

SECTION 02080 – UTILITY PIPE AND MATERIALS**PART 1 GENERAL****1.1 REFERENCES**

1. General: The Work shall comply with the most recent or tentative standards as published at the date of the Contract and as listed in the Design and Design and Construction Standards using abbreviations shown.
2. Related Sections: Additional Sections of the Documents which are referenced in this Section Include:
 - 1) Section 01450 – Testing & Inspection Requirements
 - 2) Section 02085 - Valves and Cocks
 - 3) Section 02317- Excavating, Trenching, and Backfilling for Utilities
 - 4) Section 02510 - Water Distribution
3. American Association of State Highway and Transportation Officials Publications (AASHTO):
 - 1) M 198 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets
 - 2) M 294 Corrugated Polyethylene Pipe 12- to 24-in. in Diameter
4. American Society for Testing and Materials (ASTM):
 - 1) A 48 Standard Specification for Gray Iron Castings
 - 2) A 53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
 - 3) A 123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 4) A 139 Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and over)
 - 5) A 312 Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe.
 - 6) B 88 Standard Specification for Seamless Copper Water Tube
 - 7) C 76 Standard Specifications for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
 - 8) C 443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 - 9) C 478 Standard Specification for Precast Reinforced Concrete Manhole Sections
 - 10) C 923 Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals

- 11) C 1173 Standard Specification for Flexible Transition Couplings for Underground Piping Systems
- 12) C 1244 Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill
- 13) D 1784 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
- 14) D 1785 Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- 15) D 2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- 16) D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- 17) D 2467 Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- 18) D 2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
- 19) D 2846/D 2846M Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot-and-Cold Water Distribution Systems
- 20) D 3034 Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
- 21) D 3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastometric Seals
- 22) D 5926 Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems
- 23) F 477 Standard Specification for Elastometric Seals (Gaskets) for Joining Plastic Pipe
- 24) F 493 Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings
- 25) F 679 Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
- 26) F 794 Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
- 27) F 1417 Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

5. American National Standard Institute (ANSI)/American Water Works Association (AWWA):

- 1) C 104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
 - 2) C 110 Standard for Ductile-Iron and Gray-Iron Fittings
 - 3) C 111 Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 - 4) C 151 Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
 - 5) C 153 Standard For Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm), For Water Service
 - 6) C 220 Standard for Stainless Steel Pipe 4 inches (100 mm) and Larger (Includes Addendum C 220a-99)
 - 7) C 600 Standard for Installation of Ductile-Iron Water Mains and their Appurtenances
 - 8) C 700 Standard for Cold-Water Meters – Displacement Type, Bronze Main Case
 - 9) C 901 Standard For Polyethylene (PE) Pressure Pipe And Tubing, 1/2 Inch (13 mm) Through 3 Inches (76 mm) For Water Service.
6. American National Standards Institute / National Sanitation Foundation (ANSI/NSF):
- 1) Std. 61 Drinking Water System Components-Health Effects
7. American National Standard Institute (ANSI)/American Society of Mechanical Engineers(ASME):
- 1) A 112.21.1 Floor Drains
 - 2) B 16.1 Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - 3) B 16.22 Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings
 - 4) B 16.42 Ductile Iron Pipe Flanges and Flanged Fittings
8. Virginia Department of Transportation - Road and Bridge Specifications (VDOT):
- 1) 217 Hydraulic Cement Concrete
 - 2) 232 Pipe and Pipe Arches

1.3 QUALITY ASSURANCE

1. Quality Assurance: All pipe and fittings shall be new, free from defects or contamination and shall, whenever possible, be the standard product of a single manufacturer.

2. Manufacturer's Limitations: Products used in the work of this section shall be manufactured in the U.S. where possible by manufacturer's regularly engaged in production of similar items.

PART 2 PRODUCTS

2.1 PIPE

1. Polyvinyl Chloride (PVC) Pipe: Polyvinyl chloride pipe shall be made from clean, virgin, PVC compound conforming to ASTM D 1784, and meet the following requirements. Precautions shall be taken to prevent the storage of PVC pipe under direct sunlight for extended periods. PVC pipe that has not been installed more than 18 months from the manufacture date shall not be used. The cost to replace expired pipe shall be borne by the Contractor.
 - 1) SDR 35 Pipe: SDR 35 shall be bell and spigot conforming to ASTM D 3034 with a rubber sealing ring locked in place to allow expansion and contraction but prevent displacement during assembly. Pipe stiffness at 5 percent deflection shall exceed 46 psi when tested in accordance with ASTM D 2412. Joints shall be designed to pass when tested in accordance with ASTM D 3212. The maximum allowable joint length shall be 13 feet nominal.
 - 2) Schedule 40 PVC: Schedule 40 PVC pipe shall be Type 1, Grade 1, plain end conforming to ASTM D 1784 and ASTM D 1785 with solvent weld joints and fittings.
 - 3) Schedule 40 CPVC: Schedule 40 Chlorinated Polyvinyl Chloride (CPVC) shall conform to ASTM D 2846 with solvent weld joints.
 - 4) Schedule 80: Pipe for miscellaneous applications and where specified on the plans shall be Schedule 80 conforming to ASTM D 1785 with solvent weld joints.
 - 5) SDR 21: PVC pressure pipe shall be SDR 21 bell and spigot conforming to ASTM D 2241 with a rubber sealing ring locked in place to allow expansion and contraction but prevent displacement during assembly.
2. Ribbed PVC Gravity Pipe (Sanitary and Storm): Ultra-Rib PVC pipe as manufactured by Extrusion Technologies, Inc. or approved equal may be used in 18 to 30 inch sizes and shall meet the following requirements.
 - 1) All ribbed pipe shall be seamless open profile and meet the requirements of ASTM F 794 and Uni-Bell Uni-B-9.
 - 2) Pipe shall have a smooth interior with a solid cross sectional rib exterior. Exterior ribs shall be perpendicular to the axis of the pipe to allow placement of the sealing gasket without additional cutting or machining.
 - 3) The pipe stiffness shall be a minimum of 46 psi when tested at 5 percent deflection in accordance with ASTM D 2412.
 - 4) Gasket material shall meet the requirements of ASTM F 477. Contractor shall make the appropriate connection to manholes as described in the manufactures literature.
3. Ductile Iron Pipe: Ductile iron pipe (DIP) and fittings shall meet or exceed the following requirements:
 - 1) Pipe and fittings shall be the diameter shown on the plans.
 - 2) Pipe and joints shall be manufactured in accordance with ANSI/AWWA C 151/A21.51.

- 3) All pipe shall be cement-mortar lined in accordance with ANSI/AWWA C 104/A21.4 except on air piping or as otherwise noted.
- 4) All lines below grade shall be constructed with push-on joints with O-ring gasket in accordance with ANSI/AWWA C111, and mechanical joints at fittings unless otherwise specified. Pipe lines inside of buildings or vaults and exterior non-buried lines shall be with flanged joints.
- 5) Ball and socket ductile iron pipe shall have push on joints with an allowable deflection of up to 15 degrees and be equal to Griffin SNAPLOCK River Crossing Pipe or approved equal.
4. Galvanized Steel Pipe: Pipe shall be zinc coated carbon steel pipe meeting ASTM A 53 Schedule 40 with coating complying with ASTM A 123. Pipe shall be supplied with NPT threaded couplings.
5. Copper Tubing: All copper tubing shall meet the requirements of ASTM B 88 for Type “L” copper, hard drawn for above ground and Type “K” hard drawn for services.
6. Polyethylene (PE) Pressure Tubing: PE tubing shall be pressure class 200, copper tube size, meeting the requirements of AWWA C 901.
7. Stainless Steel Pipe: Stainless steel pipe shall be welded, of material that conforms with ASTM A 312 and AWWA C 220 of size as shown on the plans.
8. Steel Casing Pipe: Steel casing pipe shall conform to the materials standards of ASTM A 139, Grade B, or approved equal. Only new prime pipe shall be permitted. Wall thickness and diameter shall be in accordance with Table A unless shown different on the plans. The pipe shall have an exterior coat of bituminous material. Casing pipe and joints shall be of leak proof construction so as to prevent leakage of any substance from the casing throughout its length. Spiral welded pipe shall not be allowed.

TABLE A

<u>Carrier Pipe Size</u> (inch)	<u>Casing Pipe Size</u> (inch)	<u>Casing Wall Thickness</u> (inch)
12 and less	24 Minimum	0.375
14	30	0.500
16	36	0.500
20-24	48	0.500

In railroad installations, the thickness of the casing shall conform to the requirements of the specific railroad and governing permit.

9. Pipe Spacers - Pipe spacers shall be metal Spider Supports or RACI plastic spacers of the appropriate size and number to firmly secure the pipe. The supports shall be attached and spaced in accordance with the manufacturer's recommendations.
10. Reinforced Concrete Pipe (RCP): Reinforced concrete pipe shall be Class II, III, IV, or V in accordance with ASTM C 76 with the exception that absorption shall be limited to 5 percent. All joints shall be O-ring type and shall conform to the requirements of VDOT, Section 232. Size shall be as indicated on the plans.

2.2 FITTINGS

1. Polyvinyl Chloride (PVC) Fittings: Polyvinyl chloride fittings shall be made from clean, virgin, PVC compound conforming to ASTM D 1784 and shall conform to the following requirements:
 - 1) Gravity Sewer: Fittings shall be gasketed bell type provided by the same manufacturer as the pipe and conforming to ASTM D 3034 for SDR 35.
 - 2) Drain, Waste, and Vent: Fittings shall be Schedule 40 socket type conforming to ASTM D 2467.
 - 3) Solvent Cement: Solvent cement for use on PVC pipe and fittings shall conform to ASTM F 493 ASTM D 2564, or ASTM D 2846 as appropriate for pipe used.
2. Ductile Iron Fittings: Ductile iron fittings shall be lined and seal coated in accordance with ANSI/AWWA C 104/A21.04, and shall be manufactured in accordance with ANSI/AWWA C 110/A21.10 for standard body and ANSI/AWWA C 153/A21.53 for compact body fittings, and meet the following requirements:
 - 1) Buried fittings shall be mechanical joint and supplied with the proper adapter and/or transition gasket for use with PVC pipe. Buried fittings shall be rated for a working pressure of 350 psi.
 - 2) Flanged fittings shall be 125 pound fittings meeting ANSI/ASME B 16.42, or meeting ANSI/ASME B 16.1 for fittings not available in ductile iron.
3. Copper Pipe Fittings: Fittings shall meet requirements of ANSI/ASME B 16.22 for wrought copper, sweat joint.
4. Pressure Tubing Fittings: Couplings and fittings for copper or polyethylene pressure tubing shall be bronze compression type Ford Pack Joint or Grip Joint, McDonald "T" series, or approved equal.
5. Couplings:
 - 1) Flexible couplings for use in joining gravity pipe of differing materials and/or sizes shall be constructed of elastomeric polyvinyl chloride conforming to ASTM C 443, C 1173, D 5926 and secured to the connecting pipes using stainless steel screw type band clamps.
 - 2) Connections between DIP to PVC pressure pipe shall be done with regular mechanical joint sleeves as manufactured by American Cast Iron Pipe Company, Anvil International, Inc., Mueller Company or coupling systems similar to Styles 38 and 138 as manufactured by Dresser Industries, Inc., Style FCI-1-510 as manufactured by Ford Meter Box Company, Inc., Style 501 as manufactured by Romac Industries, Inc., or approved equal. Shall be ductile iron.
6. Restrained Joint Fittings: Restrained joints shall use mechanical joint pipe with a mechanical retainer gland. Dimensions of the glands shall be such that they can be used with the standardized mechanical joint bell and tee head bolts conforming to the requirements of AWWA C 111 and AWWA C 153. Restraining glands shall be as listed in the ACSA Approved Products list or approved equal.
 - 1) Mechanical to Push-On Joint Connection: An appropriate adapter shall be used to convert from mechanical joint pipe to push-on joint pipe. Adapters shall be by Griffin or approved equal.
 - 2) Push On Joint Pipe: If push-on joint pipe is used, restraining mechanisms shall be a contoured wedge-action retainer gland installed on the spigot (plain) end of the pipe, connected to a standard mechanical joint gland seated behind the pipe bell.

7. Hydrant Tie Rods: 3/4 inch threaded steel rods for mechanical joint restraint shall only be used for fire hydrant applications as shown in Standard Detail W-2 or as required by the Authority due to field conditions. Rods shall be galvanized or otherwise rustproof treated. Compatible tie bolts and nut or clamps shall be similarly rustproof treated.
8. High Density Polyethylene Fittings (Smooth Bore Pipe): Fittings shall conform to AASHTO M 294. Fabricated fittings shall be welded on the interior and exterior at all junctions.

2.3 WATER METERS

1. All meters shall be supplied by the Authority once all connection fees have been paid or permit for temporary meter has been obtained.

Any meter installed by the CONTRACTOR will be removed by the Authority.

All meter assemblies shall be constructed in accordance with these Design and Construction Standards, Standard Details W-9, W-10, and W-11, and shall be capable of accepting the following meters:

- 1) 5/8"-1" Meters: Residential and commercial service meters shall be frost-proof disc meters conforming to AWWA C 700. The meter shall have internal strainer and hermetically sealed non-fogging touch read registers operated by magnetic drive and flow units in U.S. gallons. The measuring chamber shall be bronze with bottom freeze-out cap or plug. Service meters shall be Invensys SR II with touch read system.
- 2) 1 1/2"-2" Meters: Meters 1 1/2 inch to 2 inch in size shall be turbo meter type, flanged with hermetically sealed register operated by magnetic drive and flow units in U.S. gallons. Meters shall be in accordance with AWWA C 701 and shall be Invensys Series "W" Turbo Meter with touch read system.
- 3) 3" and larger Meters: Meters 3 inch and larger in size shall be turbo meter type, flanged with hermetically sealed register operated by magnetic drive and flow units in U.S. gallons. Meters shall be provided with built in stainless steel strainer on inlet end and test port plug on outlet end. Meters shall be in accordance with AWWA C 701 and shall be Invensys Series "W" Turbo Meter with touch read system.
- 4) Compound Meters: A compound meter may be necessary as conditions require. Compound meter shall be Invensys and as approved by the Service Authority.

2.4 METER BOXES & VAULTS

1. Meter Box & Cover: Each meter 5/8 inch through 1 inch shall be installed in a Mid-States MS182420-NK meter box conforming to Standard Detail W-9. Each meter 1 1/2 inch through 2 inch shall be installed in a Mid-States MS3630B-NK meter box conforming to Standard Detail W-10. Each meter box shall be equipped with a non-locking, traffic bearing where necessary, cast iron frame and cover, 11-1/2 inch lid opening, with extension ring as required. Lid shall accommodate touch pad read-out hole, and shall be in accordance with the Authority's Approved Products List.
2. Meter Vault: Vault for meters 3 inches and larger shall be as manufactured by the Clear Flow Company or approved equal. Minimum dimensions and special details shall be as given in Standard Detail W-11 for the size meter assembly required. Joints on precast unit shall be sealed with an asphaltic butyl compound to make them watertight. Access hatch shall be manufactured by Bilco, Halliday, or approved equal.

2.5 MANHOLES

1. General: Concrete manholes shall be of precast construction. All concrete shall be rodded or vibrated to minimize honeycombing and assure watertightness. Items delivered and installed at the site shall be structurally sound and free from cracks or major surface blemishes. Manholes not complying with this or these Standards as determined by the Authority's Representative will not be accepted/approved by the Authority.
2. Under no circumstances shall manholes or other structures be left in an incomplete condition such that surface water could enter into the sewer line. This constitutes a violation of the Service Authority's inflow and infiltration prohibitions and may be subject to fines in accordance with the sewer pre-treatment regulations found in Section I of these Standards.
3. Construction:
 - 1) Precast manholes shall conform to ASTM C 478 and Standard Details S-5 and as called for on the plans. Drop manholes where required shall be constructed in accordance with Standard Detail S-4. Monolithic bottoms with extended base may be required in unstable soil conditions or where floatation may be a problem.
 - 2) The eccentric design manhole shall be used, except as shown on the plans.
 - 3) Manholes larger than minimum size may be required where pipe deflection or intersection of two or more upstream lines occur. All manholes shall have monolithic bases except as shown on the plans.
4. Precast Inverts: The invert channels shall be formed with concrete monolithically with the base as shown on Standard Details S-5 and S-6 and shall be smooth and semi-circular in shape, conforming to the inside of the adjacent sewer section. Channel inverts shall be constructed to provide a smooth continuous positive slope between pipes. Changes in direction of flow (horizontally and vertically) shall be made with a smooth curve of as large a radius as size of the manhole will permit as shown on Standard Detail S-6. The floor (bench) of the manhole outside of the channels shall be smooth and shall slope toward the channels not less than 2 inches per foot nor more than 4 inches per foot. Inverts shall be sloped no less than 2 percent across manhole base.
5. Manhole Steps: Manhole steps shall be polypropylene-coated steel reinforcing bar with a minimum design live load of 300 lbs and shall be provided in all manholes in accordance with Standard Detail S-5. The steps shall be of non-slip type approved by OSHA. Steps shall conform to Standard Detail S-9.
6. Pipe Connections:
 - 1) Existing lines shall be installed with a flexible pipe to manhole connector equal to KOR-N-SEAL. When connections are made to existing manholes, invert shaping shall be modified by the Contractor to accommodate new connection.
 - 2) New sewer line pipe including services shall be connected to the manhole base section with an integrally cast approved flexible water-tight sleeve or gasket and all-stainless steel take up clamps in accordance with ASTM C 923 equal to Z-LOK pipe to manhole connector by A-LOK Products, Inc. Points of entry for mains or services which are added after fabrication of the manhole shall be provided by machine coring and installation of a flexible connector equal to KOR-N-SEAL. The connector shall be installed in the manhole wall by activating the expanding mechanism in strict accordance with the manufacturer's recommendations.
 - 3) All pipes shall extend through the manhole walls a minimum of two inches. Chipping, jacking, or breaking of concrete to make connections is prohibited. Any such occurrences shall be repaired at the expense of the Contractor.

- 4) The connector shall be of a size specifically designed for the pipe size and material being utilized on the project.
7. Sewer Pump/Force Main Receiving Manholes: Interior of new and existing force main receiving manholes shall receive an epoxy coating. Coating shall be 100 percent solids based epoxy binder combined with fibrous and flake fillers to minimize water vapor transmission and increase flexural strength. Material shall be specifically designed for manhole rehabilitation. Coating shall be corrosion resistant. Material shall be applied at 40-60 mils thick on vertical and overhead surfaces.
8. Frames and Covers: Frames and covers shall be of cast iron conforming to ASTM A 48 for Class 30 Gray Iron. Castings shall be of uniform quality, free from sand holes, gas holes, shrinkage, cracks, and other surface defects. Castings shall be ground smooth and well cleaned by shot blasting. For traffic service castings, bearing surfaces between cover and frame shall be cast or machined with such precision to prevent rocking. Bolt holes for watertight frames and covers shall be cast into the unit at the time of manufacturing to insure proper alignment of holes between frame and cover no matter how the cover is oriented on the frame.

Standard frame and covers shall conform to Standard Detail S-7. Watertight frames and covers shall conform to Standard Detail S-8.

- 1) The frame and cover shall be sealed to the outside of the concrete manhole section with a double ring of butyl sealant/rope and bolted to the manhole in accordance with Standard Detail S-7 or S-8.
- 2) Height control rings may be used to adjust manhole tops to proper grade, however, a maximum of 12 inches total height of control rings will be permitted.
9. Concrete: Concrete used for shaping of manholes, channels, and miscellaneous work shall meet requirements of VDOT Section 217 type A3.
10. Joints: Joints shall be sealed with two rings of butyl rubber rope or O-ring conforming to AASHTO M 198, Type B.
11. Vented Manholes: Vented manholes shall conform to Standard Detail S-8A.

2.6 MISCELLANEOUS DEVICES

1. Floor Drains: Drains shall conform to ANSI/ASME A 112.21.1. Floor drains shall be coated cast iron with double drainage flange, weepholes, threaded outlet connection, integral bell trap, and adjustable polished nickel alloy round removable strainer. Strainer shall be 6 inches in diameter and shall be made with light duty grate in buildings except in traffic areas where medium duty shall be used.
2. Pressure Gauges: Pressure gauges shall be bronze Bourdon tube in cast aluminum case with male 1/4 inch IPT connection at bottom, at least 4 1/2 inch face diameter with a range adequate to measure all working pressures, installed with brass piston type pulsation dampener. Gauges on the suction side of pumps shall be a pressure and vacuum gauge with a range adequate to measure all working pressures. Each gauge shall be mounted with a bronze ball cock to allow removal or servicing and a piston type pressure snubber to protect the gauge from rapid changes in line pressure. Gauges for use in wastewater applications shall be isolated from direct contact with wastewater by means of a diaphragm type isolator.
3. Pipe Repair Clamps: Shall be of stainless steel, type 304 with pre-assembled bolting mechanism. Clamps shall be manufactured by the Ford Meter Box Company, Inc., Smith Blair or AY MacDonald. Repair clamps and couplings for contract construction jobs will be ductile iron.

4. Tapping Saddles: Saddles shall be made of a malleable material and have flat stainless steel straps. Rubber gaskets shall be required for all pipe sizes and classes. Lead gaskets are prohibited. Saddles shall provide full support around the circumference of the pipe and have a bearing area of sufficient width along the axis of the pipe 1-1/2 inch minimum. Saddles shall not have lugs that will dig into the pipe when the saddle is tightened. The U-bolt type strap will not be allowed. Saddles shall be Ford FS 202, Mueller DE2S SERIES, Romac Style 202S or approved equal.
5. Sewer Connection Saddle: Saddle shall be attached to the main line by a stainless steel strap and have water tight seal to both the main line and the branch outlet. Saddle shall be equal to Romac CB.

PART 3 EXECUTION

3.1 EXCAVATION, BACKFILLING AND COMPACTION

1. General: Trench excavation shall be in accordance with Section 02317 – Excavation, Trenching, and Backfilling for Utilities

3.2 SEPARATION OF WATER AND SEWER LINES

1. Parallel Installation:
 - 1) Normal conditions – Water mains shall be separated at least 10 feet horizontally from a sewer or sewer manhole. The distance shall be measured edge-to-edge. All water and sewer lines shall be installed a minimum of 20 feet from structures, including but not limited to, buildings, columns, and signs. Sewer lines and wells shall be separated a minimum of 50 feet.
 - 2) Unusual conditions – When local conditions prevent a horizontal separation of 10 feet, the Contractor shall notify the Authority's Representative. The Authority's Representative, after consultation with the Virginia Department of Health, shall provide special instructions for construction within the area of conflict. In some cases, if authorized by the Authority's Representative, the 10 foot separation requirement may be waived provided that:
 - a) The bottom (invert) of the water main shall be at least 18 inches above the top (crown) of the sewer.
 - b) Where this vertical separation cannot be obtained, the sewer shall be constructed of AWWA approved water pipe, pressure tested in place to 30 psi without leakage prior to backfilling.
 - c) The sewer manhole shall be of watertight construction and tested in place.
2. Crossings:
 - 1) Normal conditions – Water lines crossing over sewers shall have a separation of at least 18 inches between the bottom of the water line and the top of the sewer.
 - 2) Unusual conditions – When local conditions prevent a vertical separation described above, the Contractor shall notify the Authority's Representative. The Authority's Representative, after consultation with the Virginia Department of Health, shall provide special instructions for construction within the area of conflict. In some cases, if authorized by the Authority's Representative, the following construction shall be used:
 - a) Sewers passing over or under water mains shall be constructed of AWWA approved water pipe, pressure tested in place to 30 psi without leakage prior to backfilling. Sewer pipe shall also be centered at the point of water line crossing such that the joints are equidistant from the crossing.

- b) Water lines passing under sewers shall, in addition, be protected by providing:
- A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line.
 - Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the waterline.
 - That the length of the water line be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the crossing.
3. **Intersections:** No water pipe shall pass through or come in contact with any part of the sewer or sewer manhole. Nor shall any water distribution flushing device be directly connected to any sewer.
4. **Special Cases:** In the event that existing utilities or field conditions make it impossible or impractical to meet the separation requirements, the Contractor shall notify the Authority's Representative. The Authority's Representative, after consultation with the Virginia Department of Health, shall provide special instructions for construction within the area of conflict.

3.3 INSTALLATION OF PIPE AND FITTINGS

1. **General:** No valve, hydrant, or other appurtenance on existing water lines shall be opened or closed for any purpose by the Contractor. Any opening or closing of valves, hydrants, whatsoever shall be by the Authority only. The Contractor shall notify the Authority at least 48 hours prior to the need to open or close any appurtenance, except in emergencies, at which time the Authority shall be notified immediately.
2. **Depth and Cover:** All water lines shall be constructed with a properly prepared trench, pipe bedding, and backfill. All water lines shall have a minimum of 42-inch and maximum of 60-inch cover measured from the top of the pipe to the finished grade at the proposed pipe centerline. Only under extraordinary circumstances and with special permission of the Authority shall water lines be deeper than 60 inches, or less than 42-inches deep (see Standard Detail W-1).
3. **Slope:** When installing gravity sewer on slopes of less than one percent, laser technology shall be used to insure proper grades.
4. **Handling:** Pipe shall be placed in the trench in such a manner as to prevent damage to pipe and protective coatings and linings. Under no circumstances shall pipe be dropped or dumped into the trench. As the temperature approaches or drops below freezing, extra care shall be used in handling pipe.
5. **Cleaning:** Every precaution shall be taken to prevent foreign material from entering the pipe while it is being placed in the line. Spigot and bell ends of pipe and gaskets shall be cleaned and lubricated according to manufacturer's instructions. If the pipe cannot be placed without getting debris into it, the Authority may require that a heavy tightly woven canvas bag of suitable size be placed over each end of the pipe before lowering the pipe into the trench and left there until the connection is made to the adjacent pipe. At times when pipe laying is not in progress, the open ends of the pipe shall be closed by a watertight plug. If water accumulates in the trench, plugs shall remain in place until the trench is dry.
6. **Cutting:** Pipe shall be cut in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized by the Authority's Representative, cutting shall be done by means of approved type of mechanical cutters. Wheel cutters shall be used when practicable. Use of oxy-acetylene torch or similar method to cut pipe will not be permitted.

7. Direction of Laying: All pipe shall be laid with bell ends facing in the direction of laying unless otherwise directed by the Authority’s Representative. Where pipe is laid on a grade of 10 percent or greater, or for gravity pipe systems, the laying shall start at bottom and shall proceed upward with the bell ends of pipe upgrade. Each piece of pipe shall be laid true to line and grade. The bottom of the trench shall be smoothly graded and bell holes provided so that the trench bottom provides uniform support to the barrel of the pipe when in final position. Adjustments to line or grade shall be made by removing or adding granular material under the barrel. In no case shall wedges or blocks be used under the body of the pipe. The pipe shall be pushed fully "home" by hand, with a bar and block of wood to cushion the bell, or other similar methods for large diameter pipe.
8. Bedding: Bedding of pipe shall be placed to the depth shown on the plans or standard details and shall be compacted to specified density. Bedding of ductile iron pressure pipe shall consist of firm subgrade with excavation for bell holes. When in rock excavation or for gravity sewer, bedding shall consist of a gravel base as shown in Standard Details W-1 and S-1.

Special care must be taken during installation of ribbed PVC pipe to insure ribs are completely imbedded in the bedding material to prevent settling after installation. This material (sometimes referred to as “haunching”) from the bedding to the springline must be rodded with bars or consolidated with shovels to assure complete filling of the voids between each rib. If pipe is completely covered with bedding/haunching material the same procedures shall be followed to prevent any voids between the pipe ribs.

9. Lateral Connections: In-Line wyes and tees for cleanouts/laterals shall be installed during initial construction. When lines are required to be tapped, connections shall be made using an approved watertight saddle. Tapping into the ribbed PVC pipe with the wye tapping saddle or the Inserta Tee will only be authorized to accommodate additional requirements subsequent to acceptance of project by the Authority or as explicitly authorized by the Authority’s Representative.
10. Stubouts: Stubouts when required shall be extended a minimum of 10 feet beyond the existing or proposed edge of pavement as applicable.
11. Deflection at Joints: Maximum deflection for force main and pressure pipe joints will be as follows:

Pipe Size	Allowable Deflection (in inches)							
	Ductile Iron (Push on) Lengths				Ductile Iron (Mechanical) Lengths			
	12'	16'	18'	20'	12'	16'	18'	20'
4"	12	17	19	21	21	28	31	34
6"	12	17	19	21	18	24	27	30
8"	12	17	19	21	13	18	20	22
10"	12	17	19	21	13	18	20	22
12"	12	17	19	21	13	18	20	22
16"	7.5	10	11	12	9	12	13.5	15

12. Installation of Fittings: Fittings shall be installed with the same care that mainline pipe is installed. Caps or plugs shall be braced to prevent blow off during testing.
 - 1) Ductile iron fittings used on Force main and Other Pressure Pipe shall be supported in accordance with PART 2 PRODUCTS of this Section.

Use fittings and gaskets manufactured by the pipe manufacturer designed specifically for connection to, and repair of, ribbed PVC pipe. Installation of fittings and repairs to pipe must be in accordance with the Manufacturer’s procedures and recommendations.

13. Manhole Pipe Ribbed PVC Pipe Connections:

- 1) Where manholes are manufactured with a Z-LOC Manhole Pipe Connectors as manufactured by A-LOC Products, Inc., use a ribbed PVC Bell by SDR 35 (ASTM D 3034) spigot adapter. Flexible manhole seals shall be sized for SDR 35 PVC pipe (ASTM D 3034 or F 679).
- 2) When the “flip top” gasket is used on the ribbed PVC pipe at manhole connections, the New Lock Joint Manhole Sleeve as manufactured by Interpace Corporation must be cast in place in the openings of the manhole sections. The openings must be enlarged with oversize flexible sleeve connectors cast in place that will accommodate the “flip top” gasket. Manhole fabricators must be informed when ribbed PVC pipe is to be used with “flip top” gaskets so manholes can be cast accordingly.
- 3) When ribbed PVC pipe is connected to existing manholes the opening shall be cored or drilled to provide a flat, smooth surface for the installation of a PSX Positive Seal Gasketing System as manufactured by the Press Seal Gasket Corporation. When the ribbed PVC Bell by SDR 35 (ASTM D 3034) spigot adapter is used to connect to existing manholes, the opening and flexible seal connector shall be sized to accept SDR 35 PVC pipe.

When the ribbed PVC pipe connects directly to an existing manhole using the “flip top” gasket, the opening and flexible seal connector must be enlarged to accept the ribbed PVC pipe with the “flip top” gasket in place.

Rigid, grouted connections to newly installed or existing manholes will not be allowed without explicit authorization from the Authority’s Representative.

14. Jointing:

- 1) Mechanical Joints: When installing mechanical joint (MJ) ductile iron pipe, the socket, spigot end and rubber gasket shall be thoroughly washed with soapy water to remove any grease or grit that might damage the gasket. In making up the joint, the gland for MJ pipe followed by the gasket, shall be placed over the plain end of the pipe and inserted into the socket. The gasket shall be pushed into position without excessive force and evenly seated in the socket of the pipe bell, and the gland for MJ pipe, then moved into position against the face of the rubber gasket.
 - 2) Flanged Joints: Where flanged joints are used, they shall be installed by skilled workmen in accordance with the best standard practice. Bolts shall be tightened so as to evenly distribute the joint stress and insure proper pipe alignment.
15. Roadway and Railroad Crossings through Casings: When special conditions require use of casings, care shall be taken to maintain the proposed plan grade. Before pushing the pipe through the casing, spiders shall be strapped to the pipe, in accordance with manufacturer’s recommendations, to keep the pipe centered in the casing and to prevent damage when installation is made. Care shall be taken to ensure that the installed pipeline is well secured to prevent movement. See Standard Detail G-1.

Construction of bores shall be carried out in such a manner that there will be no settlement of the ground surface above the bores. The contractor will be responsible for all settlements above the bore. Bores shall be made such that they will not be off line more than amount equal to one (1) percent of the length of the bore, not to exceed two (2) feet. Bores will not be off grade more than one (1) percent, not to exceed 0.5 ft. Where the casing pipe is not installed in accordance with the elevations, grade or alignment indicated, any deviations shall be subject to the approval of the Authority. Approval of the installation will not be given, if in the opinion of the Authority the required adjustments of the system will not conform to the Authority's design criteria.

All joints within casing pipe shall be mechanical joint pipe and be restrained.

Installation of pipeline and casing pipe by boring shall be performed by individuals or companies experienced in such construction. Properly shored boring and receiving pits shall be installed at the ends of the bore. The bore shall proceed as rapidly as possible to prevent seizing to the casing pipe. Lengths of casing pipe shall be welded at all joints to the section previously installed. The end of the casing pipe shall be sealed with brick and mortar as shown in Standard Detail G-1.

The operations shall be conducted in a manner to prevent voids between the surface of the casing and the earth. Pipe shall be backfilled using crusher run stone or VDOT approved flowable backfill material as directed by the Authority for the particular location and situation.

A boring plan and product data for casing and spacers shall be submitted for approval prior to commencement of work.

Railroad crossings shall be in accordance with all railroad permits and standards as required.

16. Installation of Tees and Laterals: Tees and laterals shall be installed with the same care that mainline sewers are laid. Slopes shall be not less than 1 percent unless otherwise indicated. Laterals shall be the same material as the main sewer pipe and shall run to property lines unless otherwise indicated on the plans. Laterals shall be properly capped and suitably sealed to prevent infiltration of water into the connections. Caps or plugs shall be braced to prevent blowoff during exfiltration or air testing. Ends of laterals shall be marked by a steel marker driven flush with the ground and in such a manner as to brace the plug on the lateral. Couplings shall be provided as needed for ductile iron pipe connections to plastic tees. Rotation of mainlines and concrete support will be required for deeper installations. Cleanouts per the appropriate detail shall be provided at the terminal points. See Standard Detail S-3.
17. Installation of Manhole Stubouts: Manhole stubouts shall be provided where indicated. Stubout pipe shall be 8 inch diameter unless otherwise indicated on the plans and shall be the same pipe material as the sewer pipe. Manhole stubouts shall be extended from the manhole a minimum of 8 feet. Stubouts shall be sealed, braced and marked as noted for tees and laterals.
18. Cleanouts: Piping and fittings shall be constructed of the same materials as the main line sewer and shall conform to Standard Detail S-3 or S-3A. Reconnecting to existing laterals shall be accomplished with proper water tight transition couplings as required.
19. Water Service Connections:
 - 1) Existing Waterlines: New service taps on existing water lines shall be made under pressure with proper tapping machine for the pipe being tapped and with the Authority's Representative present.
 - 2) New Water Lines: New service taps on new water lines shall be made under pressure with proper tapping machine for the pipe being tapped. The water main shall be tested and disinfected after service taps are made.
20. Setting of Valves: Valves shall be installed in accordance with manufacturer's instructions and shall be in accordance with Section 02085 - Valves and Cocks and as shown on the Standard Details.
21. Anchorage and Joint Restraint: For pipe installation at grades over 20 percent, the pipe shall be anchored in accordance with Standard Detail G-5. Pressure pipe lines shall be mechanical joint and protected against joint pulling or thrust damage by suitable mechanical joint restraining glands installed at direction changes as a result of fittings and all other critical points. Other methods of restraint may be approved by the Authority depending on the conditions.

Rods and clamps, for use on hydrant installations only, shall be galvanized or otherwise rust proof treated.

Concrete thrust blocks may be used when connecting to an existing unrestrained pipe or in other circumstances as approved or required by the Authority's Representative. See Standard Detail G-3 and G-4.

Mechanical joint pipe and restraining devices shall be installed in accordance with Standard Detail W-14 and shall be in accordance with the Approved Products List.

3.4 INSTALLATION OF METERS

1. Meters: Meters shall be supplied and installed by the Authority when the project is determined to be substantially complete by the Authority's Representative and all connection fees have been paid in accordance with the ACSA OPPM Policy No. 10.10. Temporary meter connections may be allowed for construction purposes or in other cases as approved by the Authority and in accordance with Policy No. 10.7 of the ACSA OPPM.
2. Meter Boxes:
 - 1) For new residential subdivisions, meter boxes shall be supplied and installed by the Developer/Contractor. A hook-up fee discount may be applied as shown on the Authority's Rate Schedule.
 - 2) For individual site developments and service connections to existing water mains, meter boxes shall be installed by the Authority up to and including 2 inch. Larger installations required a vault shall be supplied by the Developer/Contractor in accordance with these Design and Design and Construction Standards. All vaults shall be dedicated to the Authority and shall be located at the property line to permit access unless otherwise approved.
 - 3) Meter boxes in accordance with the Standard Details shall be installed around all meter yokes at the end of each service lateral. Assembly shall have a section of tubing installed on the customer side of the yoke with a 3/4" PVC pipe plug installed to prevent dirt from entering (see Standard Detail W-9). The homeowner or developer is responsible for making the connection between the pipe at the meter box to the residential service lateral.
 - 4) Wherever possible meter boxes shall be constructed in such a manner as to prevent conflict with proposed finished grading or other proposed construction such as driveways, drainage ditches, etc. If changes in grade at meter box are made by the developer or customer after initial construction approval, the cost of box adjustment shall be borne by the owner of the property being served by the meter.
 - 5) Meter boxes shall be located in nonpaved areas. Meter boxes shall be located and installed so as to prevent water, dirt or debris from entering or covering them.
3. Meter Vaults:
 - 1) Meter vaults shall be installed by the Contractor unless otherwise specified by the Authority.
 - 2) No sweated fittings are allowed. At no time shall mortar touch copper or galvanized pipe. The internal pipe may need bracing to support the valves and meter assembly. Any such bracing shall be approved by the Authority. Meter vaults shall be designed, located and installed so as to prevent water, dirt or debris from entering or covering them (see Standard Details W-11 and W-12).
 - 3) Meters 3" and Larger – Meter vault structure shall be from Clearflow or approved equal with an aluminum access hatch in accordance with Standard Detail W-11, W-12 or W-13. Size shall be in accordance with the Standard Details and these Design and Construction Standards.

4. Installation of Pipe Supports: Exposed piping inside of vault shall be supported both horizontally and vertically such that forces are transmitted to the supports and sagging is eliminated.

3.5 MANHOLE INSTALLATION

1. Manholes: The subgrade and bedding for the monolithic base for the precast manhole shall be prepared similar to that for gravity sewer pipe as shown in Standard Detail S-1.
2. Joints: Joints shall have a double ring of butyl rubber rope caulk or O-ring to form a watertight seal. Manhole frames, covers, and hatches shall also be set on a double ring of butyl rubber rope caulk. When leveling is required manhole frames shall be set level on a full bed of mortar installed to the proper grade and cured prior to the application of the butyl caulk.
3. All lift holes shall be plugged and sealed with non-shrinking grout on the inside and outside.
4. Frames & Covers: Manhole frame and cover castings shall be installed so that the cover shall be exposed and flush with the existing street surface. In no case shall the existing pavement surface be raised or lowered to meet the grade of the installed manhole frame and cover casting. If street surfaces are renewed or replaced by the developer or owner after the sewer system has been approved and accepted by the Authority, but while such streets are still the obligation of the developer or owner, the manhole frames and covers therein shall be readjusted to proper elevation relative to new street surfacing by the developer or owner. The frame and cover castings of manholes located in sodded or other off-street areas shall be installed so that the covers shall be exposed and above the surrounding surface so as to prevent entrance of surface water. If located in a drainage swale or other location subject to flooding frame and cover shall be water tight.

3.6 STREAM AND WATER CROSSINGS

1. Surface Water Crossings: Where water lines are intended to cross streams, rivers or other surface waters (either continuous or intermittent flows), only underwater crossings will be permitted. Pipes to be installed underwater shall be encased in concrete with mechanical joint pipe and shall be installed according to Standard Detail G-6 and shall be in accordance with Section 02317- Excavation, Trenching, Backfilling for Utilities in these Specifications. Valves shall be provided at both ends of the water crossing so that the section can be isolated for tests or repair; the valves shall be easily accessible and not subject to flooding. Sample taps shall be installed at each end of the crossing and at a reasonable distance from each side of the crossing and not subject to flooding. These taps are for testing and locating leaks. The water line shall be a minimum of 42" below the stream bed surface. A minimum of 24 inches below the stream bed surface may be used upon approval of the ACSA.

3.7 TESTING

1. General: Testing of pipe lines and structures shall be in accordance with Section 01450 – Testing & Inspection Requirements and these Design and Construction Standards.
2. The Authority's Representative shall be present at all required water/sewer facility testing. Copies of all test results shall be submitted to the Authority's Representative in accordance with the ACSA OPPM 10.10.

3.8 PIPELINE TESTING

1. General: Water for the first test shall be provided by the Authority. Subsequent water for tests shall be at the Contractor's expense in accordance with Section 01450 – Testing & Inspection Requirements. In the event the mains are damaged and are in need of repairing, cleaning, disinfection, flushing, testing, or similar operational actions, they shall be done in accordance with the most current standard issued by AWWA.

2. Pressure Testing – Water and Force Mains:

- 1) **Test Section:** Pressure and leakage testing shall be conducted on each valved section (between adjacent valves) of pressure pipeline. Testing taps shall be provided and installed by Contractor as necessary where service connections are not available. Forcemains and other pressure pipe without valves shall be tested in sections not to exceed 5,000 feet.
- 2) **Procedures:** Pressurization, air removal, and allowances shall be in accordance with AWWA C 600, Section 5. Testing shall begin on the first valved section of line within ten days after its completion. Waterline shall not be considered ready for testing until all service taps have been installed. If testing is performed before services are installed additional testing may be required. The pressure and leakage tests shall be conducted concurrently for a duration of two hours. Testing through fire hydrants shall not be permitted. The valved section of the pipe under consideration shall be slowly filled with water and brought to the specified 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, by means of a pump. Before supplying the specified test pressure, all air shall be expelled from the pipe.

Testing shall not begin until at least seven days after the last concrete anchor, if used, has been poured on the section of line being tested (if high early concrete is used, two days). The Authority's Representative shall observe all leakage tests. If the pipe fails to meet test requirements, all leaks shall be repaired and defective pipe replaced at the Contractor's expense. The test shall be repeated until satisfactory results are obtained. The Contractor shall be charged for all retests at the normal rates for inspection services in accordance with Section 01450 – Testing & Inspection Requirements.

Any exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until it meets the testing requirements in these Design and Construction Standards.

- 3) **Test Pressures:** Test pressure shall not exceed the rated pressure of valves, piping, or thrust restraint design pressures. For test pressures less than 200 psi, Contractor shall demonstrate that there is no significant pressure (other than static) in the adjacent sections of pipeline to the one being tested.

Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. When hydrants are in the test section, the test shall be made against closed hydrant valves. The system shall be stabilized at the test pressure before conducting the leakage test.

- 4) Leakage: Leakage shall be defined as the quantity of water that must be supplied into the valved pipe section to maintain pressure within 5 psi of the specified test pressure. The allowable leakage shall not exceed the values given in table labeled Allowable Leakage Per 1,000 Feet of Pipeline.

Allowable Leakage Per 1,000 Feet (305 m) of ductile iron or 1111 feet (339 m) of PVC Pipeline - gph (multiply by 2 for 2 hour test)

Avg. Test Pressure psi	Pipe Diameter										
	3	4	6	8	10	12	14	16	18	20	24
300	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12
275	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99
250	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85
225	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70
200	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55
175	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38
150	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21
125	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01
100	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80

- 5) Test acceptance shall be determined on the basis of passing the above mentioned test. If any test of laid pipe fails, the contractor shall locate and make approved repairs as necessary until the line passes the test.
 - 6) All visible leaks are to be repaired, regardless of the amount of leakage.
3. Gravity Sewer Testing: All gravity sewer lines shall be tested by any or all of the following methods for both displacement and structural faults and for watertightness by the Contractor. The testing methods shall be at the option of the Authority. The Contractor shall make all preparations and shall supply the labor for all tests. The Contractor shall supply specialized equipment for the conduction of such tests. The Authority’s Representative shall be present during all testing and the Contractor shall be responsible for notifying the Authority of scheduled test at least 48 hours in advance. No charge shall be made for initial witnessing of tests, but each succeeding test required on the same section of line caused by failure of the tests shall be charged to the Contractor. The Authority shall be permitted access to the construction work at anytime for inspection of the work and construction methods. All testing will be done at the contractors/developers expense. Testing shall be performed in accordance with Section 01450 – Testing & Inspection Requirements and these Design and Construction Standards.

The Authority will inspect all new gravity sewer lines with their own T.V. equipment at no cost to the Contractor for the first test on each section of pipeline. Any subsequent tests following repairs or corrections shall be performed at the rates outlined in the Fee Schedule. The Contractor shall notify the Authority at least 48 hours in advance for scheduling of T.V. inspections.

- 1) Displacement Tests - Sewers will be checked by the Authority to determine whether any displacement of pipe has occurred. The test will be as follows:
 - a) Pipe Displacement Testing - Lights: A light will be flashed between manholes by means of a flashlight or by reflecting sunlight with a mirror or by other methods as may be adopted by the Authority. If the illuminated interior of the pipeline shows visible leaks, poor alignment, displaced pipe or any other defects, they will be remedied by the Contractor at the Contractor’s expense.

- c) **Pipe Deflection Testing:** Pipe may be measured for vertical ring deflection after completion of the backfill. Maximum ring deflection of the pipe under load shall be limited to 5.0 percent of the vertical internal pipe diameter. Testing shall be accomplished by recording deflectometer or by approved mandrel, sphere, or pin type go/no-go device. Such equipment shall be furnished by the Contractor.

Mandrel and proving ring details shall be approved by the Authority's Representative and shall be sized at five percent less than ASTM dimensions for the sewer pipe. The mandrel test shall be performed no sooner than three months after backfill of the pipe is completed. If the pipe line exceeds the five percent deflection, the sections involved shall be repaired or replaced as necessary by the contractor. The "rerounder" technique shall not be allowed. The Contractor shall use approved nine-arm mandrels and proving rings for each size of mainline pipe. The contract length "L" of the mandrel arms and the actual mandrel diameter "D" (ID of the proving ring) shall equal the dimensions in the table below. Critical mandrel dimensions shall carry a tolerance of +/- .01".

Nominal Diameter	Arm Length	Pipe Base Diameter ^A	ASTM D3034 PVC SDR 35 D
8"	8"	7.655"	7.27"
10"	10"	9.563"	9.08"
12"	12"	11.361"	10.79"
15"	15"	13.898"	13.20"

^A - Base diameter is a minimum pipe inside diameter derived from subtracting a statistical tolerance package from the pipe's inside diameter. The tolerance package is defined as the square root of the sum of squared standard manufacturing tolerances.

At the discretion of the Authority, all completed sewers shall be TV inspected, a second time, for deficiencies before final approval is given. The Authority camera shall be used. If deficiencies are noted inspection services will be billed to the contractor at the Authority's prevailing rates. If no deficiencies are noted, then the inspection services cost will be absorbed by the Authority.

- 2) **Leakage Tests** - The Contractor shall perform leakage tests on sewer lines and manholes with their own equipment.

All completed sewers shall be tested for leakage by an air test

- a) **Pipe Air Testing:** Air Testing shall be conducted in accordance with ASTM F 1417 and as summarized below.
 - 1) Clean pipe to be tested by propelling a snug-fitting inflated rubber ball through the pipe with water if necessary.
 - 2) Plug all pipe outlets with suitable test plugs. Brace each plug securely.
 - 3) If the pipe to be tested is submerged in ground water, insert a pipe probe by boring or jetting into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to ground water submergence over the end of the probe. All gauge pressures in the test should be increased by this amount.

- 4) Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psig.
- 5) After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
- 6) After stabilizing the internal pressure at 4.0 psig, reduce the internal air pressure to 3.5 psig, and start stopwatch. Determine the time in minutes and seconds that is required for the internal air pressure to reach 2.5 psig. Minimum permissible pressure holding times for runs of single pipe diameter and for systems of 4 inch, 6 inch, or 8 inch laterals in combination with trunk lines are indicated in minutes and seconds in the table shown.

NOTE: The air test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. In as much as a force of 250 pounds is exerted on an 8 inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous. As a safety precaution, pressurizing equipment should include a regulator set at perhaps 10 psi to avoid over pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing. The pressure gauge used during the test shall be located completely outside of manhole.

1 Pipe Dia. (in.)	2 Minimum Time (min:sec)	3 Length for Minimum Time (ft.)	4 Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)								
				100'	150'	200'	250'	300'	350'	400'	450'	
4	3:46	597	.380 L	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:24	
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34	7:36	8:52	10:08	11:24	
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53	11:52	13:51	15:49	17:48	
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38	
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04	
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41	
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31	
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33	
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:48	
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15	
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53	
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46	

3.8 MANHOLE TESTING

1. Manhole Vacuum Testing: Manholes may be tested by vacuum testing only if constructed of precast concrete. The CONTRACTOR is encouraged to test the manhole prior to backfilling. Stubouts, manhole boots and pipe plugs shall be secured to prevent movement while the vacuum is drawn. Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications for which performance information has been provided by the manufacturer and approved by the Health Department. A measured vacuum of 10 inches of mercury shall be established in the manhole. The time for the vacuum to drop to nine inches of mercury shall be recorded.

Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 inches to 9 inches of mercury. The maximum allowable leakage rate shall be in accordance with ASTM C 1244.

TABLE 1 – Minimum Test Times for Various Manhole Diameters in Seconds

Depth (ft)	Diameter, in.								
	30	33	36	42	48	54	60	66	72
8	11	12	14	17	20	23	26	29	33
10	14	15	18	21	25	29	33	36	41
12	17	18	21	25	30	35	39	43	49
14	20	21	25	30	35	41	46	51	57
16	22	24	30	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	53	65	72	81
22	31	33	39	46	55	64	72	79	89
24	33	36	42	51	59	64	78	87	97
26	36	39	46	55	64	75	85	94	105
28	39	42	49	59	69	81	91	101	113
30	42	45	53	63	74	87	98	108	121

If the manhole fails the test, necessary repairs shall be made and the vacuum test and repairs shall be repeated until the manhole passes the test or the manhole shall be tested in accordance with the standard exfiltration test and rated accordingly.

If a manhole joint material is pulled out during the vacuum test, the manhole shall be retested after it is disassembled and the mastic/gasket replaced.

2. Manhole Exfiltration Testing: Manholes may be tested by exfiltration in accordance with the SCAT regulations. Inflatable stoppers shall be used to plug all lines into and out of the manhole being tested. The stoppers shall be positioned in the lines far enough from the manhole to insure testing of those portions of the lines not air tested. The manhole shall then be filled with water to the top of the rim. A maximum 12-hour soak shall be allowed. Leakage shall not exceed 0.25 gallon per hour. Air testing or vacuum testing of manholes for leakage maybe considered on a case-by-case basis. It is important that the entire manhole from the invert to the top of the rim be tested.

3.9 DISINFECTION

1. General: Disinfection of water mains shall be in accordance with Section 02510 - Water Distribution.

3.10 EXPOSED PIPING IDENTIFICATION

1. General: To identify exposed piping, the different lines shall have contrasting colors. Pipes and valves shall be color coded in a manner that will permit ready identification of pipes at any location. Labeling of the identification of the pipe with or without an accompanying color code shall be considered as an

acceptable substitute for the color scheme contained herein. Where color bands are utilized, the bands are to be one-inch wide and placed on 18 inch centers.

Sludge Line – Dark Brown
Raw Water Line – Green
Potable Water Line – Dark Blue
Sewage Line – Dark Gray
Backwash Water Line – Aqua
Compressed Air Line – Dark Green
Oxygen – White with Red Band
Drain Line – Light Brown

Chemical Lines:
Caustic – Green Band
Chlorine – Safety Yellow Band
Fluoride – Red Band
Soda Ash – Orange Band

END OF SECTION