



**SECTION 02534
WASTEWATER FORCE MAIN**

PART 1. GENERAL

1.01 SCOPE

- A. The work to be performed shall consist of the installation of wastewater force mains according to the Specifications and the Standard Drawings herein.
- B. CONTRACTOR shall be responsible for safely storing materials needed for the work until they have been incorporated into the completed project. CONTRACTOR shall keep the interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.

1.02 DEFINITIONS

- A. DR: Standard Dimension Ratio.
- B. HDPE: High-density polyethylene pipe.
- C. Pipe Stiffness Classification: Referred to as SN.
- D. Pressure Class: Referred to as PN.

1.03 SUBMITTALS

- A. Action Submittals:
 1. Information on gasket polymer properties.
 2. Tee fabrication details.
 3. Application methods, application requirements, and chemical resistance data for coating and lining products.
 4. Joint and fitting restraints.
- B. Informational Submittals:
 1. Certificates:
 - a. Manufacturer's Certificate of Compliance for each type of pipe that products furnished meet requirements of this section.
 - b. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
 - c. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with AWWA C900 or AWWA C905 for PVC pipe and AWWA C111 for Ductile Iron Pipe.
 2. Manufacturer's Written In-Plant Quality Control Program: Quality control procedures and materials testing to be used throughout manufacturing process. Submit prior to manufacture of any pipe for this Project.
 3. Test or historical performance data to verify joint design meets requirements of these Specifications.



4. Provide pipe test results with delivery of pipe. Do not deliver pipe not meeting test requirements to Site.
5. Manufacturer's written recommendations for pipe handling and installation.
6. PVC and HDPE pipe deflection test results.
7. Field Leakage Testing Plan: Submit at least 15 days in advance of the testing and include at least the following:
 - a. Testing dates.
 - b. Piping systems and sections to be tested.
 - c. Test type.
 - d. Method of isolation.
 - e. Method of conveying water from source to system being tested.
 - f. Calculation of maximum allowable leakage for piping section(s) to be tested.
 - g. Method for disposal of test water, if applicable.

PART 2. PRODUCTS

2.01 PIPE

- A. Materials will be visually inspected by OWNER at the site for conformance to the specifications. At OWNER's discretion, CONTRACTOR may be required to supply certified mill tests, samples, or other suitable form of verification that the material meets the required specifications.
1. Polyvinyl chloride (PVC) pipes and fittings shall be used for force mains from 4 inches to 24 inches in diameter, in accordance with the requirements of AWWA C900 or AWWA C905 and the Materials Specifications herein. The pressure class rating shall be selected based upon the design requirements of the system. PVC pipe shall be a minimum of DR 18, Class 150 for AWWA C900 pipe and DR 25 Class 165 for AWWA C905 pipe.
 2. Ductile Iron Pipe and fittings may be used for force mains 8 inches and larger:
 - a. Made of good quality ductile iron in conformance with latest revision of AWWA/ANSI C151/A21.51. The pipe shall be push-on joint with a minimum pressure class of 150 psi, thickness design according to AWWA/ANSI C150/A21.58, ceramic epoxy lined and coated outside with an asphaltic coating. Ductile iron pipe and fittings shall conform to the requirements of the Materials Specifications herein.
 - b. Ceramic Epoxy Lining:
 - 1) 40-mil nominal lining consisting of amine cured novolac epoxy containing a minimum of 20 percent by volume quart pigment manufactured under the name of Protecto 401 by the Vulcan Group.
 - 2) Line interior of bell and exterior of spigot in joint sealing areas with 6 to 10 mils of specified lining.
 - 3) Surface Preparation: SP10 near-white abrasive blast.
 - 4) Pinhole Detection: 2,500 volts minimum over 100 percent of lined surfaces.
 3. HDPE pipe and fittings may be used for force mains:



- a. Minimum HDPE DR 17, Pipe 4 inches and smaller shall be DR 11, meeting the requirements of AWWA C906, ASTM F714 and ASTM D3035.
- b. The pipe shall be manufactured by an OWNER approved manufacturer.
- c. HDPE pipe shall have a co-extruded green cover or extruded green stripes designating use for sanitary sewer. Color print lines are not an acceptable method for designation of sewer mains. Pipe with extruded green stripes shall have a minimum of three equally spaced stripes. Pipe shall have a heat indented print line containing the information required in ASTM D 3035.
- d. Fittings:
 - 1) All fittings shall be molded. Fabricated fittings are not acceptable, unless approved in writing by OWNER. Butt fusion fittings shall comply with ASTM D3261 requirements.
 - 2) Butt heat fusion or electrofusion fittings.
 - 3) Butt fusion fittings shall be installed per butt fusion welding, as specified in Paragraph Pipe Joining.
 - 4) All electrofusion joint fittings shall have ISO 9001 and NSF 61 certification.
 - 5) Manufacturer: Performance Pipe, Poly Pipe, or Central Plastics Company, Shawnee, Oklahoma; Central Electrofusion System or Friatec, Aiken, NC.

2.02 JOINT RESTRAINT

- A. Fitting and joint restraints for all pipe types specified, except HDPE pipe, shall be Megalug type restraints by EBAA Iron Sales Inc
- B. Restraints shall be supplied with bolts consisting of high strength annealed, corten steel, T-head type having hexagonal nuts. Bolts and nuts shall be machined through and nuts shall be tapped at right angles to a smooth bearing surface.
- C. Mechanical restrained type joints for ductile iron pipe shall be factory type and fabricated at the factory. Field welding for joint fabrication is not acceptable. Approved restrained type joints shall be T.R. Flex Joints as manufactured by U.S. Pipe or Lok-Ring joints as manufactured by American Ductile Iron Pipe or similar as manufactured by McWane, Clow, or Griffen Pipe.
- D. One manufacturer shall supply all components of the restraining method and accessories.
- E. Restraints on HDPE pipe joints and fittings are not required for butt heat fusion joints and fittings, or electrofusion fittings conforming to Specifications.
- F. HDPE pipe shall not be allowed with mechanical joint fittings.



PART 3. EXECUTION

3.01 INSTALLATION OF FORCE MAIN

- A. Force mains shall be installed at the lines and grades required by the Drawings. All fittings shall be at the required locations, and the spigots well centered in the bells.
- B. All PVC, Ductile Iron and HDPE pipe shall be installed with a 12-gauge copper wire for tracing purposes as specified in Section 02321, Excavation, Bedding, and Backfill for Utilities.
- C. Unless otherwise indicated by the drawings, all force mains shall have at least 36 inches of cover. The pipe shall slope continuously between high and low points to eliminate the formation of air pockets. The pipe shall have a minimum of 60 inches of cover at the high points. OWNER shall approve any exceptions.
- D. CONTRACTOR shall provide and use tools and facilities that are satisfactory to OWNER and that will allow the work to be done in a safe and convenient manner. A derrick, ropes, or other suitable equipment shall be used to lower all pipe and fittings into the trench one piece at a time. Each piece shall be lowered carefully so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances shall force main materials be dumped or dropped.
- E. Pipes and fittings shall not be lowered into the trench until they have been swabbed to remove any mud, debris, etc., which may have accumulated within them. After the pipe has been lowered, all unnecessary materials shall be removed from it. Before any pipe is laid, the outside of its spigot end and the inside of its bell shall be cleaned and left dry and oil-free.
- F. Every precaution shall be taken to keep foreign material from getting into the pipe while it is being installed. No debris, tools, clothing, or other materials shall be placed in the pipe during laying operations.
- G. After a length of pipe has been placed in the trench, the spigot end shall be centered in the bell of the adjacent pipe, and then inserted to the depth specified by the manufacturer.
- H. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, the bottom of the trench shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length.



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- I. Wherever pipe laying is not in progress, the open ends of the pipe shall be closed either with a watertight plug or by other means approved by OWNER.
- J. Pipe shall be cut so fittings can be inserted in a workmanlike manner and without any damage to the pipe. The manufacturer's recommendations shall be followed concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis. A carborundum saw shall be used for ductile iron pipe, PVC and HDPE pipe. OWNER may consider other methods for 12-inch diameter and larger pipe. HDPE pipe shall be joined in accordance with Paragraph HDPE Pipe Joining.
- K. Pipe shall be installed with the bell ends facing in the direction of laying unless otherwise directed by OWNER.
- L. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor more than 75 percent of that recommended by the pipe manufacturer, and shall be approved by OWNER. Bend fittings shall only be used when the pipe deflections are inadequate, according to manufacturer's recommendations, or as directed by OWNER. Pipe bending of PVC pipe shall not be allowed, fittings or joint deflections shall be utilized.
- M. No pipe shall be installed in water or when it is OWNER's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, its use is considered incidental to the project.
- N. Thrust blocks shall be installed wherever the force main changes direction (at tees and bends), at dead ends, or at any other point recommended by the manufacturer or required by OWNER (See Section 02513 for Water Lines). Thrust blocks shall be considered an integral part of the force main work.
- O. All pipe shall be jointed in the exact manner specified by the manufacturer of the pipe and jointing materials.
- P. Air valves shall be located at all high points on the pipeline or as directed by OWNER.
- Q. Force main outlets shall be installed in manholes as shown on the Standard Drawing herein (See Figure 1-02534-a). Force mains 2 inches and smaller may be tied directly into a manhole as approved by OWNER at a minimum of 3 feet.

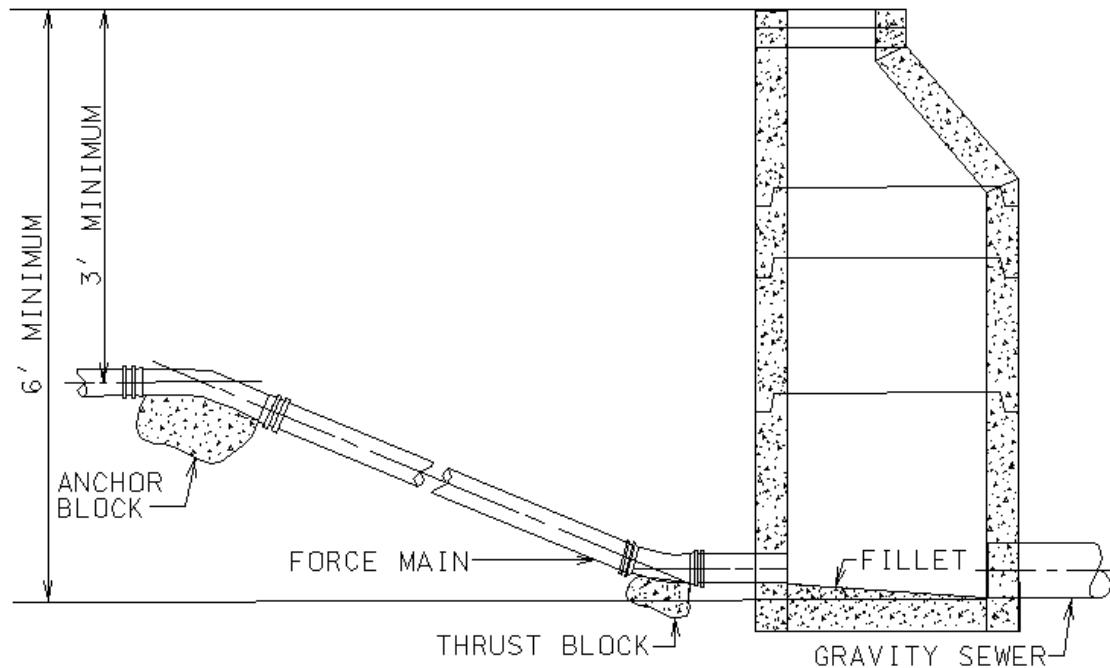


Figure 1-02534-a (Standard Detail for Connection of Force Main to Gravity Sewer)

Notes:

1. Crown of force main must be installed at same elevation as crown of receiving gravity sewer.
2. Manhole invert must be formed to provide smooth transition channel to sufficient depth to direct force main discharge with minimum turbulence.
3. Manhole frame and lid not shown.
4. Joints restraints shall be provided at change in direction.

3.02 HDPE PIPE JOINING

- A. Assemble and join at the Site using the butt-fusion method to provide a leak proof joint. Threaded or solvent-cement joints and connections are not permitted.
- B. All equipment and procedures used in shall be in strict compliance with ASTM D2657 and with the manufacturer's recommendations.
- C. Fusion shall be preformed by technicians certified by manufacturer of pipe fusion equipment.
- D. Prior to pipe installation, two trial fusion welds shall be performed, and reviewed and approved by the OWNER. Full penetration welds shall provide homogeneous material across the cross section of weld. Fusion machine employed for trial welds shall be same machine utilized for project installation.



- E. The butt-fused joint shall be true alignment and shall have uniform rollback beads resulting from the use of proper temperature and pressure. The joint shall be allowed adequate cooling time before removal of pressure. Excessive interior bead depth is cause to have the joint cut out and replace.
- F. The fused joint shall be watertight and shall have tensile strength equal to or greater than that of the pipe.
- G. All joints shall be subject to acceptance by the OWNER prior to insertion.
- H. The CONTRACTOR shall cut out and replace defective joints at no additional cost to the OWNER.
- I. Any section of the pipe with a gash, blister, abrasion, nick, scar, or other deleterious fault greater in depth than ten percent of the wall thickness (ASTM 585), shall not be used and shall be removed from the Site. However, a defective area of the pipe may be cut out and the joint fused in accordance with the procedures stated above.
- J. Any section of the pipe having other defects such as concentrated ridges, discoloration, excessive spot roughness, pitting, variable wall thickness or any other defect of manufacturing or handling as determined by the OWNER shall be discarded and not used.
- K. All connections shall be in conformance with the manufacturer's installation procedures.

3.03 LEAKAGE TEST

- A. All newly installed and backfilled pipe shall be subjected to a leakage test, conducted in the presence of OWNER.
- B. Test pressure shall be 150 percent of system operating pressure based on pressure as measured at lowest point in pipeline.
- C. The force main shall be slowly filled with water, and the specified test pressure shall be applied (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) with a pump connected to the pipe in a manner satisfactory to OWNER. CONTRACTOR shall furnish the pump, pipe, connections, gauges, and all necessary apparatus.
- D. Before applying the specified test pressure, all air shall be expelled from the pipe. If necessary, CONTRACTOR shall make taps at the points of highest elevation before testing, and shall insert plugs after the test has been completed.
- E. The leakage test shall be conducted by measuring, through a calibrated meter, the amount of water which enters the test section for a period of at least 2 hours. No



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installation will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

For Ductile Iron Pipe

$$L = \frac{ND\sqrt{P}}{1,850}$$

For PVC Pipe

$$L = \frac{ND\sqrt{P}}{7,400}$$

L = allowable leakage, gallons/hour

N = number of joints in length of pipe tested

D = nominal diameter of the pipe, inches

P = average test pressure during the leakage test, psig

The following table has been developed for the commonly used sizes of ductile iron pipe and PVC pipe with nominal laying lengths of 20 feet, under a test pressure of 150 psi. The leakage formulas above may be used when conditions differ from those stated parameters.

Allowable Leakage per 100 feet (gallons/hour)

Pipe Diameter (Inches)	Ductile Iron Pipe	PVC Pipe
4	0.13	0.033
6	0.20	0.050
8	0.26	0.066
12	0.40	0.099
16	0.53	0.132



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For HDPE Pipe:

1. Make-up Water Allowance:
 - a. Maximum allowable make-up water at conclusion of test phase shall not exceed recommended amounts stated in the following table.
 - b. Table is based on test pressure equal to 1.5 times pressure class of pipe. If lower pressure is used for test, allowances shall be reduced by ratio of test pressure to pressure class of pipe.

Make-Up Water Allowance for Test Phase (U.S. Gallons per 100 feet of Pipe)		
Nominal Pipe Size (inches)	1-Hour Test (gallons)	2-Hour Test (gallons)
3	0.10	0.15
4	0.13	0.25
6	0.30	0.60
8	0.50	1.0
10	0.75	1.3
12	1.1	2.3
14	1.4	2.8
16	1.7	3.3
18	2.2	4.3
20	2.8	5.5
24	4.5	8.9
28	5.5	11.1
32	7.0	14.3
36	9.0	18.0

Note: No observed leaks.

- F. Any cracked or defective pipes or fittings discovered in consequence of this leakage test shall be replaced with sound material in the manner specified at no cost to OWNER. The test shall be repeated until the results are satisfactory to OWNER.



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3.04 CLEANUP

After completing each section of the force main, all debris and construction materials shall be removed from the work site and disposed of in compliance with all applicable laws and regulations and with Section 02321, Excavation, Bedding, and Backfill for Utilities. Then the surface shall be graded and smoothed on both sides of the line. The entire area shall be left clean and in a condition satisfactory to OWNER. CONTRACTOR shall keep cleanup operations as close to active pipe laying activities as practical, generally following by less than 300 feet, or as approved by OWNER.

END OF SECTION