

SECTION 33 34 00 – FORCE MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Work Included:

1. Force mains (pressurized sewer conveyance).

B. Related Sections:

1. Section 33 34 00 - Excavation, Trenching, and Backfilling for Utilities.
2. Section 33 05 23.16 - Utility Pipe Jacking.
3. Section 33 39 13 - Manholes.
4. Section 33 32 00 - Sanitary Sewer Lateral Connections.
5. Section 33 31 00 – Gravity Sewers

1.2 UNIT PRICE - MEASUREMENT AND PAYMENT

A. Pipe and Fittings:

1. Basis of Measurement: By linear foot.
2. Basis of Payment: Includes excavation, bedding, backfilling, thrusts, testing, cleanup, and pipe to indicated depth and connection to sewer system. Separate line item on bid form for restrained joint pipe sections.

B. Valves:

1. Basis of Measurement: Price per valve.
2. Basis of Payment: Includes all required materials including but not limited to excavation, backfilling, collars, valve box, valve, installation, cleanup, and testing for a complete installation where indicated on Drawings. Additionally, Air release valves shall include cost of valve, tapping saddle, manhole, manhole frame/cover, markers, accessories, pipe, excavation, installation, clean up, and testing for a complete installation.

C. Additional items:

1. Basis of Measurement: Price per linear foot or per item as indicated on bid form.
2. Basis of Payment: Items in this category shall include all required materials, installation, and testing for a complete installation.

1.3 REFERENCE STANDARDS

- A. All products, installation and testing of force mains and gravity sewers shall meet the requirements of Regulation 61-67, Standards for Wastewater Facility Construction or State Primary Drinking Water Regulations (R61-58).

- B. All products, installation and testing of force mains and gravity sewers shall meet the requirements of "Recommended Standards for Wastewater Facilities" (Ten State Standards), latest edition.
- C. Any reference to SCDOT standard specifications was obtained from "Standard Specifications for Highway Construction" published by the South Carolina Department of Transportation. Unless otherwise noted, the most current date published applies.
- D. American Water Works Association:
 - 1. AWWA C104 – Cement-Mortar Lining for Ductile Iron Pipe and Fittings
 - 2. AWWA C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
 - 3. AWWA C110 – Ductile-Iron and Gray-Iron Fittings
 - 4. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 5. AWWA C150 - Thickness Design of Ductile-Iron Pipe.
 - 6. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast.
 - 7. AWWA C153 – Ductile-Iron Compact Fittings
 - 8. AWWA C517 – Resilient-Seated Cast-Iron Eccentric Plug Valves
 - 9. AWWA C600 – Installation of Ductile-Iron Mains and Their Appurtenances.
 - 10. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in through 60”
 - 11. AWWA M41 – Manual of Water Supply Practices.
 - 12. Additional applicable AWWA standards which are not specifically stated.
- E. American Society for Testing Materials:
 - 1. ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. ASTM A240 - Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 - 3. ASTM A242 – High-Strength Low-Alloy Structural Steel
 - 4. ASTM A377 – Standard Index of Specifications for Ductile Iron Pressure Pipe
 - 5. ASTM A536 - Standard Specification for Ductile Iron Castings.
 - 6. ASTM C150 – Standard Specification for Portland Cement
 - 7. ASTM C478 – Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
 - 8. ASTM C923 - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
 - 9. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
 - 10. ASTM D2241 - Standard Specification for Type Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe
 - 11. ASTM F477- Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 12. Additional applicable ASTM standards which are not specifically stated.
- F. National Sanitation Foundation:
 - 1. NSF 61 – Drinking Water System Components – Health Effects.

1.4 SUBMITTALS

- A. Product Data: Upon receiving Owner's Notice To Proceed, Submit manufacturer information indicating proposed materials, accessories, details, and construction information, including storage requirements.
- B. Provide Shop Drawings for all products in this section.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer Instructions:
 - 1. Indicate special procedures required to install specified products.
 - 2. Submit detailed description of procedures for connecting new sewer to existing system.
- E. Source Quality-Control Submittals: Indicate results of factory tests and inspections.
- F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.
- G. Submit qualifications for manufacturer and installer.

1.5 COORDINATION

- A. Coordinate Work of this Section with utility owners and local authorities.
- B. Notify affected utilities at least 72 hours prior to construction.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- B. Stored Materials:
 - 1. Store materials according to manufacturer instructions.
 - 2. Store materials, to the best of ability, to prevent damage, theft, or vandalism.
 - 3. For materials in a storage facility, the products must be classified and marked in accordance with the NFPA 704, NFPA 49, and NFPA 325M.
- C. Protection:
 - 1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
 - 2. Block individual and stockpiled pipe lengths to prevent moving.
 - 3. Provide additional protection according to manufacturer instructions.

1.7 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum ten (10) years of experience.

- B. Installer: Company specializing in performing Work of this Section with minimum five years of documented experience.

1.8 CLOSEOUT DOCUMENTS

- A. RECORD DRAWINGS - Provide the following information on all record drawings:

1. Project Name and Address
2. Subdivision Name, Lot, Block, Section, Tax Map Number, Phase and Total Number of Lots. (if applicable)
3. Scale: Prefer 1" = 50', No Less than 1" = 100'.
4. North Arrow and Location Map.
5. Developers Name, Address and Telephone Number.
6. Street Names.
7. Title Block with Engineers Name, Address, Telephone Number, and Date of Record Drawings. (Show revision dates).
8. Signature, Seal and Certification of SC Design Engineer.
9. Locate all pipe and utility system crossings (electric, cable, telephone, gas, etc.). Include vertical and horizontal separation distances, depth of cover, and pipe materials.
10. Remove any temporary features (erosion control, etc.) and the language consisting of the words new/proposed from any labels on Drawings.
11. Provide total lump sum cost for Work (include engineering, surveying, legal and contract cost as a lump sum).
12. All sheets shall be numbered consecutively in one set.
13. Easements to be dedicated to the Joint Municipal Water and Sewer Commission shall be clearly labeled on the Record Drawings.
14. The drawings shall be clearly labeled as Record Drawings with the date of the last revision.

- B. Force Main:

1. Provide pipe elevation every 100'.
2. Provide location of all fittings, valves, ARVs, manholes, etc. with two (2) pulled tape distances. Distances shall not be pulled from building structures. Distances shall be pulled from items such as drainage boxes, telephone poles/boxes, etc.
3. Provide location of all encasements and pipe material transitions.
4. As required, Provide manhole rim and inverts (in and out, as applicable) elevations for any tie-in points to a gravity system. Refer to specification sections 33 39 13 MANHOLES and 33 31 00 GRAVITY SEWERS for full manhole specification requirements.

- C. Submittal Procedure:

1. Submit 2 copies of the Preliminary Record Drawings, Deeds, Affidavits, and required inspection documentation to the Commission a minimum of 5 working days prior to the Commission's final inspection. The Commission will field verify the record drawings. If incorrect they will be returned to the Engineer. This step will be repeated until the record drawings are approved by the Commission.
2. Submit the following items 5 working days prior to the SC DES final inspection:
 - a. Three (3) Sealed Bond Copies (Five (5) if also used as Easement Map).
 - b. Three (3) Printed Copies including all information required herein and an electronic copy containing the record drawing files in PDF and AutoCAD formats.

- c. One (1) Copy of Filed Subdivision Plat showing property lines with bearings and distances.
- d. One (1) Final Easement Deed (if applicable).
- e. Three (3) Copies of Easement Map (if Easement Map is not combined with Record Drawings).
- f. Bill of Sale (conveying improvements to Commission).

1.9 WARRANTY

- A. Provide a one-year materials and workmanship warranty. The contractor shall be responsible for correcting defects in the Work during the warranty period, including defective material and workmanship.
- B. Provide any required documentation or certifications for items with a manufacturer's warranty.

1.10 EXISTING CONDITIONS

- A. Field Measurements:
 - 1. Verify field measurements prior to fabrication.
 - 2. Indicate field measurements on Shop Drawings.
- B. Protection of other utilities:
 - 1. Approximate location of certain known underground lines is shown.
 - 2. Existing small lines not shown.
 - 3. Locate small and other possible utility lines using electronic pipe finder, or other approved method.
 - 4. Excavate and expose existing underground utilities ahead of trenching operations.
 - 5. Repair or replace any damaged utility line or structure at no additional cost to Owner.

1.11 JOB CONDITIONS

- A. Work under this Section may require construction or work in a confined space, defined as any space having one or more of the following characteristics:
 - 1. Limited openings for entry and exit.
 - 2. Unfavorable natural ventilation.
 - 3. Not designed for continuous worker occupancy.
- B. The Contractor shall have on the job site at all times the following minimum safety equipment:
 - 1. Gas monitor capable of testing and detecting for combustible gas, oxygen deficiency and hydrogen sulfide.
 - 2. Confined space access and retrieval winch system.
 - 3. Ventilating fan with large diameter ventilating hose.
 - 4. Supplied air respirator, MISHA/NIOSH approved type.
 - 5. Safety harness and lifelines.

This equipment to be available for use by the Contractor, Engineer and Owner for the duration of the project.

- C. All entries into or work within confined spaces to be conducted in accordance with the U.S. Department of Health and Human Services/National Institute for Occupational Safety and Health [DHHS (NIOSH)] Publication No. 87-113, A Guide to Safety in Confined Spaces.
- D. It is the responsibility of the Contractor to maintain all necessary safety procedures in accordance with all local, state, and federal regulations.

1.12 GENERAL REQUIREMENTS

- A. All sewer lines shall have a minimum of three (3) feet of cover or as indicated on the Drawings.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pipe shall be subject to observation prior to installation for culling or rejecting pipe, independent of laboratory tests, not conforming to this Section.
- B. Rejected pipe will be marked and shall be promptly removed from the project site at no additional cost to the owner

2.2 PIPE, FITTINGS, AND VALVES

- A. Use pipe material specified herein as indicated on the Contract Drawings.
- B. Ductile-iron pipe (DIP) and Fittings:
 - 1. Ductile iron pipe (DIP):
 - a. All ductile iron pipe shall be domestically manufactured in the United States. Pipe shall be cast, cleaned, lined, coated, fabricated, tested, and certified at a United States of America manufacturing facility.
 - b. Pipe shall be in accordance with ANSI/AWWA C150/21.50 and conform to the requirements of ANSI/AWWA C151/21.51, latest revision. The raw material for ductile iron shall have an average minimum content of 90% recycled iron and steel.
 - c. The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally, the manufacturer's mark, country where cast, year in which the pipe was produced, and the letters "DI" or "Ductile" shall be cast or stamped on the pipe.
 - d. Wall thickness in accordance with ANSI/AWWA C150/A21.50 for depth of cover indicated.
 - e. Push-on and restrained joint pipe shall have a minimum rated pressure class of 150 PSI.
 - f. All buried pipe shall have a minimum of 2 to 1 safety factor and shall be pressure class as follows:

- 1) 4" – 12" Pressure Class 350
 - 2) 14" – 20" Pressure Class 250
 - 3) 24" Pressure Class 200
 - 4) 30" – 64" Pressure Class 150
- g. Push-on joints complying with ANSI/AWWA C111/A21.11 as modified by ANSI A21.51/AWWA C151 such as Fastite, Tyton, or Bell-tite, or approved equal.
- h. Use rubber gaskets and lubricant complying with ANSI/AWWA C111/A21.11 Unless otherwise specified gasket material shall be standard styrene butadiene copolymer (SBR.)
- i. Ductile iron pipe and fittings should be delivered to the application facility free of other linings and containing a compatible finish per the manufacturers recommendations.
- j. Interior Linings shall meet the following:
- 1) Lining Materials
 - a) Material must have a permeability rating of 0.0 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 Days.
 - b) Material shall be amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Provide Protecto 401 or approved equal. Any substitution submission shall be accompanied by a successful history of lining pipe and fittings for service as well as a test report verifying the properties and a certification of the test results.
 - 2) Lined DIP Tests: The following test must be run on coupons from factory lined ductile iron pipe.
 - a) ASTM B-117: Salt Spray (scribed panel) – Results equal to 0.0 undercutting after 2 years.
 - b) ASTM G-95: Cathodic Disbondment – 1.5 volts @ 77 degrees F. Results to equal no more than 0.5 mm undercutting after 30 days.
 - c) ASTM D-714-87: Immersion Testing – 20% Sulfuric Acid with no effect after 2 years, 140 degrees F 25% sodium hydroxide with no effect after 2 years, 160 degrees F distilled water with no effect after 2 years, 120 degrees F tap water with no effect after 2 years.
 - d) Abrasion resistance of no more than 3 mils (0.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.
 - 3) Application:
 - a) The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.
 - b) Surface Prep: Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance which can be removed by solvent, shall be cleaned to remove those substances. After the surface has been made free of grease, oil, or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.

- c) Lining: After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40 degrees Fahrenheit. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.
- d) Coating of Bell Sockets and Spigot Ends: Due to the tolerances involved, 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 Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining. If flanged piping or fittings are used, no coating shall be used on the face of the flange.
- e) Number of coats: The number of linings material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining manufacturer. To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.
- f) Touch-up & repair: Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.
- 4) Inspection
 - a) All ductile iron pipe and fittings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.
 - b) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired prior to shipment.
 - c) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.
- 5) Certification
 - a) The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.
- 6) Handling
 - a) Protecto 401 lined pipe and fittings must be handled from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.
- k. Exterior Coating for buried ductile iron pipe and fittings shall meet the following:
 - 1) Asphaltic (bituminous) with minimum thickness of 1 mil., comply with AWWA C151.
 - 2) For exposed service (non-buried), all ductile iron pipe and fittings unless otherwise noted, shall be primed with Tnemec N140 or approved equal. All

primed material to receive a field coating as specified by the design engineer. Contact ductile iron manufacturer for additional recommended primers. Refer to Specification Section 09 90 00 – Painting and Coating.

1. Piping or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification and that the material used was as specified.
2. Polyethylene encasement:
 - 1) Provide polyethylene encasement of pipe where indicated on the Drawings.
 - 2) Minimum nominal thickness of 8 mils.
 - 3) Comply with all requirements of ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile Iron Pipe Systems.
 - 4) Ductile iron pipe and the polyethylene encasement used to protect it shall be installed in accordance with AWWA C600 and ANSI/AWWA C105/A21.5 and in accordance with all recommendations and practices of the AWWA M41, Manual of Water Supply Practices.
3. Ductile Iron Joints:
 - a. Use mechanical or push-on joints complying with ANSI/AWWA C111/A21.11 as modified by ANSI/AWWA C151/A21.51.
 - b. Restrained Joints shall be Amarillo Fast-Grip gasket, Flex-Ring, Field Flex-Ring, Lok-Ring, Barracuda orange gasket, US Pipe Red Field Lok gaskets, US Pipe HDSS (4"-54"), TR Flex, Ebaa Megalug Series 1100, or approved equal. Restrained joint gaskets shall be colored, non-black. The color shall be consistent throughout the entire cross section of the gasket and not be attained by surface coating; the color shall be inherent within the rubber. Gaskets shall meet applicable requirements of AWWA/ANSI C111/A21.11 and shall be ANSI/NSF Standard 61 certified. Restrained gaskets shall be manufactured in the United States.
4. Ductile Iron Fittings:
 - a. Provide ductile iron fittings complying with ANSI/AWWA C110 or C153/A21.53 and in accordance with ANSI/AWWA C111/A21.11.
 - b. All fittings shall have a minimum pressure rating of 250 psi.
 - c. Supply fittings consisting of a lining as specified in section 2.2.B.1.J- k above.
 - d. The nominal diameter (each leg as required), country of origin, fitting material, manufacturer, pressure rating, degree of bend, casting period, and AWWA C-153 or C-110 conformance, shall be clearly marked on each fitting.
 - e. All fittings and valves should be restrained as specified in Part 2.2.B.2.2 above.
 - f. Welded-on outlets may be used where appropriate in lieu of fittings. Welded-on outlets may be used in lieu of the tees shown on the plans. All welded-on outlets shall be rated for a working pressure of 250 psi and shall have a minimum safety factor of 2.0; except that 36" welded-on outlets for 54"-64" parent pipe diameters shall be rated at 200-psi. Welded-on outlets may be provided as a radial (tee) outlet, a tangential outlet, or a lateral outlet. Parent pipe and branch pipe shall meet hydrostatic test requirements in accordance with AWWA C151, section 51-9, prior to fabrication.
 - 1) All joints on welded-on branch outlets shall be provided in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA

C115/A21.15, as applicable. All outlets shall be fabricated from centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured in accordance with ANSI/AWWA C151/A21.51.

- 2) All welds must be produced using 55% nickel iron welding rod or wire. Carbon steel electrodes will not be acceptable. Both branch and parent outlet pipe shall be class 53. After fabrication each outlet pipe shall be air tested to 15 psi to ensure weld integrity. A soap and water solution shall be applied during the testing procedure to inspect the weld for leakage. Any welds that show air seepage shall be refabricated and retested.

C. Polyvinyl Chloride (PVC) Pipe and Fittings:

1. Polyvinyl Chloride (PVC) Pipe
 - a. PVC Pipe 3" and less in diameter shall comply to ASTM D2241 for PVC 1120, SDR 21 with a pressure rating of 150 psi at a temperature of 73°F.
 - b. PVC Pipe 4" through 42" in diameter shall comply with ANSI/AWWA C900 with a pressure class of 150 (DR 18).
 - c. Use integral bell and spigot pipe.
 - d. Provide watertight seal using elastomeric gasket joints complying with ASTM F477. Gaskets to be factory installed and shall be of material resistant to domestic sewer and industrial wastes, including oils.
 - e. Furnish pipe in 12.5 or 20-foot lengths.
 - f. All PVC force main pipe shall be green colored.
 - g. Provide any required gaskets, adapters, etc. required to accommodate any differences in dimensions from pipe sizing (transition from DIP to PVC), fittings, and materials.
 - h. Install pipe in strict accordance with manufacturer's recommendations.
2. PVC Restrained Joints and Fittings
 - a. Where indicated on Drawings, provide restraint for C-900 PVC separate from the mechanical joint gasket sealing gland. Restraint shall be designed to provide circumferential loading over the enter restrainer.
 - b. Provide wedge type.
 - c. Provide split gland where standard gland cannot be installed.
 - d. Provide restraint device equal to or greater than the pressure rating of pipe to be installed upon. Restraint shall also be able to withstand a test pressure of a minimum of 2 times the pipe pressure rating.
 - e. Provide tee-head bolts conforming to ANSI/AWWA C111/A21.11 latest revision.
 - f. Restraints should be factory prepared and have two (2) liquid thermoset epoxy coats using a heat cure following each coat. Restraints shall use MEGA-BOND by Ebba Iron, Inc. or approved equal.
 - g. Provide MEGALUG, Series 2000PV by Ebba Iron, Inc. or approved equal.
3. Fittings for PVC
 - a. Use ductile iron fittings complying with Part 2.2.B.3 above.

D. Casing Pipe and Spacers

1. As specified in Section 33 05 23.16 – UTILITY PIPE JACKING.
2. Casing pipe shall be sized adequately to accommodate spacers, joints, and restraints.

E. Plug Valves

1. Where indicated on Drawings, provide plug valves with correlating mechanical (below grade) or flanged joint (above grade) end connections.
2. Plug valves shall be non-lubricated, eccentric type consisting of resilient plug facings for dead-tight shutoff. Valve shall comply with AWWA C517, ASTM A 126, and ASTM A 536.
3. Provide valve with cast iron bodies, one piece cast ductile iron plugs, corrosion resistant welded seats, and stainless-steel bearings.
4. All valves shall open in the counterclockwise direction with a standard 2-inch nut operator.
5. Provide rectangular valve port consisting of 100% full pipe area to promote uninterrupted flow.
6. Valve bearing housing shall be designed to reduce the possibility of grit entrance.
7. Below grade valves shall be shop prepared and coated using two coats of coal tar epoxy. Provide TNEMEC Tneme-Tar or approved equal.
 - a. Exterior body on above grade valves shall be primed using TNEMEC Series 66-1211 or approved equal. Finish coat should match above ground piping coating system compatible with primer.
8. Provide plug valves manufactured by Dezurik or approved equal.

F. Tapping Valves

1. Valves shall have a ductile iron body, resilient wedge type, symmetrical and fully encapsulated with molded rubber, conforming to AWWA C500 and rated for a working pressure of not less than 250 psi.
2. All interior and exterior ferrous surfaces of the valve, including the interior of the gate, shall be coated with a protective coating conforming to AWWA C550. Coating shall be applied to castings prior to assembly to ensure all exposed areas will be fully covered.
3. Stem shall be designed to have an external failure should stem ever fail under excessive torque. Design should allow for operation of valve by wrench or other readily available tool during time of failure without disassembly the valve.
4. Valve shall have one end flanged with alignment lip to attach to tapping sleeve.
5. Valves shall have an O-ring sealed stuffing box.
6. Provide 316 stainless steel bolts and nuts.
7. Valves 16" and larger, for working pressures greater than 50 psi, shall be provided with a spur or bevel gear operator and bypass.
8. Provide Mueller T-2361 Tapping Valve or approved equal.

G. Tapping Sleeves

1. General
 - a. Shall be the type designed for making connection to existing water lines (while "live" / "hot" / "wet") without loss of water or interruptions in service and be NSF 61/372 Certified.
 - b. Tapping sleeves for lines 12 inches and less shall have a minimum working pressure of 200 psi. Tapping sleeves greater than 12 inches shall have a minimum working pressure of 150 psi, unless indicated otherwise.
 - c. All tapping sleeves shall be designed to accommodate the existing pipe for which they will be installed. This includes pipe material, pipe outside diameter, and existing condition of the pipe itself.

- d. All gaskets and seals associated with tapping sleeve shall be vulcanized EPDM or Buna-N (NBR). Material shall be designed to withstand shrinkage or swelling after installation and must be fully comprised of non-recycled material.
- e. Joints on sleeves shall be suitable for the intended use.
- f. Sleeve shall have all pertinent information clearly marked on the side, including but not limited to, manufacturer, part number, date of manufacture, rated working pressure, and certifications.
- g. For sizes 12" and below, gate valves (flange x MJ) shall be used with tapping sleeve. For sizes greater than 12", tapping valves shall be used with tapping sleeves.

H. Size for Size Tap Sleeves

- 1. Shall be cast iron or ductile iron split repair type suitable for minimum working pressure of 200 psi.
- 2. The sleeve shall be made of two halves which can be assembled and bolted around the main.
- 3. Provide flange corresponding to specified gate valve bolt patterns.
- 4. Cast iron sleeves shall be factory coated on inside and outside.
- 5. Tapping sleeve shall have a 3/4" NPT threaded plug.
- 6. Sleeve shall include the mechanical end joint accessories and split glands necessary to assemble the sleeve to pipe.
- 7. Provide Mueller Mechanical Joint H-615 or approved equal.

I. Reduced Size Tap Sleeves

- 1. Shall be ASTM A36 steel with a fusion bonded epoxy coating in accordance with AWWA C213.
- 2. Tapping sleeve shall have a 3/4" NPT threaded plug.
- 3. Provide type 304 stainless steel hex head nuts and bolts. Coat nuts to prevent galling.
- 4. Must be certified NSF 61.
- 5. Provide gaskets rated for water service made of virgin SBR.
- 6. Tapping sleeve shall have a minimum working pressure of 250 psi for sizes 6" – 12" and 150 psi for 14"-42".
- 7. Tapping sleeve flange shall be compatible with specified gate valves.
- 8. Provide ROMAC Industries FTS 420 Model for ductile iron, cast iron, or steel piping and FTS 419 for PVC, FTS 423 for HDPE, or approved equal.

J. Air Release Valve Assembly

- 1. Combination air valves shall be installed on significant highpoints throughout the system.
- 2. Valves shall be designed for use with wastewater applications (liquid carrying solids).
- 3. Valve should be designed to discharge air (gases) from the system during the filling, admit air into the system during liquid discharge, and release accumulated air under pressure during operation.
- 4. Working pressure of 3 psi to 150 psi. Testing pressure of 250 psi.
- 5. Valve body and float to be made from composite materials.
- 6. Float rod and spring should be made of a high-quality stainless steel.
- 7. Provide with 1/4" ball valve to release trapped pressure and drain the valve body prior to maintenance. Air release valve shall be designed to accommodate back-flushing during maintenance.
- 8. Provide 1-1/2" threaded discharge outlet for connection to vent hose.
- 9. Furnish air release valve with a 2" NPT male threaded connection.

10. Provide D-025 combination air valve by A.R.I. or approved equal.
11. Provide 2"x2" FNPT x FNPT latch lever stainless-steel ball valve by Apollo or approved equal.
12. Provide 2" 304 stainless steel service saddle with NBR inserted gasket around tap style 306 by Romac Industries or approved equal. Nuts and bolts shall be coated with anti-seize compound.
13. Provide a 2" 316 stainless steel nipples on each side of ball valve (2 total).
14. Refer to JMWSC Standard detail – FORCE MAIN AIR RELEASE VALVE ASSEMBLY IN PRECAST MANHOLE.

K. Air Release Valve Manhole

1. Provide reinforced precast manhole with flat top in accordance with the Drawings and Specification Section 33 39 13 – MANHOLES.
2. Manhole shall be installed on gravel bed (8" minimum thickness) with sufficient clearance between the valve and gravel to remove or service the valve.

L. Check Valves

1. Provide check valves at all locations where a force main ties into another force main, at pump station discharge vault, and/or locations indicated on plans.
2. Check valves at pump stations shall close using an air cushioned cylinder system. Check valves at other locations shall utilize a lever and weight closing system, unless stated otherwise on plans.
3. Check valve shall have a minimum rating of 250 psi.
4. Body shall be ductile iron and lined with 12 mils fusion bonded epoxy and exterior shall have a minimum coating of 8 mils.
5. Body shall have a type 316 stainless steel seat material.
6. Provide check valve with flanged end connections.
7. Check valve disc material shall be ductile iron with an Acrylonitrile-Butadiene (NBR) seat material.
8. Shaft material shall be type 304 stainless steel.
9. Check valves shall provide a drip tight shut-off with a flow area equal to or greater than the nominal valve size.
10. Provide Dezurik APCO CVS check valve, Series 250 or approved equal.
11. Check valve operation shall be designed to open and close per sewer system needs and requirements. The contractor must confirm check valve with manufacturer and engineer before purchasing to ensure valve will meet the required system design and operation.
12. For check valves greater than 24" coordinate with JMWSC and check valve manufacturers.

M. Valve Boxes

1. Valve boxes shall be provided for all buried valves.
2. Provide a cast iron adjustable slip-joint or screw type, three (3) piece valve box suitable for depths shown on construction drawings. Provide extensions as required to meet depths. Valve box assembly shall consist of lower/base piece to fit around the stuffing box gland and rest on valve bonnet, the upper part shall be flared on lower end to telescope on a socket to receive cap or cover.
3. The valve box cover shall have the word "WATER" cast within.
4. Provide cast iron valve boxes with a minimum inside diameter of 5" at the top on all valves located below grade.

5. All castings shall have a minimum thickness of 1.5 mil of bitumastic paint.
6. For valve boxes located within pavement, provide heavy duty valve box and cover rated for use in traffic areas and conforming to AASHTO standards.
7. As required, valve shall be fitted with an extension stem for use with the buried service non-rising stem valves. The stem shall be of corrosion resistant metal and be designed to bring the valve nut within 3' of finished grade.
8. Stem shall be fitted with a self-centering disk below the operating nut to keep the extension stem aligned and limit foreign debris inside of the box.
9. Provide 24" (O.D.) concrete collar with wire reinforcement at all valve boxes. Collar shall have a minimum height of 4" at valve box opening.
10. Provide Tyler Series 6860 valve boxes or approved equal.

N. Valve Markers

- a. Approved plastic or fiberglass valve markers shall be furnished to the Owner. A marker shall be required for each air release valve and every main line valve or cluster.

O. Tracer Wire

1. Where PVC or polyethylene pipe is used, provide a continuous 12 gauge insulated copper tracer wire.
2. Insulation to be green in color and must be approved for direct bury by manufacturer.
3. Tracer wire should be located at a minimum of 6" above the top of the sewer line or wrapped around the pipe.
4. Tracer wire to terminate at each valve and allow for connection of equipment for tracing. Wire should be located at valve in a manner which prevents interference with the operation of the valve.
5. Tracer wire shall extend through air release valve manholes and wire shall be installed in a manner that allows wire to be accessed from the top.

2.3 MISCELLANEOUS MATERIALS

- A. As required, provide all other materials for a complete and proper installation for products and installation as described here within.

2.4 SOURCE QUALITY CONTROL

- A. Provide shop inspection and testing of pipe, valves, fittings, etc.
- B. Make completed pipe sections available for inspection at least 7 days prior to installation.

PART 3 - WORK EXECUTION

3.1 LAY OUT OF WORK

- A. Provide all required materials, labor, instruments, etc. required to properly lay out work.

- B. Prepare "cut sheets" for approval by Engineer and Owner.
- C. Exercise proper precaution to verify requirements on the Drawings prior to laying out Work. Any errors that otherwise might have been avoided shall be corrected at no additional cost to the owner.
- D. Provide proper notification of errors or discrepancies found to Engineer in a timely manner to ensure corrective actions are made.
- E. All force mains shall be located within SCDOT Rights-of-Way, on Joint Municipal Water & Sewer Commissions personal private property, or in deeded easements.
- F. Easements shall meet the following requirements based upon depth of pipe:
 - 1. 0'-7' depth: 15' easement width
 - 2. 7'-12' depth: 25' easement width
 - 3. 12'-15' depth: 30' easement width
 - 4. > 15' depth: Shall be reviewed and determined by the commission on a case-by-case basis.

3.2 LOCATING

- A. Sewer lines in proximity to water lines must conform to the South Carolina Standards for Wastewater Facility Construction R.61-67 section 67-300 paragraph A.14.
- B. Where the sewer location is not clearly shown by dimensions on the drawings, locate the sewer:
 - 1. Not closer than 10' horizontally from a water supply main or service line. The distance shall be measured edge to edge.
 - 2. Where it is not practical to maintain a 10' horizontal separation, the sewer pipe may be installed closer to a water main, provided that the water main is in a separate trench or on an undisturbed earth shelf located on one side of the sewer and at an elevation so the bottom of the water main is at least 18" above the top of the sewer.
 - 3. Where sewers are crossing a water main, either above or below, provide a minimum vertical distance of 18" between the outside of the water main and the outside of the sewer.
 - 4. The crossing shall be arranged so that the sewer joints will be equidistant and as far as possible from the water main joints.
 - 5. Where a water main crosses below a sewer, fully encase the sewer pipe for a minimum distance of 10' on each side of the crossing or use acceptable pressure pipe with no joint closer horizontally than 3' feet on either side of the crossing. This pipe will be pressure tested to assure watertightness prior to backfilling.
 - 6. Provide not less than 4" thickness, including that on pipe joints, when using concrete encasement on sewer at crossings.
 - 7. Potable Water Supply Interconnections. There shall be no physical connections between a public or private potable water supply system and a sewer, or appurtenance thereto which may permit the passage of any sewage or polluted water into the potable supply. No potable water pipe shall pass through or come into contact with any part of a sewer manhole.

- C. Provide adequate support for other utilities around force main line to prevent damage during construction or maintenance activities.
- D. Special Conditions: When it is impossible to locate piping as specified herein, ensure that the following conditions are met and approved by Engineer and Owner prior to proceeding:
 - 1. Maximize the distances between the water main and sewer line and do not locate joints of either pipe near the crossing.
 - 2. Use materials which meet the requirements AWWA Section C and comply with NSF 61 when installing sewer near water mains.
 - 3. When metallic piping is used for sewer line, provide lead free pipe and fittings.
 - 4. Provide adequate distance for maintenance to allow repair of either line without damaging the other.

3.3 EXAMINATION

- A. Verify that trench is ready to receive work of this Section.
- B. Verify that excavations, dimensions, and elevations are as indicated on Drawings.

3.4 PREPARATION

- A. Correct over-excavation with crushed stone.
- B. Protect and support existing sewer lines, utilities, and appurtenances.
- C. Utilities:
 - 1. Maintain profiles of utilities.
 - 2. Coordinate with other utilities to avoid conflict.
 - 3. Notify Engineer of any conflicting utilities encountered. Relay conflicting utilities when approved and directed by the Engineer and Owner.

3.5 INSTALLATION

- A. All pipe shall be installed in accordance with Drawings and manufacturer's recommendations.
- B. Trench, bed, backfill, and compact piping in strict accordance with pertinent provisions of Section 33 34 00 - Excavation, Trenching, and Backfilling for Utilities.
- C. Maximum trench widths, depths, and bedding methods.
 - 1. Install all sewer pipe complying with manufacturer's requirements for maximum depths of cover indicated on the Drawings.
- D. Pipe laying:
 - 1. General:
 - a. Follow pipe manufacturer's recommendations for proper installation.

- b. Lower individual sections of pipe into trench by means of crane, slings, or other suitable means to prevent damage to pipe, coatings, or liners. Where any part of coating or lining is damaged, repair in accordance with manufacturer's recommendation at no additional cost to the Owner.
 - c. Protect pipe during handling against shocks and free fall. Do not dump or drop pipe into trench.
 - d. Keep debris from entering the pipe interior. Continually clear and clean interior of the pipe free from any debris.
 - e. Lay pipe to slope gradients as indicated on the Drawings. Begin at the downstream end and proceed upstream with the spigot ends of bell-and-spigot pipe pointing in direction of flow when possible.
 - f. Rest the full length of each section of pipe solidly on the pipe bed, with recesses excavated to accommodate bells, couplings, and joints.
 - g. Before making pipe joints, clean and dry all surfaces of the pipe to be joined. Place, fit, join, and adjust the joints to obtain the degree of water tightness required.
 - h. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress. Remove and relay any pipe that has the grade or joint disturbed after initial laying.
 - i. As soon as possible after the joint is made, sufficient backfill materials shall be placed along the pipe to prevent pipe movement off line or grade. PVC pipe shall be completely covered to prevent damage from ultraviolet light.
 - j. Do not lay pipe in water or when trench conditions are unsuitable for the work; keep water out of the trench until jointing is completed.
 - k. No caulking of joints is permitted.
 - l. Securely close open ends of pipe, fittings, and valves when work is not in progress.
 - m. Record pipe elevation every 100' and submit elevations to Engineer weekly.
 - n. Use only gasket lubricants recommended by the pipe manufacturer.
 - o. Protect all existing utilities, curbs, pavement, etc. in the vicinity of the work and promptly repair any damages at no additional cost to the Owner.
 - p. Pipe fittings shall be handled and lifted from outside only to avoid damage to THE interior coating.
 - q. Remove defective pipe and replace at no additional cost to the Owner.
2. Ductile-iron pipe:
- a. Install pipe, mechanical, push-on joints in accordance with ANSI/AWWA C600 and ASTM A-377.
 - b. Handle, lubricate where necessary, and install gaskets in strict accordance with manufacturer's recommendations.
3. Polyvinyl chloride pipe (PVC):
- a. Comply with ASTM D2321, except as otherwise specified herein.
 - b. Lubricate and invert gaskets as recommended by manufacturer.

3.6 INSPECTIONS AND HYDROSTATIC TESTING

A. General:

1. All force main will be visually inspected and tested for leaks and pressure. Testing must be conducted in accordance with AWWA C600.
2. Any visible leaks shall be repaired.
3. All pipe must be cleaned and flushed of any air or foreign debris.
4. Broken or cracked pipe, mislaid pipe and other defects shall be corrected.
5. All required testing and materials will be performed and supplied at the expense of the contractor.
6. Contractor will be responsible for supplying and installing brass corporation cocks at high points that do not have air vents. Contractor to leave in place upon completion.
7. Failure to meet specified test requirements will result in removal, replacement, and retesting of pipe until force main is brought to the specified standards at no additional cost to the Owner.
8. All inspections and tests must be completed in the presence of representative of the Owner. Should inspections be performed by an unapproved inspector of the contractor, the contractor will be required to retest and/or make the required repairs at no additional cost to the Owner.

B. Pressure Tests:

1. Perform pressure test on all fully installed pipe sections after backfilled upon.
2. Test shall be performed on each section of force main or valved section. Perform tests using a pressure of 150 psi or 1.5 times the maximum working pressure, whichever is greater. Test should be based upon the elevation at the lowest point of the section being tested and shall be corrected to the test gauge elevation.
3. Valves at section being tested should be opened and closed multiple times during testing period.
4. Repair or replace any section not passing pressure test or visual test at no additional cost to the Owner.

C. Leakage Test:

1. Perform leakage test after the pressure test results obtained are satisfactory.
2. Test shall be performed on each section of force main or valved section. Perform tests using a pressure of 150 psi or 1.5 times the maximum working pressure, whichever is greater. Test should be based upon the elevation at the lowest point of the section being tested and shall be corrected to the test gauge elevation.
3. Perform leakage test for a minimum of two hours.
4. Leakage is defined as the quantity of water to be supplied into the newly laid pipe or any valved section thereof, necessary to maintain the leakage pressure.
5. No pipe installed will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

a.
$$\frac{SxDx(P)^{1/2}}{133,200} \text{ For DIP pipe}$$

b.
$$0.000135xNx Dx(P^{0.5}), \text{ For PVC Pipe}$$

Where: L equals the allowable leakage in gallons per hour; N is the number of joints in the length of pipeline tested; D is the nominal diameter of the pipe in inches; S is the length of the pipeline tested in feet; and P is the average test pressure during the leakage test, in psi gauge. Should any test of pipe disclose leakage greater than that specified in

the foregoing formula, the defective joints shall be located and repaired until the leakage is within the specified allowance, without additional cost to the Owner.

D. Tracer Wire Testing:

1. Provide an approved magnetic locating device to test all locations where tracer wire is installed.
2. Connect to ground rod and to tracer wire located at valves. Using manufacturers equipment instructions, located the newly installed line.
3. Perform tracing wire locating and testing in the presence of the Owners representative.
4. Where there is a break in the tracer wire, repair wire by splicing and using gel nuts or an approved equal repair at no additional cost to the Owner.

END OF SECTION 33 34 00