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SECTION 02554 - WASTEWATER COLLECTION SYSTEM

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SECTION 02554

WASTEWATER COLLECTION SYSTEM

PART 1 - PRODUCTS

Material and equipment used in the work shall conform to one of the following:

1.01 SEWER PIPE

A. PVC Pipe for Gravity Sewer - Shall be SDR 26 polyvinyl chloride plastic and shall meet all requirements of the ASTM D-3034 for diameters 4" through 15", latest revision or ASTM F679 for diameters 18" through 48", latest revision. PVC pipe shall be installed in accordance with ASTM D-2321, latest revision. All pipes shall be suitable for use as a gravity sewer conduit and shall be green in color. Provisions must be made for contraction and expansion at each joint with a rubber ring. Standard laying lengths shall be fourteen (14) feet or twenty (20) feet, ± 1-inch, for all sizes. Fittings shall meet the same specification requirements as the pipe.

Tests on PVC Pipe - Shall be designed to pass all tests at 73^{o} F. (± 3^{o} F.)

B. PVC Pipe for Force Main

PVC Pipe - Plastic pipe shall be PVC SDR 18, C-900 for 12-inch and smaller and SDR 18, C-905 for 14-inch and larger. All pipe shall conform to ASTM D-2241 and be installed in accordance with ASTM D-2321.

Pipe shall bear the National Sanitation Foundation seal of approval and shall comply with the requirements of Type I, Grade I (PVC 1120) of the ASTM resin specification D-1784. Certificates of conformance with the foregoing specifications shall be furnished with each lot of pipe supplied.

PVC pipe for force mains shall be green in color, and shall be furnished in nominal 18 to 20 foot laying lengths unless otherwise noted.

C. Ductile Iron Pipe – Standard Coating

Buried piping and exposed piping not subject to highly corrosive environments shall conform to AWWA C-150, AWWA C-151 and ASTM A-746 latest revisions. All pipes shall be thickness Class 50 unless otherwise noted.

1. Exterior Coating

    a) All buried ductile iron pipes and fittings shall receive an exterior bituminous coating approximately 1 mil thick. The finished coating shall be continuous, smooth, neither brittle when cold or sticky when exposed to the sun, and shall be strongly adherent to the iron.

    b) All exposed ductile iron pipes and fittings shall receive an exterior coating of Tnemec Series 431 Perma-Shield polyamine ceramic epoxy, (unless otherwise specified by the Engineer or subject to conditions described in 1.01 D below). Pipe surface shall be prepared by uniform rotary-abrasive blasting using angular abrasive to an NAPF 500-03-04, 3-mil anchor profile. Fitting surface shall be prepared by uniform rotary-abrasive blasting in accordance using an angular abrasive to an NAPF 500-03-05, Blast Clean #1 condition, 3-mil anchor profile. Pipe surfaces shall receive 3-5 mils dry film thickness (DFT) of Tnemec Series 140 Pota-Pox Plus epoxy primer, 30-40 mils DFT Tnemec Series 431 Perma Shield PL polyamine ceramic epoxy. To prevent UV damage, apply 3 mils DFT Tnemec Series 72 Acrylic Urethane.

2. Interior Lining - The interior of all ductile iron pipes and fittings shall be lined with Protecto 401 ceramic epoxy, unless indicated otherwise.

    a. Protecto 401 - Protecto 401 Ceramic Epoxy interior lining shall be 40-mils dry film thickness (DFT) and conform to Permeability rating ASTM E-96-80, Salt Spray ASTM B-117-09, Cathodic Disbondment ASTM G6-95, and Immersion Testing ASTM D-714-02. Interior lining shall not be applied below 40^{o} F. Lining shall not be used on the face of the flange.

    b. Gasket / 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 DFT of Protecto 401 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.

D. Ductile Iron Pipe – Exposed High Corrosion Applications

Piping exposed to highly corrosive conditions inside sanitary pumping station wet wells and dry pits, sanitary air release valve manholes, or as directed by the Engineer, shall

conform to AWWA C-151, AWWA C-115 latest revisions. Piping shall extend through the structures, (wetwell, dry pit, ARV manholes). All pipes shall be thickness Class 53 unless otherwise noted.

1. Exterior - A Zinc/Epoxy exterior coating system comprised of zinc spray metalizing, and Tnemec Series 431 Perma Shield PL ceramic epoxy coating shall be applied to pipe exterior. Immediately after annealing, all DIP shall receive zinc spray metalizing. The resultant mean mass of zinc shall not be less than 130 g/m^2 and shall be applied throughout the entire length of the pipe. The zinc coating shall be brush off abrasive blasted to scarify the surface. The pipe shall receive a prime coat of series N140-1255 primer applied at 3-5 mils DFT, and then receive a top coat of Series 431 Perma Shield PL per Tnemec's recommendations. The top coat shall be nominal 30-40-mils thick and adequately cover all exposed areas.

2. Interior – Interior pipe surfaces shall receive a nominal 40-50 mils dry-film thick coat of Tnemec Series 431 Perma Shield PL ceramic epoxy coating covering all interior surfaces. The surface shall be prepared by abrasive blasting in accordance with NAPF 500-03-04.

3. Fittings – All exposed fittings used in high corrosion applications shall receive a nominal 30-40 mils dry-film thick coat of Tnemec Series 431 Perma Shield PL ceramic epoxy coating covering all interior and exterior surfaces, with the exception of the flange faces which shall receive a 3-5 mil nominal coat of Tnemec N140 primer. The surface shall be prepared by abrasive blasting in accordance with NAPF 500-03-05.

The finished coatings shall be holiday free when high-voltage holiday tested to 4000 volts per ASTM standards. All surface prep shall be per Tnemec's recommendation which include proper grinding and blasting to ensure a 3-mil anchor profile is achieved throughout the area to be lined. Approved applicators include Electrosteel USA.

E. Interior Lining / Exterior Coating Repair

Any linings or coatings damaged in the field shall be repaired by power tool cleaning to bare metal (SSPC-S11) and touched up using manufacturer's field repair kit to a 40-mil nominal coating. The City reserves the right to reject piping or fittings due to field or shipping damage of the protective coating system.

F. Lining / Coating Applicator Certification

Lining application, inspection, certification, handling and surface preparation of the area to receive the protective coating shall be in accordance with the manufacturer's specification and requirements. Supplier shall engage a single installer (or one installer for pipe and a second for fittings) approved by the manufacturer with a minimum of three years' experience performing this type of lining installation and with documented skill and successful experience in the installation of ceramic epoxy lining to interior of ductile iron pipe and fittings. Contractor shall provide a Letter of Certification to the Engineer or City Inspector from the lining manufacturer indicating that the lining installer meets all of the manufacturer's quality assurance and quality control requirements, (Qualified Applicator).

1.02 SEWER PIPE JOINTS

A. Gravity Sewer Pipe

1. Joints for PVC Pipe - Shall be integral wall bell and spigot with a rubber ring gasket. The joints shall conform to ASTM D-3212 latest revision and the gaskets shall conform to ASTM F-477 latest revision.

2. Joints for Ductile Iron Pipe - Shall comply with the requirements of 1.02 B.2.

B. Force Main Pipe

Joints shall be in accordance with ASTM D-3036. All PVC fitting must have NSF-61 approval and must comply with, or exceed AWWA C907. Saddle type fittings shall not be used.

1. Plastic pipe shall be joined by means of a rubber ring bell joint which shall be an integral part of the barrel or solvent welded at the factory. The joints shall have a space to provide expansion and contraction of the pipe without leaking. Fittings for plastic pipes shall be PVC with ring tightened rubber joints; or ductile iron with adapters to PVC pipe. Pipe shall be manufactured to ductile iron pipe equivalent outside diameter.

   The bell shall consist of an integral wall section with a bonded-in solid cross section elastomeric ring which meets the requirements of ASTM F-477 and ASTM D-3139. The bell section shall be designed to be at least as hydrostatically strong as the pipe wall and meet the requirements of C900-07 or C905-10.

Each standard and random length of pipe shall be tested to two times the rated pressure of the pipe for a minimum of five (5) seconds. The integral bell shall be tested with the pipe.

2. Ductile Iron Joints – For various applications shall meet the below criteria:

   a. Flanged Joints: Shall conform to ANSI Specification 21.2(AWWAC–150). Flanges shall be Class 125. Gaskets for flanged pipe and fittings shall be 1/16-inch ring gasket of red sheet rubber. Bolts and bolt studs shall conform to ANSI Specification B 16.1 (AWWA C-153).

   b. Mechanical Joints: In cast and ductile iron pipe shall conform to ANSI Specification A 21.11 (AWWAC-111). All glands shall be made of ductile iron only.

   c. Push-On Joints: Shall have a rubber gasket that fits into a retainer recess in the bell and produces a watertight joint when the spigot is pushed home.

   d. Restrained Joints - Restrained joints for pipe, valves and fittings shall be mechanical joints with ductile iron retainer glands equivalent to "Mega-Lug" or push-on type joints equivalent to "Lock-Ring," "TR Flex", or "Super Lock" and shall have a minimum rated working pressure of 250 psi. Mechanical joint retainer glands shall comply with the manufacturer's specifications for the pipe material (ductile iron vs. PVC). The joints shall be in accordance with the applicable portions of ANSI/AWWA C111/A21.11. The manufacturer of the joints shall furnish certification, witnessed by an independent laboratory, that the joints furnished have been tested at a pressure of 500 psi without signs of leakage or failure. All wedge assemblies and related parts of restraint devices shall be processed through an iron-phosphate spray, rinse and drying operation in preparation for coating application. The coating shall consist of a minimum of two coats of liquid Xylan® fluoropolymer coating with heat cure to follow each coat. All casting bodies of restrained joints shall be surface pre-treated with an iron-phosphate spray, rinse and sealer before drying. The coating shall be electrostatically applied and heat cured. The coating shall be a polyester based powder to provide corrosion, impact and UV resistance. The coating system shall be Mega-Bond™ by EBAA Iron, or Star-Bond by Star Products. Restrained joints shall be capable of being deflected after assembly. Restrained joints shall have a preset deflection of no more than 5° and shall be able to take up 3° of deflection after burial.

e. Couplings - All connections of new sewer pipe to existing sewer pipe shall use rigid couplings. Flexible (e.g. Fernco) couplings shall not be allowed. Couplings shall be PVC double bell type, ductile iron mechanical joint solid sleeve type or ductile iron straight and transition type (e.g., Dresser Couplings) depending on the application.

C. Ductile Iron Fittings

Fittings shall consist of bends, tees, crosses, caps and plugs, reducers, tapped tees, sleeves, etc. All fittings furnished shall be cast and machined at one foundry location to assure quality control and provide satisfactory test data. Fittings shall have cast on them the pressure rating, nominal diameter of openings, manufacturer's name, foundry location, plant code, and degrees of fraction of the circle. Cast letters and figures shall be on the outside body of the fitting. Ductile iron welded on outlets is not acceptable.

1. Fittings for Push-On and Mechanical Joint Pipe shall be ductile iron, manufactured in accordance with ANSI A21.10 (AWWA C-110) or ANSI A21.53 (AWWA C-153) standards. Fittings shall be designed to accommodate the type of pipe used.

2. Fittings for Flanged Pipe: Shall be manufactured in accordance with ASNI B16.1, Class 125 flanges. Bolt circles and bolt holes shall also meet ANSI B16.1.

1.03 AIR RELEASE VALVES

A. General

Air Release Valves (ARV's) shall be provided as required by the Engineer, who shall specify ARV type (or function), size, and location. The combination air and vacuum release valves (CAV's) specified below are suitable for most forcemain applications.

The specification of these CAV's below does not relieve the Engineer of the responsibility to select (and locate) ARV's for proper forcemain operation and long-term durability. ARV selection shall be in accordance with AWWA Manual of Water Supply Practices M51 - Air-Release, Air/Vacuum & Combination Air Valves, the manufacturer's published information, and the Engineer's experience.

The manhole and installation of the two-inch valve shall be in accordance with the City of Savannah Standard Construction Detail S-11. Prior to deciding on the location of any air release valve, the Contractor shall provide the Engineer with an accurate profile of the installed force main so that high points in the system can be determined. The

locations of the air release valves shall be field adjusted based on the locations of the high points.

B. Combination Air Release / Air Vacuum Valves (CAV)

CAV shall be equipped with dual orifices. The small orifice (air release) shall allow entrapped air to be released under pressure. The large orifice (air/vacuum) shall discharge large amounts of air during filling of the line as well as admitting large amounts of air into the system during drainage or in response to water column separation.

CAV shall be comprised of 100% non-corrosive materials. Epoxy-coated materials will not be allowed. The valve upper body, base, and threaded or flanged inlet shall be made from 316 Stainless Steel.

CAV shall be of dual-float design in order to maintain an air gap which keeps liquids, grease and debris away from the sealing part of the valve.

CAV sealing mechanisms shall be either by EPDM rolling seal or Buna NBR roll-on diaphragm. All wastewater CAVs shall come with a full 5-year manufacturer's warranty to repair or replace valve if damage is due to manufacturer defect.

CAV shall have an operating pressure range from 1 to 250 psi.

1. Two (2) inch CAV shall be 2" NTP standard. Acceptable manufacturers and models include ARI, USA Model D-025-LTSS-02, H-TEC Model 986-T-02-SS, or pre-approved equal.

2. Four (4) inch CAV shall be class 125 flanged. Acceptable manufacturers and models include ARI, USA Model D-020-SS-04, H-TEC Model 986-F-04-SS, or pre-approved equal.

Valves shall be equipped with the necessary attachments, including 1" 316 SS ball valve and 1.5" camlock fitting to permit back flushing after installation without dismantling the valve.

1.04 MANHOLES

A. Precast Concrete – The minimum wall thickness for precast manholes shall be five (5) inches for 4-foot ID manholes and seven (7) inches for 6-foot ID manholes. Cone

sections shall have a minimum wall thickness of eight (8) inches at their top. Manholes shall be manufactured with 4,000 psi concrete, type II cement that meet ASTM C-150 and absorption shall not exceed 6%. Wall reinforcement shall meet ASTM C-478 and also have a No. 4 rebar hoop around each pipe opening. The flat top slab sections shall handle HS-20 traffic loadings. Bottom slabs shall be six (6) inches thick and be reinforced with No. 4 rebar at nine (9) inch O.C.E.W. All items shall be wet cast. Dry casting or low slump concrete will not be allowed. All bases will have proper lifting hooks in the bottom slabs (min. of 3) and there shall be no penetrating lifting holes on any structures. No holes will be allowed within six (6) inches of any joint on structures. All manholes shall be coated as per Section 02555.

Manhole sections shall be free from large honeycomb, cracks, spalls, large chips, exposed reinforcing, and broken bells and spigots. Edges of bells and spigots shall be even and straight.

It shall be the responsibility of the Contractor to insure that the manhole(s) are designed properly for the loading conditions as indicated on the plans. Should the loading conditions require greater structural integrity than the minimum, as herein specified, it shall be the responsibility of the Contractor to utilize a structural design of greater strength.

Joints – A liquid butyl primer shall be applied by the precast manufacturer to all interior and exterior surfaces per City of Savannah Section 02555 - "Protective Coating for Existing and New Concrete and Masonry Sanitary Sewer Structures." Flexible plastic gasket shall be placed on each of the three joint faces. Gasket shall be RAM-NEK or approved equal. The exterior of all joints shall be wrapped with a butyl rubber wrap ConSeal CS-212, or approved equal. Wrap shall have a minimum thickness of 65 mils and minimum width of 8". All joint sealant materials shall be applied to clean, dry surfaces and as recommended by the manufacturer. All joint sealant materials shall attach firmly to the concrete surfaces without the use of additional adhesives, tape, or other fastening devices.

Precast concrete manholes shall be manufactured at plants certified by the National Precast Concrete Association. All Manholes shall be pre-cast concrete, unless authorized by the sanitary sewer Conveyance Department.

B. Ring and Cover - Manhole ring and cover shall be gray cast iron per ASTM A48, Class 35B without perforations and suitable for addition of cast iron or steel rings for upward adjustment of top. The words "CITY OF SAVANNAH SANITARY GEORGIA" shall be cast

into the face of the cover in 1.5-inch to 2-inch letters raised flush with the top of the cover. Ring and cover shall have machine ground seats and be an approved equal to model V1327-1 RG V1327GS EPIC SAVANNAH SN as manufactured by E.J. All manhole rings and covers shall be made water resistant by means of dovetail grooves and gaskets in the cover. Provide circular cover weighing not less than 138 pounds with two (2) pick slots for removing cover spaced at 180°. No stacking lugs shall be allowed.

Proof Load Testing: Traffic service castings shall have a first article proof load test conducted and the results of that proof load test shall be made available to the City upon request. The proof load test shall be conducted in accordance with the methods and procedures outlined in AASHTO M306-10, Section 6, Proof Load Testing. The casting shall be tested on a suitable and calibrated load testing machine and the casting shall hold a 40,000 pound proof load for one minute without experiencing any cracks or detrimental permanent deformation.

Grade Adjustment – Expanded polypropylene grade adjustment rings shall be used to bring manhole ring and cover to within 1/4" to 1/2" of flat or sloping finished grade. Grade adjustment rings shall be capable of supporting AASHTO H-25 and HS-25 loads, shall be UV stable, resistant to chemicals and corrosion commonly associated with sanitary sewer environments, and shall have a minimum fifty (50) year design life. Rings shall have a tongue and groove design for vertical stacking up to 12". Rings shall be joined to manhole cone, other rings, and manhole frame and cover with a watertight adhesive sealant. Grade adjustment rings shall be Cretex Pro-Ring, or approved equal. Watertight adhesive sealant shall be M1 Structural Adhesive/Sealant, or approved equal.

In non-traffic areas, traditional brick and mortar grade adjustment is allowed. In these instances, an external manhole chimney seal shall be required. External chimney seal shall be the model X-85 as manufactured by Cretex, or approved equal. Top of manhole cone shall have a minimum vertical sealing surface of 3" that is smooth and free of any form offsets or excessive honeycomb.

C. Pipe Connections - Pipe/manhole connector shall be one piece rubber boot secured to pipe with stainless steel clamp band and to the manhole with stainless steel expansion ring. Acceptable pipe connector would be Kor-N-Seal Boot, A-lock or equal. Space between pipe connector and pipe OD shall be filled with non-shrink grout.

D. Manhole Steps – Manhole steps shall be provided at 16-inches O.C. for manholes greater than four (4) feet deep. Steps shall have impact resistant co-polymer

polypropylene plastic molded around ½" diameter, grade 60 reinforcing steel. Manhole steps shall be M.A. Industries PS1-PF reinforced plastic step complying with the requirements of ASTM C 478, or approved equal.

1.05 CASING AND CASING SPACERS

A. Casing pipe shall be steel conforming to ASTM A-139 latest revision, minimum yield strength point of 35,000 psi, and of the diameter and thickness shown on the contract drawings at each crossing. The pipe ends shall be tapered where welding is required. Full pipe lengths shall be provided. No pipe casing lengths less than eight (8) feet shall be allowed unless approved by the Owner. All casing welds shall be continuous and made by a certified welder.

For casing pipe crossings under roadways/railroads, the Contractor shall comply with the regulations of said authority in regard to design, specifications, and construction. State highway casing installations shall be as specified in the GDOT, "Utility Accommodation Manual," and for railroads, the American Railway Engineering and Maintenance-of-Way Association (AREMA) manual for Railway Engineering, Chapter 1, Part 5, Section 5.3, "Specifications for Pipelines Conveying Non-Flammable Substances," shall be applicable.

Where allowed by the affected utility owner(s), fusible PVC casing may be used with fusible PVC carrier pipe for sanitary force mains. The design engineer shall calculate the appropriate piping dimension ratio (DR) for fusible PVC casing considering earth, live, and groundwater, service loads and pullback forces.

Use of PVC casing shall require the use of rubber boots for end seals. End seals shall be neoprene with 304 SS banding clamps as manufactured by Cascade CCES, or approved equal. End seals shall be installed per manufacturer's recommendations, to include casing spacer spacing to provide adequate reinforcement at end of casing pipe.

All carrier pipes shall be restrained joint ductile iron or fusible PVC.

B. Casing Spacers shall be bolt on style with a shell made in two (2) sections of Heavy T-304 Stainless Steel. Connecting flanges shall be ribbed for extra strength. The shell shall be lined with a PVC liner. All nuts and bolts shall be 18-8 Stainless Steel. Runners shall be made of Ultra High Molecular Weight Polymer with inherently high abrasion resistance and a low coefficient of friction. Runners shall be supported by risers made of Heavy T-304 Stainless Steel. The combined height of the supports and runners shall keep the

carrier pipe a minimum of 3/4-inch from the casing pipe at all times. Installation and spacing of casing spacers shall be as required by the manufacturer. Casing Spacers shall be as manufactured by Cascade Waterworks Manufacturing Company, or approved equal.

Casing spacers for fusible PVC carrier pipe should be of a projection type that has a minimum number of projections around the circumference that total the number of diameter inches. For example: 8" pipe should have a minimum of 8 projections and 18" pipe should have a minimum of 18 projections. Spacing between spacer rings (span) should be calculated based on the actual installed load (weight of pipe filled with liquid) but should not exceed 10 feet. Refer to the manufacturer's tables for the load carrying capacity of each type of spacer used. Casing spacers should be projection type – non metallic spacers constructed of preformed sections of high-density polyethylene. Spacers should be ISO 9001:2000 certified for strength and quality. Casing spacers should be installed using double backed tape provided with the spacers in order to fasten them tightly to the carrier pipe. Casing spacers for fusible PVC carrier pipe shall be as manufactured by Raci North America, or approved equal.

1.06 SANITARY SERVICE LATERAL CONNECTIONS

A. Tee-wyes shall be a minimum of four (4) inches and shall be the same diameter as the run of the pipe. They shall be of the same material as the sewer main. Tee-wyes shall be used for all service connections to new sewer main.

B. Service Saddles: Service Saddles shall be flexible sewer saddles with double stainless steel straps or PVC Inserta Tees™. Service Saddles shall only be allowed for new service connections to existing sewer mains.

1.07 SANITARY SERVICE LATERALS

A. Laterals shall be either ductile iron with push-on joints, conforming to Paragraphs 1.01.C and 1.02.B.2, or SDR 26 Polyvinyl Chloride with bells and natural rubber rings for jointing, conforming to Paragraphs 1.01.A and 1.02.A.1.

B. A saw cut "S" shall be cut in the top of the curb directly over the lateral location. Tracer wire shall be adhered to the lateral from the main and up to the cleanout.

1.08 METAL DETECTOR TAPE

Detector tape shall be installed over all nonmetallic gravity sewers. The tape will be

equivalent to Terra-Tape by Griffolyn Co., Inc. of Houston, Texas. The tape shall be at least two (2) inches wide, green in color, and be labeled "Caution Buried Force Main Below" or “Caution Buried Sewer Line Below” on the tape in black letters. The tape shall have a tensile strength of not less than 4,000 psi, dart impact strength of not less than 120 grams per 1.5 mils, be not less than 0.0055 inches thick, and include sufficient metal to allow easy detection from above ground. The detector tape shall be designed to last as long as the pipe it is installed over, even in adverse soils.

1.09 TRACER WIRE AND CONNECTORS

A. Tracer Wire

Tracer wire shall be installed on all force mains, with direct burial connectors, and provide continuous electrified conductivity. Area markers shall be at least every 500 feet with tracer wire attached, unless a manhole is available. A six (6) foot lead attached to the inside of the ring and cover shall be provided at manholes. On laterals, the tracer wire shall connect the clean-out to the gravity sewer.

1. Tracer wire shall be copper clad steel with high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. Conductor must meet 21% conductivity for locate ability purposes. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities.

2. Tracer wire for direct burial shall be a #12 AWG HS-CCS high-strength copper clad steel conductor (HS-CCS), insulated with a 30 mil, HDPE insulation. Minimum break load shall be 380 lbs. Wire must be installed in the 3 o’clock position during installation. Tracer wire shall be Boar Tough High Strength CCS PE30 UL by Agave Wire Ltd or Copperhead HS-CCS HDPE 30 MIL or Pre-Approved Equal.

3. Tracer wire for directional drilling/boring shall be #12 AWG extra-high-strength copper clad steel conductor (EHS-CCS), insulated with a 45 mil, HDPE insulation. Minimum break load shall be 1,150 lbs. Tracer wire shall be Boar Tough Extra High Strength by Agave Wire Ltd, Copperhead EHS-CCS HDPE 45 MIL or Pre-Approved Equal.

B. Connectors

1. Wire connectors shall be UL 486D listed, one-piece direct bury twist-on type, UL

designation MDB, sealed wire connectors. Max voltage shall be 600 Volts. Connectors shall be rated to 105° C and sized to accommodate a minimum of four (4) #12 copper / steel core tracer wires. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Connector shall be DryConn King 6 Blue by King Innovation, or pre-approved equal.

2. Spliced connectors shall be direct bury design, with a maximum voltage of 50-volts. Spliced connectors shall have a tin plated high conductivity aluminum lug, zinc-plated steel screws, high-impact polypropylene housing, and a non-hardening viscous dielectric silicone sealant. Silicone sealant shall be rated for temperatures from -45° F to 400° F. Spliced connector shall be DryConn Direct Bury Lug Aqua, or pre-approved equal.

C. Area Markers – Utility marker posts equal to Rhino TriView Plus Test Station shall be installed every 500-foot along force main mains. Posts shall be marked as "Sanitary Sewer Force Main".

1.10 FORCE MAIN SUBSURFACE MARKERS

Omni-balls or equal shall be installed above force main pipe at all bends, and at least every 500-foot along straight pipe runs. Depth of burial shall be a minimum of 2' below finished grade and no greater than 3' below finished grade.

1.11 CONCRETE VALVE MARKER POSTS

Concrete valve marker posts shall be furnished and installed as indicated on the construction plans, typically in undeveloped areas or areas not routinely cleared. Place markers as directed by Engineer and set a minimum of 18-inches above finished grade.

The marker post shall be at least 42" long, have a minimum 4"x 4" square cross section, beveled edges, and at least one 3/8" diameter bar of reinforcing steel. The exposed section of the marker shall have 3" tall letters spelling "SAV" (sanitary air valve) or "STV" (sanitary tapping valve) cast into two (opposite) sides of the marker. Marker shall be painted with two coats of green paint, with care taken to not paint the inset letters.

1.12 POLYETHYLENE ENCASEMENT

Polyethylene encasement shall be used on all ductile iron piping, and shall be in tube form conforming to the requirements of ANSI/AWWA C105/A21.5 latest revision. The polyethylene film shall have the following characteristics:

Tensile Strength:	1,200 psi minimum
Elongation:	300 percent minimum
Dielectric Strength:	300V/mil thickness minimum
Thickness:	Nominal thickness of .008 inch (8 mil)

1.13 BEDDING AND BACKFILL

A. Classification of Materials – ASTM D-2321 classifies soils using the Unified Soils Classification System (ASTM D-2487). For the purpose of this specification, soils to be used as backfill material are grouped into five classes according to soil properties and characteristics.

1. Class I - Angular, 1/4 to 1-1/2 inch graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.

2. Class II - Coarse sands and gravels with maximum practical size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry. Soil Types GW, GP, SW, and SP are included in this class.

3. Class III - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Soil Types GM, GC, SM, and SC are included in this class. These materials are not to be used for bedding or haunching.

4. Class IV - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH, and CL are included in this class. These materials are not to be used for bedding, haunching, or initial backfill.

5. Class V - This class includes the organic soil, OL, OH, PT as well as soils containing frozen earth, debris, rocks, larger than 1-1/2 inch in diameter, and other foreign materials. These materials are not to be used.

B. Stone Bedding - Stone used for foundation, bedding, and haunching shall be shall be crushed stone or gravel conforming to ASTM C33, size #57, with size range of ¼ to 1-inch, free from debris, roots, trash, stones, or other harmful substances.

C. Backfill – Whether imported borrow material or from on-site excavations, backfill shall be suitable Class II or Class III material. Backfill material shall be free from debris, roots, trash, stones, or other harmful substances. Suitable soils are those complying with

ASTM-2487 soil classification groups GW, GP, GM, SW, SP, and SM.

1. Common Backfill

   Common backfill shall consist of mineral soil, substantially free of clay, organic material, loam, wood, trash, and other objectionable material which may be compressible or which cannot be compacted properly. Common backfill shall not contain stones larger than 6 inches in any dimension, asphalt, broken concrete, masonry, rubble, or other similar materials.

   The backfill shall have physical properties such that it can be readily spread and compacted during filling. Additionally, common backfill shall be no more than 12 percent by weight finer than the No. 200 mesh sieve unless finer material is approved for use in a specific location by the City.

   Material falling within the above specifications, encountered during the excavation, may be stored in segregated stockpiles for reuse. All material which, in the opinion of the Engineer, is not suitable for reuse on the site shall be removed and disposed of by the Contractor.

2. Select Backfill

   Select backfill fill shall be as specified above for common backfill, except that the material shall contain no stones larger than 1-1/2 inches in largest dimension, and shall be no more than 5 percent by weight finer than the No. 200 mesh sieve.

3. Borrow Material

   Where it is determined that sufficient suitable material is not available from the site to satisfactorily backfill the pipe to at least two (2) feet above the top of the pipe, suitable borrow material meeting the requirements of this specification, unless otherwise noted, shall be provided by the Contractor from other sources at Contractor's expense. All material from the excavation unsuitable for bedding, backfill, or other uses as directed by the Engineer and approved by the Owner, shall be removed and disposed of by the Contractor.

1.14 PRODUCT REVIEW

The Contractor shall provide the Engineer with a complete description of all products before ordering. The Engineer shall review and approve all products before they are

ordered.

PART 2 – EXECUTION

2.01 USE OF STANDARD CONSTRUCTION TECHNIQUES

A. Responsibility for Proper Construction - The standard construction techniques presented herein for bedding, backfill, and compaction are suitable in areas of favorable soils. However, the ENGINEER SHALL REMAIN RESPONSIBLE FOR CONDUCTING ON-SITE SOILS INVESTIGATIONS appropriate for the nature of the project at hand. The ENGINEER SHALL REMAIN FURTHER RESPONSIBLE for providing the procedures and details necessary for proper gravity sewer or forcemain installation throughout the entire project corridor.

B. Minimum Site Soils Investigation Requirements - All projects requiring the installation of any water or sanitary pipe other than service laterals shall require a minimum of one (1) soil boring every 300 linear feet along the proposed utility corridor. Borings shall be to a depth of two (2) feet deeper than the deepest proposed line within 150 feet. A Geotechnical Report, identifying the type(s) of soils found on the project site shall be provided with the construction plan submittal. The report shall include, at a minimum, boring logs, (types of soils encountered, e.g. - type GW, GP, SW, SP, etc., depths of soil types, observed groundwater, seasonal high groundwater, etc.), and any special requirements for pipe bedding, backfill, or compaction. The location of the boring(s) shall be clearly shown on the construction plans.

C. Use of Standard Procedures and Details - If site-specific procedures or details for bedding, backfill, compaction, and joint restraint are not provided in the contract documents and the Engineer includes only the standard City of Savannah specifications and details for pipe bedding and joint restraints, the ENGINEER IS ATTESTING THAT SOIL CONDITIONS ARE FAVORABLE, and that the STANDARD METHODS ARE ACCEPTABLE based on the soil conditions observed and the Engineer's experience.

2.02 CONSTRUCTION OBSERVATION

The line, grade, deflection and infiltration of sewers shall be tested by the Contractor under the direction of the Engineer. The Engineer will have the right to require that any portion of the work be done in his presence and if the work is covered up after such instruction, it shall be exposed by the Contractor for observation. However, if the Contractor notifies the Engineer that such work is scheduled and the Engineer fails to

appear within 48 hours, the Contractor may proceed without him. All work done and materials furnished shall be subject to review by the Engineer or Project Representative. Improper work shall be reconstructed. All materials which do not conform to the requirements of the specifications shall be removed from the work upon notice being received from the Engineer for the rejection of such materials. The Engineer shall have the right to mark rejected materials so as to distinguish them as such. The Contractor shall give the Project Engineer or Project Representative a minimum of 48 hours notice for all required observations or tests.

2.03 LOCATION AND GRADE

The line and grade of the sewers and the position of all manholes and other structures are shown on the drawings. The grade line as given on the profile or mentioned in these specifications means the invert or bottom of the inside of the pipe. The price for trenching shall include the trench for the depth below this line necessary to lay the sewer to this grade, but measurements for payment will be made only to the grade line. Master control lines and bench marks have been provided by the Engineer. The Contractor shall be responsible for the proper locations and grade of the sewers.

2.04 EXCAVATION

The Contractor shall perform all excavations of every description and of whatever substance encountered to the depth shown on the plans or specified for all sewers, manholes and other appurtenances. All trenches shall be properly dewatered before laying pipe, by the use of well points, pumping or other methods accepted by the Engineer.

The top portion of trenches may be excavated with sloping or vertical sides, except that the width of trench to a height of two (2) feet above the top of the pipe (embedment zone) shall not exceed two (2) feet greater than the diameter of the pipe.

Stone bedding beneath the pipe shall be required for all sewers and forcemains. Graded #57 stone shall be placed a minimum of six (6) inches deep and two (2) feet wider than the pipe at the barrel. Stone bedding shall be “compacted” using mechanical equipment to orient the stone and adjust trench bottom to grade. Compaction will be visually determined based on non-movement of material under compaction equipment.

Where the character of the soil is such that the Engineer determines it unsuitable to support the pipe bedding layer, an additional foot of excavation will be authorized and

the trench backfilled with an additional foot of stone to create a foundation for the pipe bedding material. If the trench bottom remains unsuitable, the Contractor shall provide additional foundation material or install a non-woven filter fabric, (Mirafi 140N or equivalent), beneath the stone layer, as directed by the Engineer. Excavation in excess of the depths and widths required for sewers, manholes and other structures shall be corrected by backfilling with stone to the proper grade.

The limit of excavation shall be such to allow for placing and removing forms, installing sheeting, shoring, bracing, etc. The Contractor shall pile excavated material in a manner that will not endanger the work and will avoid obstructing sidewalks, driveways, power poles, etc. Excavated areas shall be kept free of water during construction and proper site drainage shall be maintained.

See City of Savannah Standard Construction Detail S-16 for additional information on trench excavation and bedding.

2.05 BRACING AND SHEETING

The sides of all trenches shall be securely held by trench boxes, stay bracing, or by skeleton or solid sheeting and bracing, as required by the soil conditions encountered, to protect the adjoining property and for safety in accordance with OSHA requirements. Where shown on the drawings or where directed by the Engineer, the Contractor must install solid sheeting to protect adjacent property and utilities. The sheeting shall be steel or timber and the Contractor shall submit design data, including the section modules of the members and the arrangement for bracing at various depths, to the Engineer for review before installing the sheeting. Sheeting shall be removed in units when the backfilling has reached the elevation necessary to protect the pipe, adjoining property and utilities.

When sheeting or shoring above the elevation cannot be safely removed, it shall be left in place. Timber left in place shall be cut off at least two (2) feet below the surface.

2.06 LAYING PIPE

A. Gravity Sewer Installation:

Depth of Pipe – The Contractor shall perform excavation of whatever substances are encountered to obtain the invert elevations provided on the construction plans. Maximum depth shall be 20-feet. A four (4) foot minimum cover over the top of the

pipe is required. If the cover will be less than the minimum, ductile iron pipe shall be used.

Placement - All gravity sewer pipes shall be laid upgrade with spigots pointing downgrade. The pipe shall be laid in a trench prepared in accordance with Paragraph 2.04 "Excavation," so that after the sewer is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. Holes shall be provided to relieve bells from bedding strain, but not so large as to allow separation of the bell from the barrel by settlement after backfilling. All pipes shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The installer shall adhere to the recommendations of the manufacturer of the particular pipe joint used.

Grade - The sewer lines shall be straight and show a uniform grade between manholes. Any sags or bellies in the pipe sections shall not extend longer than ten (10) feet or hold water more than one-eighth of the pipe's inside diameter.

B. Forcemain Installation

Depth of Pipe – The Contractor shall perform excavation of whatever substances are encountered to obtain the invert elevations provided on the construction plans. Pipe 12-inches in diameter and smaller shall have 36-inches of cover from the proposed finished grade. Pipe larger than 12-inches in diameter shall have 48-inches of cover from the finished grade. If the depth of cover will be less than the minimum, ductile pipe shall be used. A maximum cover of 60-inches from finished grade shall be used unless approved by the City to avoid a conflict.

Placement - Forcemain shall be laid in a trench prepared in accordance with Paragraph 2.04 "Excavation", so that after the forcemain is complete, the interior surface shall conform on the bottom accurately to the grades and alignment fixed or given by the Engineer. Holes shall be provided to relieve bells from bedding strain, but not so large as to allow separation of the bell from the barrel by settlement after backfilling. All pipe shall be cleaned out and left clean. Every third joint shall be filled around immediately after being properly placed. The installer shall adhere to the recommendations of the manufacturer of the particular pipe joint used.

C. Field-Cut Ends

Whenever a pipe is cut to length in the field, the interior coating system (Protecto 401

ceramic epoxy) shall be repaired using the manufacturer's approved touch-up kits. Field repairs shall be made in accordance with the manufacturer's recommendations for surface preparation and compound application.

2.07 METAL DETECTOR TAPE

As a part of the installation of gravity or force main sewer, the Contractor shall place metallic detector tape, suitably coded, over the installed pipes at a depth not to exceed eighteen (18) inches below the finished surface.

2.08 TRACER WIRE

All force mains and sanitary sewer laterals below grade shall have tracer wire installed directly on the pipe in the 3 o'clock position. The wire shall be secured to the pipe with tape or other accepted methods at a spacing of no more than 36-inches apart. Where appurtenances connect to the force main, the specified spliced connector shall be used. The insulated wire must maintain electrical conductivity. In addition, tracer wire shall locate laterals by connecting cleanouts to gravity sewers. This tracer wire system shall be checked and tested by the Contractor, in the presence of the Engineer or project representative, prior to acceptance of the installation. All equipment, meters, detectors, etc. needed for testing shall be furnished by the Contractor.

2.09 SEPARATION BETWEEN WATER & SEWERS

Water mains and/or laterals shall not be laid below or closer than ten (10) feet horizontally to a sanitary or storm sewer without written instruction from the Engineer. Some deviation for unusual conditions may be allowed on a case by case basis if approved by the City for installation of the water main closer to a sewer, provided that the water main is laid in a separate trench, such that the bottom of the water main is at least eighteen (18) inches above the top of the sewer. In no case, shall the water and sewer lines be closer than five (5) feet horizontally edge to edge. Water mains crossing sewers should be laid to provide a minimum vertical distance of eighteen (18) inches between the invert of the water main and the top of the sewer line. For unusual crossing conditions where the water line is below the sewer, one full length of ductile iron water pipe shall be located so both joints will be as far from the sewer as possible and the . Refer to City of Savannah Standard Detail WS-1.

2.10 CONNECTIONS TO EXISTING SEWER MAINS

A. General

Lateral connections to existing sewer mains shall be either four (4) or six (6) inches in diameter. All laterals shall be attached to the main at either the 2:00 or 10:00 position; no laterals shall be attached to the main at the 12:00 position. Connections to existing sewer mains shall only be performed using a gasketed saddle or an Inserta Tee. The existing main shall be cut with a round cutter so that the saddle hub or tee boot and hub fits inside the opening; square holes cut with a pipe saw are not acceptable. The main must be protected from debris entering the pipe during the connection procedure. The area around the main shall be compacted to 100% standard proctor density. All connections to existing mains must be inspected by the City prior to backfilling.

B. Saddle Connections

Gasketed saddle shall match the existing sewer main pipe diameter. Stainless steel straps must be used to attach the saddle to the existing sewer main.

C. Inserta Tee Connections

Inserta Tee shall be designed for use with the existing sewer main pipe material and thickness. The Inserta Tee is installed by inserting the rubber boot inside the main. A properly lubricated PVC insert is then inserted inside the boot, and a stainless steel strap ties the boot to the insert. The insert then accepts PVC pipe of the appropriate size.

D. Depth of Pipe

Sanitary service laterals shall have a minimum depth of cover of three (3) feet under paved or other traffic areas or two (2) feet under non-traffic areas. If the minimum cover is not available, a ductile iron service lateral shall be required. Sanitary laterals shall have a minimum slope of 1% towards the collection system.

2.11 BACKFILLING

See City of Savannah Standard Construction Detail S-16 for additional backfilling information.

A. All trenches and excavation shall be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. Backfill shall be spread in

successive layers of loose material. Each layer shall be spread uniformly and tamped until thoroughly compacted.

B. Haunching - Haunching for gravity sewer and forcemain pipe shall be #57 stone and installed from invert to springline by hand placement to ensure material is worked under the haunch of the pipe and so as to provide full bearing around the bottom of the pipe. Haunching shall be carried up evenly on both sides to prevent injurious side pressure.

C. Initial Backfill – Initial backfill is placed from the springline of the pipe to two (2) feet above the pipe. It is the final layer of backfill in the embedment zone. Initial backfill for gravity sewer lines shall be performed using Class II or better select backfill and for forcemains initial backfill shall be performed using Class III or better select backfill. Backfilling of the trench shall be carried on simultaneously on both sides of the pipe in such a manner that injurious side pressure does not occur. Trench backfill in the embedment zone shall be compacted in six (6) inch lifts.

D. Final Backfill – Final backfill is placed from above the embedment zone (two-feet above top of pipe) to final grade. Final backfill shall be performed using Class III or better common backfill material. Backfill may be selected from excavated material anywhere on the project site if the material is suitable. Backfill may be by hand or mechanical placement. Trench backfill above the embedment zone shall be compacted in twelve (12) inch lifts.

E. Compaction - Under traffic areas the top 12-inches of backfill material shall be compacted to a density of not less than 100% at optimum moisture. Below the 12-inch line and to and including the area around the pipe the density shall not be less than 95% at optimum moisture. In non-traffic areas, the backfill material shall be compacted to 95% density at optimum moisture. Compaction tests shall be conducted in accordance with ASTM D-1556 or D-2922 by an independent testing laboratory. The tests are to be taken at the direction of the Engineer at a frequency averaging not more than 100-foot intervals. Laboratory Tests shall conform to ASTM D-698.

F. Whenever the trenches have not been properly filled, or if settlement occurs, they shall be refilled, smoothed off and finally made to conform to the surface elevation of the ground. Backfilling shall be carefully performed and the original surface restored to the full satisfaction of the Engineer immediately after the installation. The finished surface shall be free of depressions and shall not allow ponding of runoff above utility lines.

G. Where thermoplastic (PVC) pipe is installed, the Contractor shall take precautions in accordance with ASTM D-2321, during the backfill operations so as not to create excessive side pressures, or vertical or horizontal deflection of the pipe so as not to impair flow capacity.

2.12 JACKING AND BORING

Steel casing of the diameter shown on the plans shall be jacked and bored in the locations indicated. Joints between sections of the steel casing shall be welded by a certified welder. Boring and jacking shall be in accordance with the provisions of Section 65 of the Georgia Department of Transportation Standard Specifications. After the carrier pipe has been installed, the ends of the casing shall be sealed with Class "C" concrete after observation by the Engineer.

Where the work involves a State highway, the Resident Engineer of the State Department of Transportation shall be notified by the Contractor three (3) working days before the crossing is started. Where the work involves a railroad, the work shall conform to the requirements of American Railway Engineering Association specifications and the Division Superintendent of the Railroad shall be notified three (3) working days prior to beginning the work. Before commencing work within the rights-of-way of the railroads or highways, the Contractor shall verify that the Owner has obtained the required permits.

2.13 MANHOLES

A. Manholes shall be constructed on compacted bedding material so structure is plumb and pipe inverts are at the proper elevation where shown on the drawings or where directed by the Engineer. Manholes shall be installed at the end of each line, at all changes in grade, size, or alignment, at all intersections, and at distances not greater than 400-feet. The channel in the bottom of the manholes shall be smooth and properly rounded and the invert channel shall be same size as installed sewer line. Special care must be exercised in laying the channel and adjacent pipes to grade. Invert piping shall not extend inside manhole any further than two (2) inches. Manhole sections with either honeycomb defects; exposed reinforcing; broken/fractured bell or spigot or cracked walls will be subject to rejection by the Engineers for use on the project. When mastic sealant is used, improperly applied primer will also be cause for rejection. Manholes in roads, streets, or highways shall be built to the pavement grade, the grade designated on the plans, or as directed by the Engineer. Tops of manholes outside of roads, streets, and highways shall be flush with the finished ground surface unless

otherwise shown on the plans. Manholes shall not be located in areas where ponding or the collection of surface water may occur.

B. No leaks in any manhole will be acceptable. All repairs made from inside the manhole shall be made with non-shrink grout.

C. When manhole repairs are made from the outside, liquid butyl primer and butyl rubber wrap shall be required per Section 1.04 A of this specification. When repairs require the removal and replacement of manhole barrel sections, liquid butyl primer, flexible plastic gasket, butyl rubber wrap, and grade adjustment rings or chimney seal gaskets shall be required per Sections 1.04 A and 1.04 B of this specification.

D. A one-tenth (0.1) foot minimum drop shall be required through all manholes where the horizontal alignment change is less than 45°. A two-tenths (0.2) foot minimum drop shall be required through all manholes where the horizontal alignment change is 45° to 90°. Horizontal alignment changes greater than 90° at a single manhole shall not be allowed.

E. Flow channels in the manhole base shall be formed of 3,000 psi concrete while the manhole is under construction. Flow channels shall be solid concrete or concrete with solid concrete filler block. No rubble shall be allowed. Non-shrink grout may be used for repair of existing manhole flow channels. The flow channel through manholes shall be made to conform in shape and slope to that of the sewers. Changes in size and grade of channels shall be made gradually and evenly. Changes in direction of flow shall be made with a smooth curve of as large a radius as the size of the manhole will permit.

F. Installation of and surface preparation for expanded polypropylene grade adjustment rings shall be in accordance with the manufacturer's instructions. Repair any surface defects or irregularities of the mounting surface using a uniform bed of non-shrink grout. For concrete manholes the mounting surface shall be the top of the concrete cone section. For existing all-brick manholes, the mounting surface shall be the first full course of brick that is structurally sound, free from cracks or other voids that may allow infiltration into the collection system.

   Dry-set grade adjustment rings and casting prior to sealing. Center casting over the opening of the cone and adjustment rings. The top adjusting ring upon which the casting is set shall be level from side to side unless a pitch is required to match the surface in paved areas. Manhole ring and cover shall be adjusted to within 1/4" to 1/2" of flat or sloping finished grade. Seal all joints from the mounting surface to the casting

using M-1 structural adhesive/sealant.

No other material shall be used in the construction of the chimney section beyond the materials specified. This includes shims of any material, bricks, stones, etc. If, after pavement placement, foreign material is discovered (i.e. – shims) in the manhole structure, the pavement surrounding the structure shall be removed and replaced and the manhole structure re-built as specified at the expense of the Contractor. Grade adjustment using expanded polypropylene rings shall range from a minimum of 2" to a maximum of 12".

Manhole chimneys are limited to a maximum height of 12". When adjusting the frame and cover elevation on existing pre-cast concrete manholes with brick chimneys in excess of the maximum 12" height in paved areas, the pre-cast barrel or riser cone sections will need to be replaced so that grade adjustment is obtained using expanded polypropylene rings between 2" and 12" in height.

2.14 PROTECTION OF EXISTING SANITARY SEWER SYSTEMS

During the construction of new Sanitary Sewer Systems, the existing sanitary sewer shall be protected at the point of connection with use of a pneumatic or mechanical plug. This isolation shall remain in place until the new system is fully accepted. Provisions must be in place to prevent sediment and excess water from entering the City's existing Sanitary Sewer System.

The isolation of the new system must be performed at the Contractor's expense. Any breach of this isolation shall be resolved by the Contractor to meet City expectations and standards. The Contractor may also be liable and responsible for remediation costs due to this breach.

2.15 CLEANING

Prior to mandrel tests, televising, and before acceptance of the gravity sewer systems, all sewer lines shall be cleaned to the satisfaction of the Engineer. Where any obstruction occurs, the Contractor will be required to clean the sewers by flushing and by means of rod and swabs or other instruments. Cleaning of new sewers is to be completed without impacting the existing sewer system; debris/foreign material from the new line (i.e. dirt, sand, and trash) shall not be discharged into the existing system.

2.16 TESTING AND INSPECTION

A. Leakage Testing: Mains and Laterals

All new public and private gravity sewers and laterals shall be pressure tested within 30 days following final backfill in accordance with the Time-Pressure Drop Method specified in ASTM F1417 - Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, latest revision. The procedure is summarized as follows:

1. Isolate the section of the sewer line to be tested using inflatable plugs or stoppers.

2. Cap all laterals and stubs using glued caps. All caps and plugs shall be securely braced to prevent blow-out.

3. One of the plugs or caps shall have an inlet tap or other provision for connecting a hose to a portable air control source.

4. Connect the air hose to the inlet tap and portable air control source. The air source equipment shall include necessary valves and pressure gages to pressurize an oil-free air source at a controlled rate into the test section.

5. Add air slowly to the test section until the pressure inside the pipe reaches four (4) psi greater than the average backpressure of any groundwater submerging the pipe. (NOTE: All test pressures are measured as gage pressure, which is any pressure greater than atmospheric pressure. Since water produces a pressure of 0.43 psi per foot of depth, air test pressures must be increased to offset the depth of groundwater over the sewer line. If the groundwater is two (2) feet or more above the top of the pipe at the upstream end, or if the required test pressure exceeds nine (9) psi, this test should not be used).

6. Disconnect the air supply and allow a minimum of two (2) minutes for pressure stabilization.

7. Measure the pressure drop over the following time period, depending on the diameter of the sewer pipe being tested (based on a maximum test section length of 400 feet between manholes):

8 inch:	6 minutes
10 inch:	8 minutes

12 inch:	12 minutes
15 inch:	18 minutes
18 inch:	26 minutes

8. Acceptable pressure drop over time period: Not more than 0.5 psi.

The testing shall be performed by the Contractor, and a representative of the City shall be present to observe the test. The Contractor shall be responsible for all costs associated with performing the leakage testing, locating leaks, repairing leaks, and conducting additional leakage testing as necessary until the system passes the pressure test. No gravity sewers or laterals will be accepted by the City without a passing pressure test.

B. Deflection of Mains

It is the responsibility of the Contractor to assure that backfill is sufficient to limit deflection for all PVC pipe, eight (8) inch diameter and larger, to no more than 5% of the internal diameter of the pipe which shall be tested by a mandrel permitting no greater than maximum 5% deflection. All pipe shall be tested no sooner than 30 days after installation. All pipes not passing the 5% deflection limitation test shall be repaired or removed and replaced.

The mandrel shall be pulled through the pipe (SDR-26) with the following diameter:

Nominal Pipe Size (Inches)	Average inside Diameter (Inches)	Mandrel Diameter (Inches)
8	7.754	7.37
10	9.692	9.20
12	11.538	10.96

C. Deflection of Laterals

It is the responsibility of the Contractor to assure that installation and backfill is sufficient to limit obstructions and deflections in the laterals. Laterals shall be tested by dropping a tennis ball in the upstream end of the pipe. The tennis ball must show up at the next downstream manhole. If not, the lateral must be repaired or removed and replaced. The tennis ball may be followed by water to help with its travel to the next downstream manhole.

D. Televising

After the completion of successful mandrel tests and cleaning, all newly constructed sewer lines must be televised by the City prior to acceptance. Accordingly, all sewer lines, eight (8) inches in diameter and larger, that are installed within accepted public right-of-ways and easements will be televised, including those lines on private property that are connected to the public lines. The Contractor will be charged a fee per linear foot by the City, and will be responsible for preparing the lines to insure that they are cleaned and free of debris prior to televising. The Contractor shall notify the Inspector on his progress prior to the televising request. Details and procedures of this program are included in the "Televising Procedures Manual" developed by the City's Water Quality Control Department who will be providing the television services. The Contractor will be responsible for becoming familiar with this manual, which is available on the City's Website.

E. Compaction

Laboratory tests of the soil shall be made in accordance with ASTM D-698. In-place density tests shall be made in accordance with ASTM D-1556 or D-2922. Results of the tests shall be furnished to the Engineer by the testing laboratory. The minimum number of tests required shall be:

1. Backfill over sewer in traffic areas: 1 per 100 linear feet or less for each four (4) feet of depth or portion thereof.

2. Backfill over sewer in non-traffic areas: 1 per 200 linear feet or less for each six (6) feet of depth or portion thereof.

2.17 CLOSING PIPE

When the work or pipe laying is suspended, either for the night or at other times, the end of the gravity sewer or force main pipe must be closed with a water tight cover. The Contractor will be held responsible for keeping the gravity sewer or force main free from obstruction. Plugs shall remain in pipe ends until all water is removed from the trench.

2.18 GRASSING

Grassing of areas disturbed during construction shall be in accordance with Section 02485 – "Grassing".

2.19 ACCEPTANCE OF PORTIONS OF THE WORK

The Owner reserves the right to accept and use any portion of the work whenever it is considered to the City's interest to do so. The Engineer shall have power to direct on which line the Contractor shall work and the order of the work.

2.20 RECORD DATA

As required under Section 1500, Paragraph 54, of the General Conditions, the Contractor is required during construction to keep accurate, legible records of the location of all new sewers, force mains, tees and laterals. This record data will include survey coordinates of all bends and fittings on force mains. These records will be made available to the Engineer before his final review for incorporation into the consulting Engineer's Record Drawings. Final payment to the Contractor will be withheld until all such information is received and accepted.

END OF SECTION 02554