - a. Val-Matic Valve and Manufacturing Corp.; Model No. 48 BWA.
    - b. Or Equal.
- B. Sewage Air and Vacuum Valve: Designed to automatically exhaust large quantities of air during the filling of a system and to allow air to re-enter the system during draining or when a vacuum occurs. Valve design shall feature long body and float stem components so that the operating mechanism is kept free from contact with sewage during operation. Valve construction as follows:
1. Valve Body and Cover: Cast iron, ASTM A48, Class 35.
  2. Inlet Size: 2-inches.
  3. Discharge Orifice: 2-inches.
  4. Float Stem and Guide: Bronze, ASTM B584.
  5. Floats: Stainless Steel, ASTM A240.
  6. Orifice Seat: Buna-N, Nitrile Rubber, ASTM SB 800.
  7. Backflushing and Cleaning Accessories: Factory assembled to the valve and consisting of an inlet shut-off valve, a 1-inch blow-off valve near the bottom of the valve body, quick disconnect couplings and a 1/2-inch shut-off valve at the top of valve, and a section of rubber hose with quick disconnect coupling.
  8. Acceptable Manufacturers:
    - a. Val-Matic Valve and Manufacturing Corp.; Model No. 300 Series.
    - b. Or Equal.
- C. Sewage Combination Air Valves: Consisting of an air release valve and an air and vacuum valve factory piped into a compact assembly. The combination assembly shall automatically release air, gas or vapor under system operating pressure and shall also allow air to re-enter the system during draining or when a vacuum occurs. Combination valve designs shall feature long bodies and float stem components so that the operating mechanisms are kept free from contact with sewage during operation. Valve construction as follows:
1. Valve Bodies and Covers: Cast iron, ASTM A48, Class 35.
  2. Inlet Sizes: 2-inches.
  3. Air Release Outlet Size: 1/2-inch, NPT.
  4. Vacuum Discharge/Outlet Size: 2-inches.
  5. Air Release Valve Maximum Working Pressure: 75 psi.
  6. Air Release Valve Vent Orifice: 5/16-inch.
  7. Air Release Valve Discharge Orifice Seat, Mechanism and Valve Stem: Stainless Steel.

8. Air Release Valve Orifice Button: Stainless Steel and Buna-N, Nitrile Rubber ASTM SB 800.
9. Air Release Valve Mechanism Lever Pins and Float: High strength stainless steel, ASTM A240.
10. Air and Vacuum Valve Float Stem and Guide: Bronze, ASTM B584.
11. Air and Vacuum Valve Floats: Stainless Steel, ASTM A240.
12. Air and Vacuum Valve Orifice Seat: Buna-N, Nitrile Rubber, ASTM SB 800.
13. Backflushing and Cleaning Accessories: Factory assembled to the combination valves and consisting of two inlet shut-off valves, two blow-off valves, two clear water inlet valves, section of rubber hose and quick disconnect couplings.
14. Acceptable Manufacturers:
  - a. Val-Matic Valve and Manufacturing Corp.; Model No. 48 or 49/300 Series.
  - b. Or Equal.

### 2.03 AIR RELEASE MANHOLES

- A. Materials for air release manholes as specified for precast manholes in Section 02601.

### 2.04 CLEANOUTS

- A. Cleanouts shall be constructed of PVC, Schedule 80 material. The transition from iron fittings to PVC material shall be made by use of Long Hub Companion Flange or other approved methods.

### 2.05 VALVES AND APPURTENANCES

- A. Valves: Cast iron ball or plug valves shall be installed on service and force main lines at the locations required by the Project Drawings. Valves installed in valve/cleanout pits shall be actuated with a quarter turn type hand lever. Buried valves shall be actuated with an underground actuator through a cast iron valve box. Ball valves on individual properties shall be oriented with the seat in place for pressure.
- B. Painting: All surfaces of each valve body assembly shall be clean, dry and free from grease before painting. All unmachined surfaces of the valve body assembly shall be wire brushed down to clean metal. Two coats of an asphalt varnish shall be applied in accordance with AWWA C500.
- C. Spare Parts and Tools: Repair or service parts for one of each type and size of valve used in this work shall be furnished and stored as directed by the Engineer. The equipment shall include, in general, the following items: special tools required for maintenance or operation of valves, gaskets, rings, seals, lubricants, bolts, washers, and miscellaneous accessories required to maintain valves in proper operating service.
- D. Flanges: All flanged valves shall be drilled and faced to the ASA 125 pound standard template, and in accordance with ANSI B16.1.
- E. Gate Valves 2 Inches and Larger: All gate valves 2" and larger shall conform in all respects to AWWA Specification C500, and Federal Specification WW-V-50b, Type II, Class I. All valves shall be of the double disc, non-rising stem type, with iron body full bronze mounted. Gate

valves shall be of such design as to maintain the full area of the pipe through the valve when open and shall be designed to take the full unbalanced pressure upon either face.

1. Valves shall open left (counter-clockwise) and shall be supplied with operators as shown on the drawings and specified herein.
2. Exposed manually actuated valves shall be handwheel actuated unless otherwise indicated on the Drawings. Handwheel operators shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering.
3. Buried valves shall have 2" square cast iron operating nuts. Each valve shall also be supplied with a roadway type valve box.
4. Buried valves shall be supplied with mechanical joint end connections.
5. Valves 3-inch and larger shall be flanged end Dresser, Series 800, X-Centric, or equal.
6. Valves 2-inch and 2½ inch shall be flanged end DeZurik, Eccentric, or equal.
7. One and one-half inch valves shall be screwed end DeZurik, Eccentric, or equal.

F. Non-Lubricated Plug Valves (Eccentric-Type):

1. Designed for a minimum working water pressure of 175 psi for valves through 12-inch, 150 psi for valves 14-inch through 36-inch, and 125 psi for valve sizes 42-inch through 54-inch.
2. Provide non-lubricated eccentric-type plug valve with valve bodies of cast iron conforming to ASTM A126 Grade B or valve bodies of semi-steel with coated plug suitable for wastewater and nickel or stainless steel seats.
3. Provide full-pressure, drip-tight shutoff with rated pressure from either direction.
4. Provide straight-through, round-port configuration or rectangular-style design; however, port area shall be a minimum of 80% of corresponding pipe area.
5. Valves 8-inch and larger operated by enclosed worm and gear.
6. Provide enclosed worm and gear operator for valves less than 8-inch that must be chain operated.
7. Acceptable Manufacturers:
  - a. DeZurik; Series 100 Eccentric Valves.
  - b. Keystone, USA Valve Division; Ballcentric.
  - c. Clow.
  - d. Victaulic Series 365.
  - e. Or Equal.

- F. Valve Boxes: Standard 7-inch cast iron extension roadway type valve boxes shall be installed over buried valves and service line cleanouts. Screw threads shall be cast integrally with box wall. Welded screw threads are not acceptable.

### PART 3 – EXECUTION

#### 3.01 PREPARATION

- A. Earthwork: Perform earthwork for force mains as specified in Trenching, Backfilling and Compacting: Section 02221.
- B. Boring, Jacking, or Tunneling: As specified in Section 12 of the General Information.

### 3.02 PIPE INSTALLATION

- A. General: All pipe shall be laid and maintained to the required lines and grades with fittings and valves at the required locations; spigots centered in bells; and all valves plumb. The pipe shall be laid in the backfill materials as specified. Pipe laying shall commence at the lowest point and proceed upgrade.
- B. Construction Control: During the installation of a force main, the pipe shall be laid at a constantly increasing grade to each high point, air release manhole, or point of discharge. The Contractor shall provide sufficient construction control to assure that there are no sags or loss in grade in the force main which could tend to accumulate air other than at the high points. Failure to comply with this requirement shall necessitate the Contractor take remedial steps to correct this situation. All such costs shall be borne by the Contractor.
- C. Variations: The Engineer reserves the right to vary the line and/or grade from that shown on Project Drawings for the pipe lines and manholes and to vary the location of fittings and valves when such changes may be necessary or advantageous. No claims for extra work will be allowed for changes in location or grade except as such changes are made after trenching has been done.
- D. Caution in Excavation: The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined, and he shall be held responsible for the repair of such structures when broken or otherwise damaged because of carelessness on his part.
- E. Subsurface Explorations: Whenever, in the opinion of the Engineer, it is necessary to explore and excavate to determine the location of existing underground structures, the Contractor shall make explorations and excavations for such purposes. If the Contractor is required to perform additional work in making the explorations and excavations, extra compensation will be allowed for such additional work.
- F. Depth of Pipe: All pipe shall be laid to the depth indicated on the Project Drawings or a minimum of 3.5' from grade to the crown of pipe.
- 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, valves, 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, protective coatings and linings. Under no circumstances shall such materials be dropped or dumped into the trench.
- H. Hammer Test: Ductile iron pipe and cast iron fittings shall be inspected for defects and while suspended above grade, be rung with a light hammer to detect cracks.
- I. Cleaning Pipe and Fittings: All lumps, blisters and excess coal tar coating shall be removed from the bell and spigot end of each pipe, and the outside of the spigot and the inside of the bell shall be wire-brushed and wiped clean and dry and free from oil and grease before the pipe is laid.
- J. Laying Pipe: Every precaution shall be taken to prevent foreign material from entering the pipe while the pipe is being placed in the trench. If the pipe-laying crew cannot put the pipe into the trench and in place without allowing earth into it, the Engineer may require that before lowering



the pipe into the trench, a heavy, tightly woven canvas bag of suitable size shall be placed over each end and let there until the connection is to be made into the adjacent pipe. During laying operations, no debris, tools, clothing or other material shall be placed in the pipe. After placing a length of pipe in the trench, the spigot end shall be centered in the bell or coupling and the pipe forced home and brought to correct line and grade. The pipe shall be secured in place with approved backfill material tamped under it except at the joints. Pipe and fittings which do not allow a sufficient and uniform space for joints shall be removed and replaced with pipe and fittings of proper dimensions to ensure such uniform space.

1. Precautions shall be taken to prevent dirt from entering the joint space.
2. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.

K. **Cutting Pipe:** The cutting of pipe for inserting valves, fittings or closure pieces shall be done in a neat and workmanlike manner, without damage to the pipe, so as to leave a smooth end at right angles to the axis of the pipe.

L. **Threaded Plastic Joints:** All plastic pipe utilized for threaded connections shall be Schedule 80 pipe.

M. **Bell Ends to Face Direction of Laying:** Bell and spigot pipe shall be laid with bell ends facing in the direction of laying, unless directed otherwise by the Engineer.

N. **Permissible Deflection of Joints:** If deflection is required, make after joint is assembled. The amount of deflection shall not exceed fifty percent (50%) of the maximum limits as specified in the AWWA Standard C600.

O. **Unsuitable Conditions for Laying Pipe:** No pipe shall be laid in water or when, in the opinion of the Engineer, trench conditions are unsuitable.

### 3.03 PIPE JOINTING

A. **Jointing Ductile Iron Pipe:**

1. **Mechanical Joints:** The spigot end of the pipe shall be centrally located in the bell so that the rubber gasket is evenly seated.
  - a. All loose rust or foreign matter shall be removed from the inside surfaces of the bell and outside surface of the spigot prior to assembly. Bolts shall be tightened uniformly with a ratchet wrench so as to effect the joint seal. The normal range of bolt torques to be applied are:

<u>Bolt Size - Inches</u>	<u>Torque - Ft. Lbs.</u>
5/8	45 - 60
3/4	75 - 90
1	100 - 120

- b. If effective sealing is not attained at the maximum torque indicated above, the joint shall be disassembled and reassembled after thorough cleaning.
2. **Push-On Type Joints:** Make joints as recommended by the manufacturer so as to effect the joint seal.

- B. Jointing PVC Pipe: Make joints as recommended by the manufacturer so as to effect the joint seal.

### 3.04 SETTING FITTINGS AND VALVES

- A. General: Valves and fittings shall be set and jointed to pipe in the manner specified previously for cleaning, laying and jointing pipe.
- B. Provide a precast concrete manhole for every air release and vacuum valve meeting the requirements for manholes as previously specified. The manholes shall be constructed to permit valve repairs and afford protection to the valve and pipe from impact where they pass through the manhole walls. All valves and fittings shall be supported by saddles as indicated on the Project and Detail Drawings. The saddles shall be continuous under all valves and fittings within the valve manholes.

### 3.05 ANCHORAGE

- A. Concrete Thrust Blocks: Provide concrete thrust blocks for all fittings, and at all locations where horizontal and/or vertical deflections are made in the joints of the piping. Thrust blocking and buttresses of design indicated on Project and Detail Drawings.
  - 1. Reaction Backing: Reaction backing shall be 3,000 psi concrete as specified in Section 03300. Backing shall be placed 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 Project Drawings or directed by the Engineer. The backing shall, unless otherwise indicated or directed, be so placed that the pipe and fitting joints will be accessible for repair.
  - 2. Metal Harness: Metal harness of tie rods of adequate strength to prevent movement shall be used. Steel rods or clamps shall be type 304 stainless steel.
- B. Anchorage for Bends: All bends deflecting 11.25 degrees or more on mains 6-inches in diameter or greater shall be provided with a thrust restrain system to prevent movement.
  - 1. Either a restrained joint pipe or thrust block system will be permitted for ductile iron pipe.
  - 2. Only a thrust block system will be used for PVC pipe.
  - 3. Suitable metal rods shall be used only as indicated on the Project Drawings or directed by the Engineer.
  - 4. Mechanical joint retainer glands on ductile iron pipe and split retainer flanges on PVC pipe shall not be used to obtain a restrained joint.

### 3.06 MANHOLES

- A. As specified in Section 02601.

### 3.07 FIELD QUALITY CONTROL

- A. Hydrostatic Tests
  - 1. Pressure Test: After the pipe has been laid and backfilled as specified, all newly laid pipe or any valves section thereof, shall be subjected to a hydrostatic pressure of 150 pounds per square inch, or 50% in excess of the normal working pressure, whichever is greater.

Where any section of a main is provided with concrete reaction backing, the hydrostatic pressure test shall not be made until at least five days have elapsed after the concrete reaction backing was installed. If high early strength cement is used in the concrete reaction backing, the hydrostatic pressure test shall not be made until at least two days have elapsed.

- a. Duration of Test: Two hours.
  - b. Procedure: Each section of pipe shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer. The pump, pipe connections, and all necessary apparatus including gauges, shall be furnished by the Contractor. The Contractor will make all taps into the pipe, and furnish all necessary assistance for conducting the tests.
  - c. Expelling Air Before Test: Before applying the specified test pressure, all air shall be expelled from the pipe. If permanent air vents are not located at all high points, the Contractor shall make the necessary taps at such points before the test is made. After the test has been completed, the Contractor shall insert plugs at the tapping points.
  - d. Examination Under Pressure: Any cracks or defective pipes, fittings, or valves discovered in consequence of this pressure test, shall be removed and replaced by the Contractor with sound material, and the test shall be repeated until satisfactory to the Engineer.
2. Leakage Test: A leakage test shall be conducted concurrently with the pressure test. The Contractor will furnish laboratory calibrated test gauge and measuring device, and all necessary assistance to conduct the test.
- a. Leakage Definition: Leakage is defined as the quantity of water that must be supplied into the newly laid pipe, or any valve section thereof, to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
  - b. Permitted Leakage: No pipe installed will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

in which "L" equals the allowable leakage in gallons per hour; "S" is the length of pipeline tested in feet; "D" is the nominal diameter of the pipe, in inches, and "P" is the average test pressure during the leakage test, in pounds per square inch gauge. (The allowable leakage according to the formula is equivalent to 11.65 U.S. Gal. per 24 hours per mile of pipe per inch nominal diameter, for pipe in 18' lengths evaluated on a pressure basis of 150 psi). When testing against closed metal seated valves, an additional leakage per closed valve of 0.0078 gallon per hour per inch of nominal valve size shall be allowed. There shall be no additional leakage allowed for service connections.

- (1) The Engineer will record both the makeup water and pressure at one-half hour intervals during the test period.
- (2) Should any test of pipe laid disclose leakage greater than that specified above, the Contractor shall, at his own expense, locate, repair, and replace the defective joints, pipe, or fittings until the leakage is within the specified allowance.

3. Common Requirements:
- a. Engineer Presence: The Engineer shall monitor the pressure and leakage tests. The Contractor shall notify the Engineer of the test day at least 48 hours in advance.
  - b. If test fails to meet test requirements, the Contractor shall pay for all additional engineering personnel testing time.
  - c. Weather: No testing will be authorized unless air temperature is 35°F or higher.
  - d. Field Joints: All field joints of fittings and valves shall be exposed and examined during pressure and leakage test.
  - e. Acceptance: Observation of successful testing of force mains or manholes 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 warranty period as specified for the force main or manholes will commence. If, during this final inspection, any irregularities are observed, the condition must be corrected at the Contractor's expense prior to acceptance.

END OF SECTION