PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section includes furnishing and installing all piping 4-in. in diameter and larger shown on the Drawings, or required to complete the Work.

B. Work to be furnished and installed shall include but is not limited to all pipe, fittings, specials, bends, beveled pipe, adapters, bulkheads, stoppers, plugs, joint restraints, joints and jointing materials; pipe supports; granular bedding and encasement; Class B concrete as specified in Section 03300 for blocking and encasement; making connections; providing temporary services; installing plugs, stoppers, and harnessing; testing, cleaning, and sterilizing; and any related structure penetrations or building modifications required.

C. Electrical, instrumentation, and control equipment that is furnished under other Sections but located in or on this Section piping shall be installed under this Section.

D. Referenced and related Sections include: 01300 Submittals, 01310 Progress Schedule, 01400 Quality Control, 02130 Trench Excavation, Bedding and Backfill, 03300 Cast-in-Place Concrete, 09900 Painting.

1.02 QUALITY ASSURANCE

A. Submit manufacturer's certifications, signed by an authorized agent, attesting that all products furnished under this Section meet the specified Federal, ASTM, AWWA, ANSI or other referenced specifications, requirements, or standards. If requested by the Engineer, each certificate shall be accompanied by a report comparing the test results to the specification requirements. Test specimens shall be selected in conformance with the designated specification or standard.

B. Laboratory testing shall be provided to assure compliance with this Section when required by the Specifications or if ordered by the Engineer.

C. All pipe and jointing materials shall be carefully examined for defects and no piece shall be used that is found to be defective. Defective pipe and materials shall be promptly removed from the site and replaced at no cost to the Owner.

D. The pipe and materials furnished shall be produced by manufacturers regularly engaged in the manufacture of such products and that have a history of satisfactory production acceptable to the Owner.

E. Pipe and materials shall be subject to inspection and approval. The Engineer may select one sample of each production run of each size and type of pipe for testing by the laboratory. The Contractor shall furnish the first test piece or pipe core and any additional samples required because of failures. Should the sample fail to meet specifications, retests shall be conducted by the laboratory in conformance with the specifications.

F. Installers shall be well qualified and use an adequate number of skilled workers who are thoroughly trained and experienced in the necessary crafts and with the specified requirements and methods needed for the proper installation of the work in this Section.

1.03 SUBMITTALS

A. Comply with pertinent provisions of Section 01300 Submittals.

B. The following product data shall be submitted in accordance with the approved Construction Schedule required in Section 01310

1. Shop Drawings in sufficient detail to show fabrication; the layout plan with dimensions, elevations, valves, pumps, meters, and other elements that are to be installed in the piping system; the material, class, size, and type of pipe; a schedule showing fittings and specials; jointing methods and details; installation, anchorage, and interfacing of the work of this Section with the work of other trades.

2. Manufacturer's recommended installation procedures which, when approved by the Engineer, will become the basis for accepting or rejecting actual installation procedures used on the Work.

3. Test data required elsewhere in this Section.

1.04 VERIFICATION OF CONTRACT DOCUMENTS

A. The Contract Drawings indicate the required pipe sizes and the general arrangements of the piping and equipment. Location shall be verified in the field by the Contractor. In the event it should become necessary in some cases to change the location of a portion of the work, the Contractor shall consult with the Owner before making any changes. Any such changes approved by the Owner shall be made with no added cost. Under no circumstances shall any pipe size shown on the Contract Drawings or specified be changed without first obtaining the written approval of the Owner.

B. The Contractor is especially cautioned to install no work that connects to equipment or inserted elements until shop drawings of such equipment or elements have been approved by the Engineer. Any such work installed by the Contractor prior to the approval of the relevant shop drawings will be at the Contractor's risk.

PART 2 - PRODUCTS

2.01 SEWER PIPE AND JOINT MATERIALS

A. Sewer pipe shall meet the requirements and be of the type specified, shown on the Drawings, or listed in the Piping Schedule.

B. **VITRIFIED CLAY PIPE (VCP)** and fittings unless otherwise noted shall meet requirements of ASTM C 700 ES, except that full inside diameter pipe shall be furnished. Joints shall have a bell and spigot meeting the requirements of ASTM C 425 or factory applied PVC collar conforming to ASTM D 1784 Class 12454-B.

C. **CORRUGATED STEEL PIPE (CSP)** for Storm Sewers shall meet the requirements of the Ohio Department of Transportation Specifications pertaining to base metal, weights and dimensions, rib spacing and depth, corrugations, rivets and riveting, galvanizing, end finish, workmanship, inspection, and other applicable requirements pertaining to corrugated steel pipe of the various types. The type and gauge of galvanized corrugated steel pipe to be furnished shall be as shown on the Drawings or specified. Unless otherwise specified, pipe shall be the riveted type, with lap joint construction. Jointing shall be by means of outside collars or bands of not less than 7 in. wide for pipe 30 in. and smaller in diameter, and not less than 12 in. wide for pipe over 30 inches in diameter. Where watertight joints are required, use 16 gauge galvanized metal bands with 3/8 in. neoprene gaskets or an alternative type band as approved by the Engineer.

D. POLYVINYL CHLORIDE PIPE (PVC)

1. **PVC SOLID WALL PIPE** and fittings having nominal diameters 4 in. through 15 in. shall conform to ASTM D 3034 SDR 35. All sewer fittings shall be SDR26 or lower.
2. Stiffness shall be in accordance with ASTM D2412.
3. The maximum calculated long-term deflection shall not exceed 5 percent of the mean diameter of the pipe. The maximum allowable deflection measured at least 30 days after completion of the backfill, using an approved nine-point mandrel, shall not exceed 3.3 percent of the mean diameter of the pipe.
4. All joints shall be bell and spigot push-on type with elastomeric seals and conform with ASTM D-3212. Gasket material shall conform to ASTM F477 and be factory installed.
5. Mechanical joint cast iron fittings with proper transition gaskets, meeting all requirements of ANSI A-21.11 (AWWA C111) may be used in lieu of PVC fittings.

E. **CORRUGATED POLYETHYLENE PIPE (CPP),** for the Storm Sewer shall be closed profile bell and spigot pipe conforming to AASHTO M 294 Type S or SP, and ODOT Specification 707.33 in its entirety.

F. NON-SHRINKING MORTAR MATERIAL for pointing joints shall be Sauereisen F-100 Grout as manufactured by Sauereisen Cements Co., Pittsburgh, Pennsylvania; Five-Star Grout as manufactured by U.S. Grout Corp., Old Greenwich, Connecticut; or equal.

G. FLEXIBLE PIPE REPAIR COUPLINGS for the repair of existing pipes shall be 18-8 Type 304 stainless steel. The coupling shall have a full length and diameter rubber gasket, Type 304 stainless steel nuts, bolts, and washers, and be manufactured by Rockwell, Romac, Ford or equal.

H. FLEXIBLE CONNECTION COUPLINGS shall be an elastomeric polyvinyl chloride boot with Series 300 stainless steel connecting clamps. Couplings shall be used as manufactured by Fernco Joint Sealer Co., Mission Day Products Corp. or equal.

I. FLEXIBLE WATERTIGHT CONNECTORS used to connect smaller sewers to larger sewers shall be elastomeric polyvinyl "boot" type sealed to the larger pipe with a stainless steel internal expanding band and around the connecting pipe with a stainless steel external adjusting band. Connector shall be as manufactured by Fernco Joint Sealer Co., Mission Clay Products Corp or equal. Other types of applicable flexible connectors may be submitted for approval.

2.02 UNDER-DRAIN PIPE AND JOINTS

A. Drainpipe shall be of the type specified or shown on the Drawings and of the quality specified.

B. **PERFORATED VITRIFIED CLAY PIPE (PVCP)** shall conform to the requirements of ASTM C-700 standard strength and extra strength. Joints shall be slip seal bell and spigot type.

C. **CORRUGATED POLYETHYLENE DRAINAGE TUBING (CPDT)** shall conform to AASHTO M 252 and ODOT section 707.31 in its entirety.

D. **CORRUGATED POLYETHYLENE DRAINAGE PIPE (CPDP)** shall conform to AASHTO M 294, Type C and ODOT section 707.32 in its entirety.

E. **PERFORATED PVC PIPE (PPVCP)** and fittings, in sizes 4, 6, & 8-inch diameter with smooth wall shall conform to ASTM F758, Type PS 46 minimum with four or more rows of perforations.

2.03 PROCESS AND PRESSURE PIPE

A. Ductile Cast Iron Pressure Pipe (DIP)

1. DUCTILE CAST IRON PRESSURE PIPE (DIP), Joints and fittings shall comply with ANSI A21.51 & A21.50, AWWA C151 & C150, and shall be Class 52 thickness unless otherwise specified or shown on the Drawings. Push-on and mechanical Joint Fittings shall conform to ANSI A-21.11 and AWWA C111 and shall have a minimum working pressure of 250 psi, (including 100 psi for pressure surges) for sizes greater than 12 in., and 350 psi (including 100 psi for pressure surges) for sizes 12 in. and smaller, unless otherwise specified. Flanged fittings shall conform to ANSI A21.15 or A21.10 and AWWA C115 or C110 and shall have a minimum working pressure of 250 psi for all pipe sizes unless otherwise specified.

2. Ductile iron pipe that is buried, unless otherwise noted, shall have rubber gasket slip-on type joints in straight runs and otherwise have mechanical joints with ductile iron retainer glands, for a sufficient distance in each direction to prevent joint separation. The gasket shall be a single molded rubber ring fitted into a specially shaped recess in the bell forming a watertight seal. All fittings shall have mechanical joints with retainer glands unless otherwise specified or shown. Setscrews shall be made of the same material as used for the bolts or be of other corrosion-resistant material approved by the Engineer.

3. Ductile Iron pipe that is installed inside buildings or structures shall be joined with factory-attached flanges or mechanical joints as shown on the Drawings. All mechanical joints shall have ductile iron retainer glands or equivalent. Flanges shall be ANSI 125 lb. drilling, unless otherwise specified or noted. Flanged joints shall be made up with full-face 1/16-in. rubber gaskets approved by the Engineer. Flanges shall be firmly bolted with machine, stud, or tap bolts of the proper size and number.

4. Ball and socket river crossing joints shall be restrained, boltless, push-on type and capable of deflecting 15 degrees in any direction.

5. Couplings, if required or permitted, shall be Dresser Style 38, Rockwell, or equal. Restrained coupling shall be Dresser Style 167 Lock Coupling, Rockwell, or equal.

6. Mechanical groove-type couplings, if required or permitted, shall be Victaulic Style 31, Aeroquip, or equal. Ductile iron pipe used at the joint must be minimum Class 53 wall thickness and grooved in accordance with coupling manufacturer recommendations.

7. Coatings and Linings

   a. Ductile iron pipe and fittings unless otherwise specified, shall be lined on the interior with standard thickness cement lining meeting ANSI Specification A-21.4 and AWWA C-104. An epoxy seal coat, suitable for contact with potable water shall be applied in conformance with the above Specifications. Piping used for compressed air shall not receive a cement lining.
   b. All buried ductile iron pipe shall be coated on the outside with a standard coating of coal tar or asphalt at least 1 mil thick unless otherwise specified. The finished coating shall be continuous, smooth, cured, and well bonded to the pipe. The coating materials shall impart neither harm nor objectionable color, odor, or taste to water in contact with the coating. The Contractor shall repair any damaged coatings by field applying a similar coating material. Where approved, the coating material used for an interior seal coat may be used for the exterior coating of buried pipe.
   c. All pipe used within buildings and structures that are to receive field coats of paint shall <u>not</u> be coated with bituminous paint. After proper cleaning, such pipe shall be painted with one coat of primer that will be compatible with the field coats. Painting specifications 09900 shall be followed for cleaning and painting.

8. Linear low-density polyethylene encasement shall be installed on buried ductile iron pipe and fittings unless otherwise noted. Material shall be minimum 8-mil linear low-density polyethylene film conforming to ANSI A21.5 and AWWA C105.

B. Steel Pipe (SP)

1. Steel pipe shall be designed, fabricated, and installed in accordance with these Specifications, the applicable "Good Practice" outlined in AWWA Design and Installation of Steel Water Pipe, and applicable AWWA C-200, C-203, and C-205, and ASTM A-53 Grade B for pipe less than 24-in. in diameter and API-5L for pipe greater than 24-in. diameter.

2. Pipe shall be manufactured of materials conforming to ASTM A-53 Grade B in accordance with the applicable AWWA Standards quoted above. It shall be supplied in nominal lengths approved by the Engineer. Not more than two circumferential welds per joint will be permitted.

3. Specials shall be fabricated of steel plate and designed for the same conditions as the pipe. Collars, stiffeners, and other reinforcement shall be used as required to obtain the necessary strength in all parts of the specials. A plate collar shall be welded around all outlet connections.

4. Minimum wall thickness shall be as follows:

Pipe Diameter	Min. Thickness
Less than 12-in.	Schedule 40
12-in. to 24-in.	1/4-in.
30-in. to 36-in.	5/16-in.
42-in. to 48-in.	3/8-in.
54-in.	1/2-in.

5. Wherever called for, a coupling, Dresser Style 38, Rockwell, or equal shall be used. Unless otherwise specified, the sleeve length shall be 5-in. and the sleeve thickness shall be 1/16-in. greater than the pipe wall thickness.

6. Wherever called for, a mechanical groove-type coupling shall be used. Unless otherwise specified, a thicker ring shall be welded to the pipe to form the necessary shoulder for the joint. The coupling shall be Victaulic, Aeroquip, or equal.
7. Welded joints shall be used wherever specified or shown on the Drawings. Welding shall comply with the specifications of AWWA covering such work.

8. Unless otherwise specified, at each connection to an existing buried pipeline a pair of insulated flanges shall be used to completely insulate the new line from the old one. The system to be used shall be submitted to the Engineer for his approval. Flange gaskets shall be full face at least 1/8-in. thick molded phenolic with neoprene facings. Molded phenolic sleeves shall encase each bolt from outside face of flange to outside face.

Sleeves shall be 1/16-in. thick. A 1/8-in. thick molded phenolic washer shall be installed under each nut and bolt head.

9. Joint harnesses, harness couplings, lock couplings, flange adapters with set screws, and other flexible restrained joints shall be provided as called for on the Drawings.

10. Where flanged joints are shown on the Drawings, flanges conforming to the requirements of AWWA C-207, Table 1, Class D shall be used. All flanged joints shall have full-faced gaskets.

11. Coatings and Linings

a. Steel pipe shall be shop lined on the inside with centrifugally spun cement mortar lining or field applied-in-place cement lining, in accordance with AWWA C205 and C602. If pipe is field lined, it shall be given an inside shop coat of bituminous primer after sandblasting before shipment to the site.
b. The outside of all buried steel pipe shall receive a coat of an approved bituminous primer, followed by a coat of coal tar enamel into which shall be bonded a single layer of felt wrap, and finished with a single wrap of Kraft paper unless otherwise specified. All materials and application procedures to be in full accordance with the pertinent sections of AWWA C203. Protective coatings are to be shop applied.
c. The outside of steel pipe located inside buildings and structures, and exposed exterior shall be properly cleaned and shop painted with one coat of primer that is compatible with field coats.

C. Stainless Steel Pipe (SSP)

1. Stainless steel pipe 12-in. diameter and smaller shall be designed and fabricated in accordance with either ASTM A-312 or ASTM A-778. Stainless steel pipe larger than 12-in. diameter shall be designed and fabricated in accordance with either ASTM A-409 or ASTM A-778. The interior surface of the pipe shall be smooth with no protrusions, stiffeners, or bracing. The pipe and fittings shall be constructed of 304L stainless steel.

2. Stainless steel pipe shall have the following minimum wall thickness and in all cases shall have sufficient structural strength for the intended use.

Pipe Diameter	Minimum Wall Thickness
4-in. to 14-in.	0.109-in. (12 gauge)
16-in. to 18-in.	0.140-in. (10 gauge)
20-in. to 24-in.	0.172-in. (8 gauge)

a. Stainless steel requiring threading shall be minimum Schedule 40.

3. Fittings shall conform to either ASTM A-403 or ASTM A-774 and shall have

the same wall thickness and structural properties as the pipe. All bends shall be long radius smooth type. Mitered bends will not be acceptable.

4. Flanges where required shall be ASTM A182-F304L flanges with full facing gaskets and centering rings. Flange bolts shall be stainless steel.

5. Wherever possible, butt weld fittings shall be used for field welding. All welds shall be made by a certified welder, and shall conform to standard welding procedures. The Contractor shall submit certification statements for the welders and the methods employed. Belled end fittings may be used in lieu of butt weld fittings on air lines.

6. All welds shall have full penetration and be smooth and without protrusions on the interior of the pipe. Weld metal shall be equal to or greater than the parent metal. Any cracks or blow holes appearing on the surface of a welding bead shall be ground away before depositing the next bead.

7. All stainless steel surfaces shall be treated as follows:

   a. All outside weld areas shall be wire brushed to remove weld splatter. Brushes shall be stainless steel and used only on stainless steel.
   b. All stainless steel assemblies and parts shall be completely immersed in a pickling solution of 6% nitric acid and 3% hydrofluoric acid at 140 degrees Fahrenheit for a minimum of 15 minutes. Parts shall be free of iron particles or other foreign material after this procedure.
   c. Previously pickled parts shall be neutralized by immersion in a trisodium phosphate rinse.

D. Polyvinyl Chloride Pipe (PVC)

1. Underground PVC pipe used for water lines and force mains shall conform to the requirements of AWWA C-900, and be Class 150 with DR 18 unless otherwise shown on the Drawings.

2. All fittings and specials shall be as specified for ductile iron pressure pipe.

3. Polyvinyl chloride pipe joints shall be integral bell push-on type meeting the requirements of ASTM D 3139. Gaskets shall be rubber ring type meeting the requirements of ASTM F 477. Where called for on the Drawings, flanged joints shall be used. Flanged joints shall be supplied with 1/16-in. thick full-faced gaskets of suitable material for the application. Flange bolts and nuts shall be stainless steel.

4. Sewer Force Main shall be ASTM – D2241, SDR21. Joints shall be integral bell push-on type, meeting ASTM3139. Gaskets shall be ASTM F477 rubber ring type.

5. A detectable tracer tape shall be installed on top of all buried PVC pipelines. Tape shall be metallic with the usage “Force main, waterline, etc. Clearly written on the line. Material shall be 3” wide.

E. Chlorinated Polyvinyl Chloride Pipe (CPVC)

1. Chlorinated polyvinyl chloride pipe, Schedule 40 or 80 as shown on the Drawings shall conform to ASTM F 441. CPVC fittings shall be Schedule 80 socket type and conform to ASTM F 439.
2. The method of jointing shall be as recommended by the piping manufacturer.
3. A detectable tracer tape shall be installed on top of all buried CPVC pipelines.

F. Polyethylene Pipe (PE)

1. Polyethylene piping, fittings and specials shall be PE3408, high density, high molecular weight polyethylene resin piping materials in accordance with ASTM D1248, Type III, Class C, Category 5, Grade P34 (III C5P35) polyethylene compounds.

2. The piping materials shall be in conformance with ASTM D3350 with a cell classification of PE345434C. Its dimensions and workmanship shall meet ASTM F714.

3. Fittings for PE pipe shall be ASTM D3261 - Fittings Standard and shall be as follows:

   a. Use SDR11 Fittings with SDR 15.5 pipe
   b. Use SDR 15.5 Fittings with SDR 25.5 pipe
   c. Use SDR 15.5 or 25.3 Fittings with SDR 32.5 pipe

4. All components of the PE piping system shall be NSF listed - Standard #14.

5. Polyethylene pipe joints shall be butt-fused.

6. Flanges shall be butt-fused to the pipe and shall meet the pressure rating required for fittings.

7. Nuts and bolts used on PE pressure pipe and fittings in contact with earth shall be of Type 316 stainless steel.
8. A detectable tracer tape shall be installed on top of all buried or submerged PE pipelines, as described above.

2.04 PROCESS AND PRESSURE PIPE NUTS AND BOLTS

A. Unless specified under the specific type of pipe, nuts and bolts used on pressure pipe and fittings shall be high quality, low alloy steel with true threads. Nuts and bolts shall be cathodic to the pipe, have a minimum yield strength of 45,000 psi, and meet the requirements of ANSI B16.1.

B. Nuts and bolts encased in grout on concrete pressure pipe shall conform to recommendations of the pipe manufacturer.

C. All other nuts and bolts shall be low carbon steel in conformance with the chemical and mechanical requirements of ASTM A-307, Grade B. Higher strength bolts will be acceptable.

2.05 PIPE HANGERS AND SUPPORTS

A. Pipe Supports

1. All large piping shall be mounted or suspended with ring type hanger Grinnel or equal. Floor supports shall be heavy duty welded steel pipe, complete with adjusting screw or jack, allowing final fraction of an inch adjustment. A pipe saddle shall be provided to fit this support. A detail drawing of all supports shall be submitted to the Engineer for approval prior to installation of the piping.
2. Angle iron braces, hangers and pipe support shall be provided and installed wherever shown on the drawings and as needed to provide a complete piping system.
3. Where underground pipes enter or leave a structure or building, the Contractor shall take special precautions to provide adequate support for such pipe over the span between the structural walls and undisturbed soil bearings. A pipe joint shall be located with two (2) feet of all structures.
4. This can consist of special reinforced concrete support beams laid below the pipe or adequately spaced timber or metal posts, located below the pipe and carried down to undisturbed earth.
5. In any event, should underground pipe fail in any manner due to earth settlement around structures with the guaranteed period of this contract, such failures are to be corrected by the Contractor.
6. Concrete pipe shall be furnished where located on the Drawings.

B. Pipe Hangers

1. All pipes, where suspended from the underside of floors or ceilings shall be held with substantial adjustable pipe hangers designed for use in connection with concrete, brick or tile wall, ceiling, or floor construction.

2. Provide adjustable inserts, properly located and set in the forms before placing the concrete, whenever possible. Hangers are to be of rodded steel, adjustable screw rod pattern, not strap hangers. Particular care shall be taken to arrange and support pipes in an orderly and neat appearing manner.
3. In all cases where a concrete or metal pipe support is used, a 1/8 inch thick Teflon strip is to be placed under all piping at the point of bearing with pipe support. The full width of the support in contact with the pipe shall be covered.

M. Piping Supports

1. Pipe hangers and roller chairs shall be large enough to accommodate pipe covering and pipe covering protectors. Support spacing and hanger rod sizes shall be as follows:

NOMINAL PIPE SIZE INCHES	MAXIMUM SUPPORT SPACING FEET	MINIMUM HANGER ROD INCHES DIAMETER
STEEL AND WROUGHT IRON PIPE		
3/4	5	3/8
1	6	3/8
1-1/4	8	3/8
1-1/2 and 2	9	3/8
2-1/2 and 3	11	1/2
4 and 5	12	5/8
6	14	3/4
8 to 12	15	7/8
14 and 16 OD	15	1
18 OD	15	1-1/8
20 OD	15	1-1/4
Larger than 20 OD	15	...
DUCTILE IRON PIPE		
1-1/2 and 2	6	3/8
3 and 4	8	5/8
6	9	3/4
8 to 12	9	7/8
14 and 16	9	1
18	9	1-1/8
20	9	1-1/4
Larger than 20	9	...

2.06 BEDDING AND BACKFILL MATERIAL

A. Unless otherwise shown on the Drawings or specified herein, all pipe bedding and backfill material shall be in conformance with Section 02130.

2.07 PIPE ESCUTCHEONS

A. Split-type escutcheons shall be used for piping passing through finished wall, floors, or ceiling. Escutcheons shall be brass plated or chromium plated Model 3A by Ritter, Model 284 by Fee & Mason, or equal.

2.08 WALL PIPE AND SLEEVES

A. Type A Wall Pipe

1. Cast iron wall pipe with ends as indicated shall be cast in place as shown on the Drawings.
2. Where wall pipe flange is flush with wall, tap flange holes for studs prior to casting in place. Use stainless steel studs.

B. Type B Pipe Sleeves

1. Type B pipe sleeves are used in walls and floors as designated on the Drawings.
2. Type B pipe sleeves shall use a modular mechanical type seal of interlocking synthetic EPDM rubber links suitable for corrosive service. The bolts, nuts, and washers shall be of 18-8 stainless steel. Openings shall be steel with water collar, removable sheet metal, or removable laminated fiber concrete form. Adequately brace form before placing concrete to assure opening is round and true.
3. If sleeve is to be gas tight, fill voids with non-metallic, non-shrink grout.

C. Type C Floor Sleeve

1. Type C sleeves are used for pipes passing through floors.
2. Type C sleeves consist of casting in place a Schedule 40 steel sleeve with four anchors in the floor slab. The sleeve shall be one size larger than the service pipe or 1-in. larger than the flange on the service pipe. The sleeve shall extend 1-in. above the finish floor surface. Use round expanding foam rope gasket and caulk to seal finished floor slab side. On existing floors, core opening and seal without steel sleeve.
3. Type D Pipe Sleeve
4. Type D sleeves shall be used for passing through existing masonry walls. Use minimum 3/16 in. steel sleeve and modular mechanical type seal of interlocking synthetic EPDM rubber links with stainless steel bolts, washers, and nuts. Fill voids with non-metallic, non-shrink grout.
5. If sleeve is to be gas tight, use sealant on surface between steel sleeve and modular rubber links
6. All wall pipes and sleeves shall be coated and lined in accordance with the appropriate materials for its service.

2.09 EXPANSION JOINTS

A. Expansion joints as specified below shall be installed as directed by the Owner.

B. Expansion joint construction shall include a neoprene inner tube extending through the bore to the outside edge of both flanges. The inner tube shall be covered with a flexible multiple layer fabric carcass of high strength rubber impregnated synthetic fibers with steel wire or reinforcement rings integral with the fabric to assure sufficient rigidity for vacuum service and high pressure. An outer cover coated with hypalon paint shall cover the carcass and provide full protection against ozone and weathering.

C. Flange faces shall be neoprene covered and drilled to match drilling in mating flanges. Flange faces shall also be backed by split steel flange retaining rings.

D. All expansion joints shall be suitable for service temperatures of 225 deg F.

E. All expansion joints used for vacuum service shall be capable of withstanding a 30-in. Hg vacuum.

F. Expansion joints shall have recommended working pressures compatible with the service for which they are installed.

G. All expansion joints shall be equipped with control units to restrict excess axial compression and elongation. Control units shall consist of plates bolted to pipe flanges on each end of the expansion joint and long control bolts extending between pipe flanges.

H. Expansion joints on pipes used for digester gas service shall be the open arch type.

I. Expansion joints on sludge piping shall be of filled arch construction to prevent solids accumulation at the joint.

J. Expansion joints on pipes used for fuel oil and digester gas service shall have Buna-N tubes.

K. For those locations where expansion joints are used to replace valves, spool pieces, or other short sections, standard single arch expansion joints may be of insufficient length. At these locations double, triple and quad arch expansion joints shall be used as required.

L. Expansion joints shall be Mercer Rubber Company Style 500-700 or equal.

2.10 MANHOLES

Manholes shall be precast in accordance with ODOT Items 706.13 and conform to the District's standard drawings.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING

A. Care shall be taken in handling and transporting to avoid damaging pipes and their coatings. Loading and unloading shall be accomplished with the pipe under control at all times and under no circumstances shall the pipe be dropped. Pipe shall be securely wedged and restrained during transportation and supported on blocks when stored in the shop or field.

B. Store all pipe on a flat surface and support the barrel evenly. Limit stacking height to less than 4 ft. If plastic pipe is stored outside, cover it with an opaque material to protect it from the sun.

3.02 PREPARATION OF TRENCH

A. Trench excavation shall conform to requirements of Section 02130.

B. Unless otherwise specified or called for on the Drawings, the width of trench at the top of pipe 24-in. in diameter or less shall not exceed the outside diameter of the pipe or encasement, plus 9-in. on each side of the pipe measured to the face of the trench or to the back of the sheeting when used. For pipe having a diameter greater than 24-in., the width of trenches at the top of the pipe shall not exceed the outside diameter of the pipe or encasement, plus 15-in. on each side of the pipe measured as specified above.

C. Unless otherwise directed or called for on the Drawings, all pipe trenches shall be excavated below the proposed pipe invert as required to accommodate the depths of pipe bedding material as scheduled on the Drawings.

3.03 PIPE INSTALLATION

A. General

1. All loose dirt shall be removed from the bottom and the trench backfilled with the specified bedding material to the pipe grade shown on the Drawings. Bell holes shall be dug in the bedding where necessary and the pipe shall be placed and supported on bedding material the full length of the barrel. Bedding material shall then be placed 4-in. maximum depth along both sides of the pipe and tamped firmly under the pipe haunches. Additional bedding material shall be placed and compacted in 6-in. layers to the height shown on the Drawings or as directed. A mechanical tamper shall be used when installing bedding material for pipe 24-in. diameter and larger. The remainder of the trench shall be backfilled as specified and called for on the Drawings.
2. All pipes shall be laid to the lines and grades shown on the Drawings.
3. Wherever piping passes through walls or floors, a wall casting pipe or sleeve of the type indicated on the Drawings or specified shall be installed. Escutcheons shall be provided for pipe passing through finished walls, floors, or ceilings.

4. Pipe Anchoring

a. Disjointing hydrostatic pressure at bends, valves, plugs, tees, and wyes shall be counteracted by restrained joints or reinforced concrete anchorage as directed, shown on the Drawings, or specified. On plant sites, concrete anchors shall not be used.
b. Thrust blocks shall be installed only where directed or specifically called for on the Drawings, unless otherwise specified. Installation shall be in conformance with Drawings.
c. Approved joint restraints shall be installed for the distance from each side of each bend, valve, plug, tee, or wye in locations shown or scheduled on the Drawings.

5. Unless otherwise shown on the Drawings, all buried pipe, carrying liquids, shall be installed with a minimum cover of 5-ft. Pressure piping which carries gases shall be installed with a minimum cover of 4-ft. When new piping crosses existing utilities and other obstructions that force a change in elevation or horizontal alignment, the Contractor shall install the new piping at a deeper elevation, or new alignment to avoid the obstructions unless otherwise

instructed by the Engineer. Such changes in elevation or alignment shall be made either by installing fittings or by deflecting joints in accordance with the pipe manufacturer's recommendations. Such work shall be performed at no additional cost to the Owner. To the extent possible, pressure and process piping shall be installed at a constant grade. All changes in grade and alignment shall be approved by the Engineer.

B. Sewer Pipe

1. The laying of pipe in finished trenches shall be commenced at the lowest point, with the bell end or groove end laid upgrade. All pipes shall be laid with ends abutting and true to line and grade. They shall be carefully centered to form a sewer with a uniform invert of line and grade shown on the Drawings. Laser beams shall be used to maintain line and grade unless other methods are approved by the Engineer.
2. Where holes are cast in concrete pipe for handling, they shall be completely filled with non-shrinking mortar after the pipe is placed. A metal disc of proper size may be inserted near the bottom of the hole to retain the mortar until hardened. Wood plugs or rocks intended to plug the hole for retention of the mortar will not be permitted.

3. Joints

a. Pipe jointing surfaces shall be clean and dry when preparing surfaces for joining. Lubricants, primers, adhesives, etc., shall be used as recommended by the pipe or joint manufacturer's specifications. The jointing materials or factory-fabricated joints shall then be placed, fitted, joined, and adjusted in such a manner as to obtain a watertight joint. Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing. As soon as possible after the joint is made, sufficient backfill material shall be placed along each side of the pipe to prevent movement of the pipe from any cause.

b. Where specified or shown on the Drawings, joints of concrete pipe sewers shall be thoroughly pointed full inside circumference with a non-shrinking mortar in conformance with the material manufacturer's instructions. The mortar shall be tightly packed and the interior face of the joint shall be left smooth and continuous with the interior face of the pipe. Pointing shall not be done until the backfill over the pipe is placed and compacted.

4. Connections to Existing Sewers

a. Unless otherwise specified, shown on the Drawings, or directed, connections to existing sewers shall be made as follows:

i. Vitrified clay pipe and plain concrete pipe 15-in. diameter and smaller, and larger diameter at the option of the Owner, shall be connected by removing a section of the existing sewer and inserting connecting fittings using specified flexible connection couplings.

ii. Reinforced concrete pipe and larger sizes of plain concrete pipe, unless otherwise shown on the Drawings, shall be connected by coring the existing sewer pipe wall and inserting a flexible watertight connector to receive the new pipe.

iii. Polyvinyl chloride pipe, ABS pipe, and ABS truss pipe shall be connected in conformance with the manufacturer's recommendations as approved by the Owner.

b. Connections shall be made in conformance with the jointing materials manufacturer's recommendations and as directed by the Owner.

C. Drain Pipe

1. Drainpipe shall be laid in a manner conforming to the laying of sewer pipe.
2. In addition, drainpipe shall be laid with perforations on the underside.
3. The ends of all pipelines shall be closed with stoppers to prevent entry of soil or other foreign materials.

D. Process and Pressure Pipe

1. Pipe and appurtenances shall be installed true to line, grade, and location; with joints centered, spigots home; pipe properly supported and restrained against movement; and all valve stems plumb.
2. All elbows, tees, plugs, etc., shall be properly anchored, blocked, or otherwise restrained to prevent movement of the pipe in the joints due to internal or external pressure.
3. The open ends of all pipes and special castings shall be plugged or otherwise closed with a watertight plug to the approval of the Engineer before leaving the work for the night, and at other times of interruption of the work. All pipe ends that are to be permanently closed shall be plugged or capped and restrained against internal pressure.
4. Where new or existing pipe requires cutting in the field it shall be done in a manner to leave a smooth end at right angles to the pipe centerline. The finished cut must be approved by the Owner.
5. Joints

a. Just prior to joining the pipes, the surfaces of the joint rings shall be wiped clean and the joint rings and rubber gaskets shall be liberally lubricated with an approved type of vegetable oil soap. The spigot end, with the gasket placed in the groove, shall be entered into the bell of the pipe already laid, making sure that both pipes are properly aligned. Before the joint is fully "home," the position of the gasket in the joint shall be determined by means of a suitable feeler gauge supplied by the pipe manufacturer. If the gasket is found not to be in proper position, the pipes shall be separated and the damaged gasket replaced. The pipe is then forced "home" firmly and fully. In its final position, the joint between the pipes shall not be deflected more than 1/2-in. at any point.

b. A band at least 5-1/2-in. wide shall be placed around the outside of concrete pressure pipe, over each joint as recommended by and available from the pipe manufacturer. This band shall serve as a form for placing a 1:2 cement mortar grout in the external recess formed by the face of the bell and the shoulder of the spigot. If the air temperature is below 40 deg the spigot, bell, and mortar shall be heated. If a reinforced paper joint band is used, it shall be drawn up tight around the pipe and backfill tamped

against it up to the spring-line before pouring the grout. If a cloth band is used, it shall be wired around the outside of the pipe and the grout poured before backfilling.

c. The interior joint recess of pipe 24-in. and larger concrete pressure pipe shall be pointed using a non-shrinking mortar specified in Subsection 2.01. The inside surface shall be struck off smooth with the pipe interior. On pipe 20-in. and smaller a rope type mastic or trowelable mastic shall be affixed to the concrete face of the bell socket just prior to pushing the spigot into the bell, such that the mastic material squeezes to fill the internal joint recess. Mastics that are detrimental to rubber gaskets shall not be used. Similarly, primers to be used in conjunction with rope type mastics must be kept off gaskets and sealing surfaces of joint rings.

d. Where specified, electrical continuity shall be provided in concrete and steel pressure pipes by welding an insulated #4RR copper cable across joints. The cable shall be welded to the steel of bell and spigot of concrete pressure pipe and across joints including each piece of coupling on jointed steel pipes.

e. Where new piping is to be connected into an existing joint, said joint shall be cleaned sufficiently to result in a liquid- or gastight seal. If applicable, a new gasket shall be supplied and installed.

3.04 SLEEVES AND WALL PIPE

A. Type A wall pipes shall be provided for all pipes passing through the exterior walls unless other sleeve types or wall pipes are designated on the Drawings. Type B sleeves shall be provided in interior walls unless designated otherwise on the Drawings.

B. At all points where piping passes through floors, Type C sleeves shall be provided, unless otherwise designated on the Drawings.

C. Other sleeve types and wall pipe shall be provided as indicated on the Drawings.

D. All wall pipes and sleeves shall be coated and lined in accordance with the appropriate materials for its service.

3.05 TESTS FOR INFILTRATION AND EXFILTRATION IN SEWER PIPE

A. Preparation

1. Before sections of sewers may be tested for infiltration or exfiltration, all house leads from it must be constructed to limits called for and plugged or capped and all trenches backfilled and compacted.
2. Sewers to be tested shall be clean and free from construction debris. Sand, dirt, concrete, or other materials shall be completely removed in a manner that will not damage the sewer pipe.
3. Pipe joints shall be watertight. The Contractor shall repair manholes and pipe joints as required to stop all visible leaks. Seepage permitted through walls or patched joints shall be at the discretion of the Engineer but in no instance will the specified allowable infiltration be exceeded.

4. Where sewers are above the ground water table, the Contractor may flood the trench or air test the sewer to find and repair leaks prior to exfiltration tests.
5. The materials and methods for repairing leaks shall be submitted to the Engineer for approval before beginning work.

B. Inspection

1. After a sewer has been cleaned and all repairs made as specified, the sewer shall be inspected and approved by the Engineer before conducting infiltration or exfiltration tests.
2. Sewers 36-in. diameter and larger shall be inspected from the inside. Inspection of sewers smaller than 36-in. diameter from the inside shall be at the discretion of the Engineer.
3. Unless otherwise specified, smaller sewers shall be inspected by lamping between manholes.
4. The Engineer may require the Contractor to run close circuit television through smaller sewers that appear defective or do not pass infiltration tests.
5. The Contractor shall furnish all lights, carts, television, and other equipment and labor required to assist the Engineer in the inspection.

C. Test Sections:

1. The maximum length of a sewer test section shall be 1000 lf. Every manhole shall be included in at least one test section.
2. The Contractor shall furnish and install bulkheads, sewer plugs, weirs, water level tubes, lighting, and other equipment required to conduct the tests in locations and as directed by the Engineer.
3. Infiltration
   a. Where the ground water level is above the top of the pipe, the sewer shall be tested for infiltration.
   b. The Contractor shall plug or bulkhead the sewer to isolate the test section and install a weir in the pipe at the outlet manhole. The weir shall be direct reading of an approved design calibrated to read gallons per day.
4. Exfiltration
   a. Where the ground water level is below the top of the pipe and cannot be maintained above it, the sewer shall be tested for exfiltration.
   b. The Contractor shall bulkhead or plug each end of the designated test section and fill the water to the elevation directed by the Engineer. Exfiltration will be computed from the loss of water as measured in the manholes.

5. Allowable Leakage
   a. The test in each section shall be continued for at least 24 hours and, if its measured leakage during that period exceeds 100 gallons per inch of diameter per mile of pipe, the Contractor shall locate the points of leakage and make necessary repairs, continuing the work until leakage is reduced to the permissible maximum as specified.

b. The amount of infiltration allowed for storm sewers shall be limited to reasonable seepage, except that, if specified, the total in any section shall not exceed the amounts allowed for sanitary sewers as herein specified.

3.06 LOW PRESSURE AIR ACCEPTANCE TESTS

A. Where approved by the Owner, the Contractor may perform low-pressure air acceptance tests in lieu of infiltration and/or exfiltration tests, for pipe 24-in. in diameter or smaller.

B. The Contractor shall furnish all equipment, materials, and labor, and conduct the tests under supervision of the Engineer.

C. Equipment

1. All air used in performing the test shall pass through a single, above ground control panel which shall include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge, and a continuous monitoring pressure gauge having a pressure range from 0 to 10 psi. The continuous monitoring gauge shall be no less than 4-in. in diameter with minimum divisions of 0.10 psi and an accuracy of $\pm$0.04 psi.
2. Either mechanical or pneumatic plugs may be used to seal the line. All plugs shall be designed to resist internal test pressures without external bracing or blocking.
3. Two separate hoses connected to the sealed line shall be used to:
   a. Introduce low pressure air to the sealed line.
   b. Monitor the air pressure in the sealed line.
4. If pneumatic plugs are used, a separate hose from the control panel shall also be required to inflate the pneumatic plugs.

D. Safety

1. The air test may be dangerous if the line is improperly prepared. All plugs shall be installed and braced in such a manner to prevent blowouts. No one shall be allowed in manholes during testing.

2. Pressurizing equipment shall include a regulator set at 10 psi maximum.

E. Line Preparation

1. Sewers to be air tested shall be prepared and inspected as specified herein for infiltration and exfiltration tests.
2. Where porous pipe materials are used, the pipe walls may be wetted to temporarily reduce the porosity of the material.
3. All pipe outlets shall be plugged, braced, and the joints restrained adequately to prevent blowouts.

F. Test Procedure

1. Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average back pressure of any ground water above the pipe.
2. When a constant pressure of 4.0 psig greater than the average back pressure of any ground water above the pipe is reached, the air supply shall be throttled to maintain that internal pressure for a least 2 minutes to permit temperature equalization.
3. When temperatures have been equalized and the pressure stabilized at 4.0 psig greater than the average back pressure of any ground water above the pipe, the air supply shall be shut off or disconnected.
4. Decrease the pressure in the sealed line until the continuous monitoring pressure gauge reads 3.5 psig greater than the average back pressure of any ground water above the pipe. When this pressure is reached, timing shall commence with a stopwatch.
5. Determine the time, as shown on the stopwatch, required for the pressure in the sealed line to drop 1.0 psig.

G. Allowable Leakage

1. The pipe shall be considered acceptable if the time interval required for the 1.0 psig pressure drop is not less than the minimum holding time as calculated using the following table:

Nominal Pipe Size (in.)	T (time), min/100-ft	Nominal Pipe Size (in.)	T (time), min/100-ft
3	0.2	21	3.0
4	0.3	24	3.6
6	0.7	27	4.2
8	1.2	30	4.8
10	1.5	33	5.4
12	1.8	36	6.0
15	2.1	39	6.6
18	2.4	42	7.3

2. The minimum holding time for the 1.0 psig pressure drop shall be calculated on the basis of the diameter and length of main sewer tested with no adjustment made for service connections included in the test section.

H. Air Pressure Adjustment For Ground Water

1. In areas where ground water is known to exist, the Contractor shall install a one-half inch diameter capped pipe nipple, approximately, 10-in. long, through the manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test the ground water level shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to the pipe nipple. The hose shall be held vertically and a measurement of the height in feet of water shall be taken after the water stops rising in this plastic tube.

2. The air pressure correction, for the average back pressure of the ground water above the pipe, shall be calculated by dividing the average vertical height, in feet of ground water above the invert of the sewer pipe to be tested, by 2.31. This correction must be added to the test pressures stated in the test procedure.

3.07 SPECIAL TESTING - DEFLECTION OF PVC AND ABS COMPOSITE SEWER PIPE

A. In addition to infiltration and exfiltration testing all PVC & ABS composite sewer pipe shall receive the following testing.

1. Before final acceptance of sewer lines constructed of these materials, all sections of sewer pipe 8 in. and larger specified diameter shall be measured for vertical ring deflection by the Contractor and witnessed by the Owner. Maximum deflection under full load shall not exceed 5% of the average inside diameter as determined by the laboratory for the specified piping.
2. Should any pipe exceed the allowable deflection, the Contractor shall replace those pipes and retest the section as directed by the Owner.
3. Equipment used in testing shall be go-no go pull through gauges of a type approved by the Engineer. Each gauge must be checked and approved by the laboratory before using. A metal or plastic gauging ring of diameter equal to 95% of the specified average pipe diameter shall be furnished with each gauge required.
4. Testing equipment and personnel to perform the required tests, shall be provided by the Contractor. Tests must be witnessed by the Owner.
5. Use of mechanical pulling devices will not be permitted.

3.08 PRESSURE AND LEAKAGE TESTS FOR PROCESS AND PRESSURE PIPE

A. The Contractor shall furnish the pump, pipe connections, taps, gauges, auxiliary water container, bulkheads, plugs, and other necessary equipment and make pressure and leakage tests of all lines including the joint between existing and new pipes unless otherwise directed by the Engineer.
B. Tests shall be conducted on all pipelines or valved sections of pipe as directed by the Engineer. Testing of pipelines laid in excavation or bedded in concrete shall be done prior to backfilling or placing concrete cover, except restrained sections of pipe which shall be backfilling prior to testing, unless otherwise permitted by the Engineer. Tests on lines anchored or blocked by concrete shall not be conducted until the concrete has taken permanent set.

C. The line or section thereof to be tested shall be filled slowly with water to expel all air. Hydrostatic pressure shall be applied by pumping water from an auxiliary supply. The test pressure shall be maintained two hours minimum and additional time as required for thorough inspection to find any leaks or defects in the force main and appurtenances. Unless indicated otherwise in Part 4, the test pressure shall be 100 lbs/sq in. or 50% above the normal operating pressure, whichever is greater. Should the pipe section fail to pass the tests, the Contractor shall find and correct failures and repeat the tests until satisfactory results are obtained.

D. Leakage tests shall be made simultaneously with or following completion of pressure tests of all lines or valved sections thereof. Leakage is defined as the quantity of water added to the pipe under test to maintain the required test pressure for a specified time. The leakage test pressure shall be not less than the maximum operating pressure of the section under test. The duration of the leakage test shall be not less than two hours. Allowable leakage for buried piping shall not exceed 9 gal/in. of pipe diameter per mile of pipe in 24 hours. For piping not buried, any leakage during the test is unacceptable.

E. Lines that conduct fuel oil, gasoline, or chemicals that would have a deleterious affect upon the pipeline or process when mixed with water shall be purged after the pressure and leakage tests. Purging shall be performed with air or an inert gas such as nitrogen or carbon dioxide. Purging shall be continued for a minimum of two hours after all visible water has disappeared.

F. Testing of lines governed by other authorities, i.e. natural gas, shall be witnessed and approved by the authority.

3.09 CLEANING POTABLE WATER MAINS

A. All water mains shall be cleansed in accordance with AWWA C-651.

B. Precautions shall be taken during construction to protect the pipe interiors, fittings and valves against contamination. Pipe interiors shall be thoroughly cleaned of dirt and foreign matter before laying, by brushing, swabbing or other method approved by the Engineer, and means shall be provided to prevent entry of dirt during the progress of installation. Ground water shall be kept out of the pipe at all times.

C. After the pressure test and prior to sterilizing, the water lines shall be thoroughly flushed through hydrants or by other means as approved by the Engineer.

3.10 DISINFECTING POTABLE WATER MAINS

A. All water mains shall be sterilized in accordance with AWWA C-651.
B. The Contractor shall furnish required materials and apparatus and perform the work of sterilization.

C. Pipes shall be sterilized by the introduction of (a) a chlorine gas-water mixture by means of a solution feed machine; (b) direct feeding of chlorine gas through approved devices for regulating rate of flow and effective diffusion; (c) calcium hypo chlorite as a water mixture. Chlorinating powders shall be mixed with water, in proportions of 5% powder to 95% water by weight, to a paste and thinned to a slurry, to be introduced into the pipe by pumping, or other means approved by the Engineer.

D. Application shall be made at the beginning of the line through a corporation stop with water supplied from the pressure side of a valve to fill the line, controlled to a very low flow. Extremities of the lines being treated shall be opened to insure removal of air and complete filling.

E. The dosage of chlorinating agent shall be of the amount to produce a chlorine residual of 40 to 50 parts of chlorine per million. Tests with the DPD method shall be made at selected points to determine the residual.

F. Treated water shall be retained in the lines for sufficient time to accomplish the desired sterilization but not less than 12 hours. Valves in the line shall be operated during the retention period.

G. Following chlorination, all treated water shall be flushed from the lines at their extremities until the replacement water throughout the lines shall, upon test, be chemically and bacteriologically acceptable to the Public Authority having jurisdiction. Should the initial treatment prove ineffective, the chlorination shall be repeated until confirmed tests show acceptable results.

3.11 INSTRUMENTATION CONNECTIONS

A. The Contractor shall make all necessary allowances for and install all controls and instrumentation furnished under any Contract Division and which require in-line connection to process and pressure piping.

B. The Contractor shall provide all necessary mounting bosses, pipe and boss taps, plugs, tees, and any miscellaneous appurtenances to allow connection of Instrumentation and Controls and their associated piping to process and pressure piping.

C. Thermo wells complete with all appurtenances listed in Division 16 shall be furnished and installed under that Division. Thermo wells complete with all appurtenances that are not included in the list in Division 16 and are to be installed in piping under this Section shall be furnished and installed under this Section.

D. Instrumentation and Controls are furnished and specified under various Sections including Section 16900. Any schedules shown in Section 16900 are not guaranteed to be complete.

3.12 MANHOLE TESTING

A. Vacuum Test: All manholes shall be vacuum tested in accordance with ASTM C1244-93. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.

A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop 1 inch.

The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in the following table.

Minimum Test Times for Various Manhole Diameters

Depth	Diameter (Inches)								
(Feet)	30	33	36	42	48	54	60	66	72
	Time (Seconds)								
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	34	41	46	51	57
16	22	24	28	34	40	46	52	58	67
18	25	27	32	38	45	52	59	65	73
20	28	30	35	42	50	58	65	72	81
22	31	33	38	46	55	64	72	79	89
24	33	36	42	51	59	70	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 initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

PART FOUR - SPECIAL PROVISIONS

4.01 PIPING SCHEDULE

A. The following letter designations are used in the Piping Schedule:

Material Designation

VCP - Vitrified Clay Pipe
PVCP - Perforated Vitrified Clay Pipe

PVC - Polyvinyl Chloride
PPVCP - Perforated Polyvinyl Chloride Pipe
CPVC - Chlorinated Polyvinyl Chloride Pipe

PCP - Plain Concrete Pipe
RCP - Reinforced Concrete Pipe
CPP - Concrete Pressure Pipe

DIP - Ductile Iron Pipe
GLDIP - Glass Lined Ductile Iron Pipe
SP - Steel Pipe
SSP - Stainless Steel Pipe

CSP - Corrugated Steel Pipe

CPDT - Corrugated Polyethylene Drainage Tubing
CPDP - Corrugated Polyethylene Drainage Pipe
CPP - Corrugated Polyethylene Pipe

FRP - Fiberglass Reinforced Pipe

B. Schedules are not guaranteed to be complete. All piping shown on the Drawings or specified shall be furnished and installed by the Contractor whether or not listed in the above schedule.

4.02 INSULATION FOR EXTERIOR ON BURIED PIPE LINES

A. Insulation shall be 100% closed-cell insulation, Pittsburgh Corning Foamglass or equal. Insulation shall be completely non-absorptive, non-combustible, a compressive strength of 100 psi, a density of 8.5 pdf, and a thermal conductivity of .33 btu-in/hr., sq ft deg F at a mean temperature of 50 deg F. Insulation thickness shall be two-inch thickness.

B. Exterior Exposed Pipes:

1. Jacketing is to be aluminum that is impervious to moisture and sunlight. Method of attachment shall be submitted for approval.
2. "S" clips must be structurally sound with the jacket submitted. Centers and sizes are to be submitted by the Contractor.
3. Fittings flanges and all other pipe appurtenances or projections all be insulated and receive an aluminum jacket.

C. Buried Pipes:

1. Buried pipes shall be insulated, coated with Pittcote, and wrapped with Pittwrap SSII.

a. Pittcote and Pittwrap SSII shall be installed per manufacturer's recommendations.

4.04 SPIRAL WELDED STEEL PIPE

A. Spiral welded steel pipe shall be formed under tension on a lathe-turned mandrel to assure a round pipe of accurate outside diameter as shown on the Drawings. Pipe shall be installed in accordance with the applicable "Good Practice" as outlined in "AWWA Design and Installation of Steel Water Pipe."

B. Pipe shall be manufactured of 12-gauge minimum thickness carbon steel sheet in accordance with ASTM A-211. It shall be supplied in nominal lengths approved by the Engineer.

C. Pipe to pipe joints shall be welded or mechanical groove-type coupling. Pipe ends which connect with standard cast or ductile iron pipe fittings shall have a 6-in. length of standard weight steel pipe.

END OF SECTION