

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.

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. Complete shop drawings and laying diagrams showing location of each pipe section as requested by the OWNER. Drawings shall include:
 - a. Pipe dimensions, pipe class, pipe joints, fitting fabrication details, and gasket properties,
 - b. For ductile iron pipe indicate coating and lining data including its chemical resistance data.
- 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.
 - d. Certificates of qualifications including experience and training records for persons fusing HDPE 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.
8. Bypass pumping submittals shall be in accordance with Section 02542, Sewer Flow Control.

1.04 QUALITY ASSURANCE

- A. Materials will be visually inspected by OWNER or RESIDENT PROJECT REPRESENTATIVE 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. Any material that fails to conform to these Specifications shall be rejected and removed from the project by the CONTRACTOR at no cost to the OWNER.
- B. Installation of materials shall be performed by qualified personnel.
- C. HDPE Pipe:
 1. Pipe Manufacturer: Listed with Plastic Pipe Institute.
 2. Pipe jointing shall be performed by personnel trained in the use of butt-fusion equipment and the recommended methods for new pipe connections. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing the polyethylene pipe. Such training shall be certified and conducted by a qualified representative of the pipe manufacturer. Personnel shall have a minimum of 2 years' experience of fusion welding of HDPE pipe.

- D. Ductile Iron Pipe:
 - 1. Pipe Manufacturer shall be ISO 9001 registered or provide the services of an independent inspection agency responsible, on a daily basis, for sample monitoring of chemical and mechanical tests, sample visual inspection of quality assurance tests performed on a in-process pipe and fittings, and sample visual and dimensional inspection on finished products.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products as recommended by the manufacture to prevent damages. Materials shall be made safe from theft, vandalism, and damage.
- B. Limit stacking of pipe to height that will cause excessive deformation of bottom pipes under anticipated temperature conditions. Store pipe so as not to be deformed axially or circumferentially.
- C. Use pads, strips, skids, or blocks for each pipe during transportation and while awaiting installation in the field.
- D. Keep all pipe materials from direct sunlight prior to installation. HDPE pipe without ultraviolet inhibitor shall not be stored unprotected against outside elements.
- E. After delivery to the Site, any materials that have been damaged in transit or are otherwise unsuitable for use in the Work shall be rejected and removed from the Site by the CONTRACTOR at no cost to the OWNER
- F. Handling: Use wide band slings for lifting and skids, rollers, or non-abrasive pads for moving HDPE or PVC pipe. Use of chains and dragging is prohibited.

PART 2. PRODUCTS

2.01 TRACER WIRE

- A. Material: Minimum 12-gauge (or larger) solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.
- B. Manufacturers:
 - 1. Copperhead Industries, LLC.
 - 2. Performance Wire & Cable Inc.
 - 3. Pro-line Safety Products Company.
- C. Splices: Use mechanical connector, 3M™ Direct Bury Splice Kit DBR/Y-6(KIT).

2.02 PIPE

A. Polyvinyl chloride (PVC):

1. Pipes and fittings may be used for force mains from 4 inches to 24 inches in diameter unless noted otherwise on the Project Drawings and in accordance with material specifications herein:
 - a. AWWA C900 for pipe diameters between 4 inches and 12 inches.
 - b. AWWA C905 for diameters greater between 14 inches and 24 inches.
2. 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.
3. Joints shall be rubber gasketed in accordance with ASTM D3139.
4. Joint Restraints:
 - a. Cast-in-place concrete thrust blocks.
 - b. EBAA Iron Sales Inc; MEGALUG.

B. Ductile Iron Pipe:

1. Ductile iron pipe and fittings may be used for force mains 8 inches and larger unless noted otherwise on the Project Drawings and in accordance with the material specification herein:
2. Meet requirements of AWWA C150/A21.50, AWWA C151/A21.51, and AWWA C111/A21.11
3. The pipe shall be push-on joint with a minimum pressure class of 150 psi with ceramic epoxy lined and coated outside with an asphaltic coating.
4. Ceramic Epoxy Lining:
 - a. 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 Induron.
 - b. The gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401™ Joint Compound.
 - c. Surface Preparation: SP10 near-white abrasive blast.
 - d. Pinhole Detection: 2,500 volts minimum over 100 percent of lined surfaces.
5. Joint Restraints:
 - a. Manufactures and Products:
 - 1) U.S. Pipe; TR Flex and HP Lok.
 - 2) American Cast Iron Pipe; Flex Ring, Field Flex-Ring, and LOK-Ring.
 - 3) Pacific States Pipe: Thrust Lock.
 - 4) Equivalent restrained joints manufactured by McWane, Clow, or Griffin Pipe.

- b. MEGALUG restrained joint by EBAA Iron Sales Inc. as approved by OWNER or where indicated on Project Drawings.
 - c. One manufacturer shall supply all components of the restraining method and accessories
 6. Fittings:
 - a. Fittings shall be new and recently manufactured. Refurbished fittings will not be accepted
 - b. Minimum pressure ratings in accordance with AWWA C110/A21.10 and C115/A21.15 Ductile Iron Fittings.
 - c. Rubber gasket joints in accordance with AWWA C111/A21.11
 - d. Mechanical joint fittings in accordance with AWWA C110/A21.10 and AWWA C153/A21.53.
 7. Flanged Connection Bolts:
 - a. Carbon Steel, ASTM A307, Grade A hex bolts and ASTM A 563, Grade A hex head nuts.
 8. Flat Faced Flange Gaskets: For pipe less than 54 inches, rated for working pressure 150 to 250 psi, 1/8 inch thick, red rubber (SBR) hardness 80 (Shore A), rated 200 degrees F, conforming to ASME B16.12, AWWA C207, and ASTM D1330, Grade 1 and 2.
- C. HDPE Pipe:
 1. Conform to requirements of AWWA C906 or ASTM F714.
 2. Polyethylene resin shall meet or exceed requirements of ASTM 3350 for PE 4710 material. Pressure rating shall be based on hydrostatic design stress of 800 psi at 73.4 degrees F.
 3. DR:
 - a. Pipe Larger than 4 Inches: Minimum DR 17 (unless otherwise noted on the design drawings).
 - b. Pipe 4 Inches and Smaller: Minimum DR 11 (unless otherwise noted on the design drawings).
 4. Outer diameter basis: DIPS.
 5. Pipe lengths, fittings, flanged connections to be joined by thermal butt-fusion shall be of compatible resin mix for the fusion process.
 6. 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.
 7. Pipe Manufacturers:
 - a. Performance Pipe.
 - b. Rinker Polypipe.
 - c. Uponor North America.
 - d. ARNCO, Elyria, OH.

8. Fittings:
 - a. Sizes 6 inches or smaller: Molded and fabricated from polyethylene
 - b. Sizes 8 inches and larger: Use thermal butt-fusion.
 - c. Polyethylene fittings shall have same or higher pressure rating as pipe
 - d. Butt fusion fittings shall comply with ASTM D3261 requirements.
9. Backup Rings:
 - a. Convoluted for flanged connections:
 - 1) ASTM A536, ductile iron.
 - 2) Complete with one piece, molded polyethylene flange adapters.
 - 3) Flanged connections: Same or greater pressure rating as pipe.
 - b. Ductile Iron: Shop primed with red oxide and shop coated with two part-part epoxy material in accordance with AWWA C550. Dry film thickness shall be 10 mils minimum.
10. Electrofusion joint fittings shall have ISO 9001 and NSF 61 certification.
 - a. Manufacturers:
 - 1) Central Plastics Company; Central Electrofusion System.
 - 2) IPEX, Inc.; Friatec.
11. Joint:
 - a. Thermal-butt fusion or electrofusion, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly or as indicated on the Drawings.
 - b. Mechanical joints shall not be utilized with HDPE pipe.
12. Gaskets: Material, size, and thickness shall be as recommended by pipe or flange manufacturer, and in accordance with PPI Technical Note 38.
13. Bolts, Nuts, Washers:
 - a. Carbon steel, ASTM A307, Grade A hex head bolt, and ASTM A563, Grade A hex head nuts.
14. Thrust Restraint:
 - a. Wall Anchor: Material, internal diameter, shear strength shall be the same as the HDPE pipe. Butt fusion shall be method of joining. Extrusion bead welding is not allowed. Concrete thrust collars around wall anchor shall be in accordance with Project Drawings.
 - b. Products that restrain HDPE pipe with wedges, machined serrations, or clamps are not acceptable.
15. Electrofusion Flex Restraint:
 - a. Material: HDPE.
 - b. Design for restraining movement of HDPE pipe.
 - c. Electrofusion shall be method of joining.
 - d. Manufactures: Central Plastics Company or ISCO Industries.

PART 3. EXECUTION

3.01 INSTALLATION OF FORCE MAIN

A. General:

1. Force mains shall be installed at the lines and grades required by Drawings and backfilled in accordance with Section 02321, Excavation, Bedding, and Backfill for Utilities. All fittings shall be at the required locations, and the spigots well centered in the bells.
2. All pipe shall be installed with a 12-gauge solid copper wire for tracing purposes.
3. Unless otherwise indicated by the Drawings, all force mains shall have a minimum of 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.
4. CONTRACTOR shall provide and use tools and facilities that are satisfactory and that will allow the Work to be done in a safe and convenient manner. 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.
5. 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.
6. For bell and spigot pipe, 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.
7. For bell and spigot pipe, 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.
8. For bell and spigot pipe, pipe shall be installed with the bell ends facing in the direction of laying unless otherwise directed by OWNER.
9. Whenever 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.
10. 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.

11. 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.
 12. 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.
 13. Joint restraints shall be installed wherever indicated on the Project Drawings or required by the OWNER. Joint restraints shall be considered an integral part of the force main work.
 14. All pipe shall be jointed in the exact manner specified by the manufacturer of the pipe and jointing materials.
 15. Air valves shall be located at all high points on the pipeline as shown on the Drawings or as directed by OWNER.
 16. Crown of force main must be installed at same elevation as crown of receiving gravity sewer.
 17. Manhole invert must be formed to provide smooth transition channel to sufficient depth to direct force main discharge with minimum turbulence.
- B. PVC:
1. Install in accordance with AWWA C605, ASTM D2321, and AWWA Manual 23.
 2. Joints: In accordance with manufacture's written instructions.
- C. HDPE:
1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer's recommendations.
 2. Allow pipe to sufficiently cool, in accordance with manufacturer recommendations, prior to making any connections to flanges, existing pipeline systems or structures. Coordinate pipe surface temperature as measured with infrared temperature gun with ENGINEER/OWNER prior to making connections.
 3. Joining:
 - a. Preparation: Inside and outside of pipe ends shall be cleaned with cotton or non-synthetic cloth to remove dirt, water, grease, and other foreign materials. Pipe ends shall be cut square and carefully aligned prior to heating.

- b. 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.
 - c. All equipment and procedures used in shall be in strict compliance with ASTM F2620 and with the manufacturer's recommendations.
 4. Where indicated on the Project Drawings connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other pipe systems with flanged connections as follows:
 - a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange "stub-ends" are not allowed.
 - b. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacture's standard
 - c. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.
 5. Support heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.
 6. Minimum long-term bending radius restricted to limits recommended by AWWA M 55, Table 8-2. 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.
 7. 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 replaced.
 8. The fused joint shall be watertight and shall have tensile strength equal to or greater than that of the pipe.
 9. All joints shall be subject to acceptance by the OWNER prior to insertion.
 10. The CONTRACTOR shall cut out and replace defective joints at no additional cost to the OWNER. 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. 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.

D. Ductile Iron:

1. Cleaning Pipe and Fittings:

- a. Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
 - b. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.
2. Joining Pipe:
- a. Restraint shall be through use of restrained joint pipe.
 - b. Join pipe with push-on joints and mechanical joint fittings in accordance with manufactures recommendations.
 - c. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.
 - d. If necessary, lubricate end of pipe to facilitate sliding of gasket in place. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.
3. Cutting Pipe:
- a. Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
 - b. Cut pipe with milling type cutter or saw. Do not flame cut.
 - c. Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gaskets. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.
4. Field welding will not be allowed.

3.02 TRACER WIRE

- A. The contractor shall install tracer wire in the trench above the polyethylene pipe. The tracer wire shall be approximately 6 inches above the pipe where practical. The tracer wire shall be installed so that electrical continuity is maintained throughout the pipe system. As few connections as possible shall be made in the tracer wire. Connections will be made by stripping the insulation back one inch and joining the two ends using a specified mechanical connector and an approved split bolt connector. Twisting of copper wire will not be acceptable. To complete this connection, wrap all exposed wire thoroughly with electrical tape. A minimum 5 foot of additional tracer wire will be coiled, buried and terminate at the ends of the pipeline. Of the 5 foot tracer wire section at the ends of the pipeline, one foot of insulation will be stripped back, prior to burial.

3.03 LEAKAGE TEST

- A. General:
1. Notify OWNER or RESIDENT PROJECT REPRESENTATIVE (RPR) in writing at least 5 days in advance of testing.
 2. All newly installed and backfilled pipe shall be subjected to a hydrostatic leakage test using water as the test medium. All newly installed pipe shall successfully pass leakage test prior to acceptance.
 3. Testing shall be conducted in the presence of OWNER or RPR.

4. Conduct field hydrostatic test on buried piping after the trench has been completely backfilled and compacted. Testing may be conducted prior to placement of asphaltic concrete.
 5. CONTRACTOR may, as approved by the OWNER, partially backfill trench and leave joints open for inspection and conduct an initial informal service leak test. Final field hydrostatic test shall not be conducted until backfilling has been completed as specified above.
 6. If concrete thrust blocks are used wait a minimum of 5 days after installation to perform leakage test.
 7. Isolate new piping from existing piping with end caps, blind flanges, or other means acceptable to the OWNER.
- B. Test Water:
1. Any and all OWNER water used by CONTRACTOR shall be from a metered supply with an approved backflow device to protect the water supply. All metered water supply shall be paid to OWNER through the regular billing system.
 2. CONTRACTOR shall be responsible for obtaining transient water meter(s) from OWNER, which shall be installed on the trucks or at fire hydrant(s). All related charges for the set-up shall be considered incidental to the cleaning of the existing sanitary sewer mains.
 3. CONTRACTOR shall be responsible for preventing contamination of the potable water system. CONTRACTOR when drawing water from a public hydrant shall use a backflow preventer or an 18-inch air gap.
 4. No fire hydrant shall be obstructed or used when there is a fire in the area.
 5. It shall be CONTRACTOR's responsibility to obtain approval to use OWNER's fire hydrants.
 6. CONTRACTOR shall remove the water meter(s)/piping etc. from all fire hydrants at the end of each working day and to dispose of water used during testing.
- C. Testing Procedure:
1. Test pressure shall be 150 percent of system operating pressure based on pressure as measured at lowest point in pipeline. Coordinate with OWNER to determine the appropriate test pressure.
 2. 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.
 3. 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.

4. 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, adding make-up water only as necessary to restore test pressure to within 5 psi of specified test pressure
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration test.
6. No installation will be accepted until the leakage is less than the number of gallons per hour as determined by the methods:

D. For Ductile Iron Pipe and PVC Pipe:

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

L = allowable leakage, gallons/hour

S = length of pipe tested, feet

D = nominal diameter of the pipe, inches

P = average test pressure during the leakage test, psig

E. For HDPE Pipe:

1. In accordance with ASTM F2164:
 - a. Initial Expansion Phase: Add water as required to maintain test pressure for 4 hours.
 - b. Test Phase: Reduce pressure by 10 psi and start test
 - c. Test is successful if pressure stays within 5 percent of initial value for 1 hour.
2. If test is not completed because of leakage, equipment failure, or other reasons, depressurized test section, and allow it to relax for at least 8 hours before retesting.
 - a. If there is leakage, repair defective pipe section and repeat hydrostatic test.

3.04 CLEANUP

- A. After completing each section of the force main, all debris and construction materials shall be removed from the 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.

END OF SECTION