

## SECTION 01100

### FORCE MAINS AND GRAVITY SEWERS

#### PART I - GENERAL

#### 1.0 APPLICABLE STANDARDS

- 1.1 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).
- 1.2 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.
- 1.3 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.

#### PART II - MATERIALS

#### 2.0 MATERIALS: All materials for sewer pipe shall be new and shall be furnished in accordance with the following requirements unless shown otherwise on the approved plans.

##### 2.1 Gravity Sewers (8-Inch Through 16-Inch):

###### 2.1.1 Ductile Iron Pipe:

Pipe: AWWA C151, Class 150, ASTM A-746, ANSI A21.50, ANSI A21.51 "Ductile Iron Pipe, Centrifugally cast in Metal Molds or Sand Lined Molds, for Water and Other Liquids." Thickness Class 50 unless shown otherwise on the drawings.

Fittings: AWWA C110/A21.10 or AWWA C110, Class 50, grey or ductile iron.

Joints: AWWA C111 push-on unless shown otherwise.

###### 2.1.2 PVC Pipe:

Pipe: ASTM D-3033, D-3034 or F-789-82; "Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings." SDR 35 with minimum cell classification of 12454-B.

Fittings: ASTM D3034

Joints: ASTM D3212, Elastomeric gaskets conforming to ASTM F477.

Installation: ASTM D-2321.

##### 2.2 Force Mains: All PVC force main pipe shall be green colored.

### 2.2.1 Ductile Iron Pipe (4-Inch Through 12-Inch):

Pipe: AWWA C151 "Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water and Other Liquids" Thickness Class 51 unless shown otherwise on the approved drawings.

Fittings: AWWA C153, grey or ductile iron. Ebba megalugs – 1100 series.

Joints: AWWA C111 push-on or mechanical for general buried service; flanged for exposed service unless shown otherwise on the approved drawings.

Installation: ASTM A-377, Latest Revision.

### 2.2.2 PVC Pipe (14-Inch and Greater – Minimum Requirements)

Pipe: AWWA C905 SDR 25 Polyvinyl Chloride (PVC) pressure pipe. Pipe provided shall be cast iron pipe equivalent O.D. Pipe shall be pressure Class 100.

Fittings: Cement lined, cast or ductile iron fittings conforming to AWWA C153. Ebba megalugs – 2000 series.

Joints: Pipe; elastomeric gasket, push-on joints, conforming to AWWA C905 SDR 25. Joints may be either integral bell and spigot or couplings. Fittings; AWWA CI 11, push-on.

Installation: ASTM D-2321.

### 2.2.3 PVC Pipe (4-Inch Through 12-Inch – Minimum Requirements):

Pipe: AWWA C900 SDR 25 Polyvinyl Chloride (PVC) pressure pipe. Pipe provided shall be cast iron pipe equivalent O.D. Pipe shall be pressure Class 100.

Fittings: Cement lined, cast or ductile iron fittings conforming to AWWA C153. Ebba megalugs – 2000 series.

Joints: Pipe; elastomeric gasket, push-on joints, conforming to AWWA C900 SDR 25. Joints may be either integral bell and spigot or couplings. Fittings; AWWA C111, push-on.

Installation: ASTM D-2321.

## 2.3 Protecto 401 Lining Specification:

### 2.3.1 Condition of Ductile Iron Prior to Surface Preparation

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been to the first six inches of the exterior of the spigot ends.

### 2.3.2 Lining Material

The Standard of Quality if Protecto Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be

accompanied by a successful history of lining pipe and fittings for service, a test report verifying the properties and a certification of the test results.

2.3.3 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.

2.3.4 The following test must be run on coupons from factory lined ductile iron pipe:

2.3.4.1 ASTM B-117 Salt Spray (scribed panel) – Results to equal 0.0 undercutting after two years.

2.3.4.2 ASTM G-95 Cathodic Disbondment 1.5 volts @ 77 degrees F. Results to equal no more than 0.5 mm undercutting after 30 days.

2.3.4.3 Immersion Testing rated using ASTM D-714-87.

a. 20% Sulfuric Acid – No effect after two years.

b. 140 degrees F 25% Sodium Hydroxide – No effect for two years.

c. 160 degrees F Distilled Water – No effect for two years.

d. 120 degrees F Tap Water (scribed panel) – 0.0 undercutting after two years with no effect.

2.3.4.4 An 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.

2.3.5 Application:

2.3.5.1 Applicator

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.

2.3.5.2 Surface Preparation

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.

2.3.5.3 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 Precto 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.

- 2.3.5.4 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.
- 2.3.5.5 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.
- 2.3.5.6 Touch-Up & Repair  
Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.
- 2.3.6 Inspection and Certification
- 2.3.6.1 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.
- 2.3.6.2 Certification  
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.
- 2.3.7 Handling  
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.

## 2.4 Sewage Air Release Valves:

Sewage air release valves shall be the type shown on plans and as approved by the Commission. Universal Sewer Air Release Valves shall be installed on all significant high points of the system. Sewage Air and Vacuum Valves shall be installed on prolonged uphill or downhill segments that are subject to vacuum collapse from rupture of the force main. Sewage Air Release Valves shall be installed on all other high points of the system.

2.4.1 Universal Sewer Air Release Valves shall be designed to permit automatic escape of large quantities of air from a pipeline when the line is being filled, and permit air to enter to pipeline when the line is being emptied. It will also allow accumulating air to escape while the line is in operation. This shall be accomplished through the functioning of a compound lever system in conjunction with a large and small orifice in one integral body casting. Materials shall include cast iron body and cover, bronze float stem and guide, rubber seat and stainless steel float. Valves shall be furnished with provisions for backflushing. Valve shall be designed for working pressure of 150 psi and required venting rates. Universal Sewer Air Release Valve shall be Golden Anderson Fig. 942, Crispin or approved equal.

2.4.2 Sewage Air and Vacuum Valves in Sewer Force Mains: Shall be the type specifically designed for use with sewage. Valves shall be designed to vent large quantities of air when the line is being filled and to allow air to re-enter the line when it is being drained. Overall height of valve body without accessories shall be not less than 15 inches. Materials shall include cast iron body and cover, bronze float stem and guide, rubber seat and stainless steel float. Valves shall be furnished with provisions for backflushing. Valve shall be designed for working pressure of 150 psi and required venting rates. Sewage Air and Vacuum Valve shall be Golden Anderson Fig. 935, Crispin or approved equal.

2.4.3 Sewage Air Release Valves in Sewer Force Mains: shall be the type designed for use with sewage. Valves shall be designed to operate (open) while pressurized allowing entrained air in a sewage force main to escape through the air release orifice and prevent media from escaping. Materials shall include cast include cast iron body and cover, rubber seat, stainless steel float stem and internal linkages. The valve shall be designed for working pressures of 150 psi and required venting rates. Sewer Air Release Valves shall be Golden Anderson Fig. 925, Crispin or approved equal.

2.5 Sewage Air Release Valve Vault: Valves shall be installed in a 4 feet diameter precast concrete manhole in conformance with ASTM C-478. Flat tops shall be provided unless otherwise approved. Frame and cover shall be good quality domestic manufacture conforming to ASTM A48, Class30 or better. Cover shall be a solid heavy-duty casting with the word "SEWER" cast on the lid. Cover shall be set off center to facilitate access. Heavy-duty hard rubber MH steps shall be provided in all manholes. The vault shall be installed on a gravel bed (8" min. thickness), with sufficient clearance between the valve and gravel to remove or service the valve.

- 2.6 Steel encasing Pipe: shall be smooth wall meeting or exceeding ASTM A-139, Grade B 35,000 psi min. yield strength with a minimum wall thickness as defined below:

Steel encasing Pipe Size O.D.	Wall Thickness (Inches)	For Use with Gasket-Joint DIP or PVC Carrier Pipes of the Following Diameter
8"	0.188	4"
12"	0.188	6"
16"	0.188	8"
18"	0.250	10" & 12"
24"	0.250	14" & 16"
30"	0.312	18"
36"	0.375	24"

Note: Mechanical joint pipe joints require increasing the steel casing pipe to the next recommended size. Railroad requirements may be alter casing thickness.

- 2.7 Carrier Pipe Supports Within Steel Casing: shall be steel plate, cold formed structural collar with flanges and a minimum of four support legs welded to the collar. Each support leg shall have a foot or skid welded on the end extending beyond the front and back edge of the collar. The front and rear of each foot shall be angled inwardly towards the collar to serve as a stable, effective skid during installation of the carrier pipe. The carrier support shall be securely fastened to the carrier pipe with a heavy duty 1/2" grade 5 bolt and locking nut passing between the flanges, compressing the collar against the carrier pipe. The support device shall be a Spider or approved equal.
- 2.8 End Seals:
- Provide 1/8" thick rubber end seal to seal each end of the casing.
  - Secure to casing and carrier pipe with Type 316 stainless steel bands.
  - Acceptable product: Cascade Manufacturing or approved equal.
- 2.9 Utility Line Marking Wire: where PVC or polyethylene pipe is used in sewer force main construction, a continuous #12 gauge insulated copper tracer wire with green insulation, approved by the manufacturer for direct burial, shall be installed in the trench a minimum of six inches (6") above the top of the sewer line or wrapped around the pipe. The tracer wire shall terminate at each valve and be arranged to allow the connection of equipment for tracing pipe and preventing interference for operation of the valve.

### PART III - EXECUTION

#### 3.0 INSTALLATION

##### 3.1 Gravity Sewer Installation

###### 3.1.1 Adjacent Facilities:

- 3.1.1.1 Water Lines: Sewer shall not be closer horizontally than 10 feet to a water supply main. If separation can not be maintained, it shall meet Ten state Standards Section 38.3 requirements.

### 3.1.2 Pipe Laying:

3.1.2.1 Pipe shall be protected during handling against impact shocks and free fall and the pipe interior shall be free of extraneous material.

3.1.2.2 Pipe laying shall proceed upgrade with the spigot ends of bell and spigot pipe and tongue ends of tongue and groove pipe pointing in the direction of the flow. Each pipe shall be laid accurately to the line and grade shown on the drawings. Pipe shall be laid and centered so that the sewer has a uniform invert. As the work progresses, the interior of the sewer shall be cleared of all superfluous materials.

3.1.2.3 Before making pipe joints all surfaces of the portions of the pipe to be joined shall be clean and dry. Lubricants, primers, and adhesives shall be used as recommended by the pipe manufacturer. The joints shall then be placed, fitted, joined, and adjusted so as to obtain the degree of water tightness required.

3.1.2.4 Caulked Joints: Not allowed.

3.1.3 Trenches: Trenches shall be kept free of water and as dry as possible during bedding, laying, and jointing and for as long a period as required. When work is not in progress, open ends of pipe and fittings shall be satisfactorily closed so that no trench water or other material will enter the pipe or fittings. Bedding shall be in accordance with Section 01500.

3.1.4 Backfill: 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. Plastic pipe shall be completely covered to prevent damage from ultraviolet light. Compaction of backfill shall be in accordance with Section 01500.

3.1.5 Handling and Storage: Pipe, fittings and joint material shall be handled and stored in accordance with the manufacturer's recommendations. Storage facilities for plastic pipe, fittings, joint materials and solvents shall be classified and marked in accordance with NFPA 704, with classification as indicated in NFPA 49 and NFPA 325M.

3.1.6 Leakage Tests: Lines shall be tested for leakage by low pressure air testing, infiltration tests or exfiltration tests, as appropriate. Low pressure air testing procedures for PVC pipe shall use the pressures and testing times prescribed by the pipe manufacturer. When the water table is 2 feet or more above the top of the pipe at the upper end of the pipeline section to be tested, infiltration shall be measured using a suitable weir or other device acceptable to the Engineer. When the Engineer determines that infiltration cannot be properly tested, an exfiltration test shall be made by filling the line to be tested with water so that a head of at least 2 feet is provided above both the water table and the top of the pipe at the upper end of the pipeline to be tested. The filled line shall be allowed to stand until the pipe has reached its maximum absorption, but not less than 4

hours. After absorption, the head shall be reestablished. The amount of water required to maintain this water level during a 2-hour test period shall be measured. Leakage as measured by either the infiltration test or exfiltration test shall not exceed 200 gallons per inch diameter per mile of pipeline per day. When leakage exceeds the maximum amount specified, satisfactory correction shall be made and retesting accomplished. Testing, correction, and retesting shall be made at no additional cost to the Commission.

3.1.7 Test for Deflection: When flexible pipe is used, a deflection test shall be made on the entire length of the installed pipeline on completion of all work, including the leakage test, backfill, and placement of any fill, grading, paving, concrete, or superimposed loads. Deflection shall be determined by use of a deflection device or by use of a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. The ball, cylinder, or circular sections shall have a diameter, or minor diameter as applicable, of 95 percent of the normal inside diameter of the pipe. A tolerance of plus 0.5 percent will be permitted. The ball, cylinder, or circular sections shall be of a homogeneous material throughout, shall have a density greater than 1.0 as related to water at 39.2 degrees F, and shall have a surface Brinell hardness of not less than 150. It shall be center bored and through bolted with a 1/4 inch minimum diameter steel shaft having a yield strength of 70,000 psi or more, with eyes at each end for attaching pulling cables. The eye shall be suitably backed with flange or heavy washer such that a pull exerted on the opposite end of the shaft shall produce compression throughout the remote end of the ball, cylinder or circular section. Circular sections shall be so spaced that the distance from the external faces of the front and back sections shall equal or exceed the diameter of the circular section. Failure of the ball, cylinder, or circular section to pass freely through a pipe run, either by being pulled through or by being flushed through with water, shall be cause for rejection of that run. When a deflection device is used for the test in lieu of the ball, cylinder, or circular sections described hereinbefore, such device shall be approved prior to use. The device shall be sensitive to 1.0 percent of the diameter of the pipe being measured and shall be accurate to 1.0 percent of the indicated dimension. Installed pipe showing deflections of 4.5 percent of the normal diameter of the pipe shall be retested by a run from the opposite direction. If the retest indicates a deflection in excess of the 4.5 percent, the suspect pipe shall be replaced. Any pipe showing deflections in excess of 5 percent at the end of 1 year following installation and acceptance will be replaced at no cost to the Commission.

3.1.8 The contractor must provide the Commission with two (2) copies of a VHS tape of a video of all newly installed gravity sewer mains.

## 3.2 FORCE MAIN INSTALLATION

### 3.2.1 Adjacent Facilities:



3.2.1.1 Water Lines: Force mains shall not be closer horizontally than 10 feet to a water-supply main. If separation can not be maintained, it shall meet Ten State Standard Section 38.3 requirements.

3.2.2 Pipe Laying:

3.2.2.1 Pipe and fitting shall, unless otherwise directed, be unloaded at the point of delivery, hauled to and distributed at the site of the project by the Contractor. They shall at all time be handled with care to avoid damage. In loading and unloading, they shall be lifted by hoists or slid or rolled on skidways in such a manner as to avoid shock. Under no circumstances shall they be dropped. Pipe handling on skidways must not be skidded or rolled against pipe already on the ground. In distributing the material at the site of the work, each piece shall be unloaded opposite or near the place where it is to be laid in parallel with the trench alignments and with bell ends facing the direction in which the work will proceed unless otherwise directed. The interior of all pipe, fittings and other accessories shall be kept free from dirt and foreign matter at all times. Cutting pipe for inserting fittings, or closure pieces, shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise directed, pipe shall be laid with the bell ends facing the direction of laying. Wherever necessary to deflect the pipe from straight line, whether in the vertical or horizontal plane to avoid obstructions, the degree of deflection shall be in accordance with manufacturer's instructions. No pipe shall be laid in water or when the trench condition or the weather is unsuitable for such work. Installation shall be in accordance with manufacturer's instructions. PVC pipe shall be installed in accordance with ASTM D2321. Bedding material shall conform to SCDOT size 57 gravel or crushed stone.

3.2.3 Blocking and Anchoring: All plugs, caps, tees and bends shall be provided with thrust blocks as shown on the plans. Thrust blocks shall bear directly against the undisturbed trench wall and shall be constructed using 2,500 psi concrete. Thrust blocking joints shall be kept free of concrete to allow removal of bolts or fittings should such work become necessary.

3.2.4 Joint Restraints: As per manufacturer's specifications.

3.2.5 Hydrostatic Tests: The Contractor shall provide all necessary equipment and shall perform all work required in connection with the tests. Each section shall be tested by hydrostatic pressure of 150 pounds per square inch or as directed by the Commission. Each section shall be slowly filled with water, care being taken to expel all air from the pipes. The required pressure as measured at the point of lowest elevation shall be applied for not less than two hours and all pipe, fittings, valves, hydrants and joints shall be carefully examined for defects. All defective joints shall be repaired or replaced.

3.2.6 Leakage Test: A leakage test shall be conducted after the pressure test has been satisfactorily completed or concurrently with approval of the

Commission. The duration of the leakage test shall be 2 hours and during the test the main or section of the main under test shall be subjected to a pressure of 150 psi based on the lowest point in the line or section under test, and corrected to the elevation of the test gauge. Leakage is defined as the quantity of water supplied into the newly laid pipe or any valved section thereof, necessary to maintain the specified leakage test pressure. No pipe installed will be accepted until the leakage is less than the number of gallons per hour as determined by the formula:

$$L = \frac{S \times D \times (P)^{1.2}}{133,200} \quad \text{for DIP pipe}$$

$$L = 0.000135ND (P^{0.5}), \text{ for PVC pipe, and}$$

In which 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.

END OF SECTION