

**SECTION 13**

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**SANITARY SEWER CONSTRUCTION**

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## SECTION 13

### SANITARY SEWER CONSTRUCTION

**1. SCOPE OF WORK:** This work shall include the furnishing of all pipe, fittings, support blocking, labor, construction equipment and other necessary appurtenances for the complete construction of sewers of the size and character shown on the Plans.

1.1 All design, construction and testing shall conform to the current Department of Natural Resources, Division 20- Clean Water Commission; Chapter 8- Design Guides.

**2. MATERIALS:** The type of pipe and other materials used in the construction of sewers shall conform to the respective Specifications as described herein.

Where the plans call for 10-Inch and 8-Inch sanitary sewer pipe, the Contractor may use polyvinyl chloride plastic pipe.

2.1 Polyvinyl Chloride (PVC) Plastic Pipe:

2.1.1 Gravity Sewer Lines: Polyvinyl Chloride (PVC) pipe and fittings in nominal sizes of 4-inch through 15-inch with integral bell elastomeric seal joints, shall conform to the requirements of ASTM Designation: D-3034 with a standard dimension ratio (SDR) of 35 or better for all gravity sewers. Pipe and fittings shall be manufactured from Type I, Grade I, Polyvinyl Chloride (PVC) compound and materials conform to the requirements of ASTM Designation: D 1784, Class 12454-B. The materials shall have a tensile strength and tensile modulus tested in accordance with ASTM Designation: D 638. The laying of PVC pipe shall not be permitted at temperatures below 23 degrees F.

2.1.1.1 PVC pipe fittings shall have the same pressure rating as the pipe and shall be marked on the body or hub on both sides. The markings shall include the manufacturer's name or trademark, nominal size, grade rating and symbol PCV type designation; i.e. PVC Type 1.

2.1.2 Gravity Sewer Pipe: Polyvinyl chloride (PVC) ribbed pipe and fittings for gravity sewer lines shall conform to the requirements of ASTM F-794 and Uni-Bell Uni-B-9. Pipe shall be made of PVC material having a cell classification of 12454-B as defined in ASTM D-1784. Pipe stiffness at 5% deflection shall be 46 psi for all sizes when tested in accordance with ASTM D-2412.

2.1.3 Joints: The pipe shall be jointed with a bell-and-spigot type of rubber gasketed joint. Each joint shall consist of a formed bell compete with a single rubber gasket. All fittings shall utilize rubber gasketed joints. The gaskets shall meet the requirements of ASTM Designation: F 477 with configuration conforming to the requirements of ASTM Designation: D 3212.

- 2.2 Gasket Joint Pipe (PVC): The following requirements shall be applicable to all varieties of Polyvinyl Chloride (PVC) Plastic pipe provided under this Contract.
- 2.2.1 Gasket joint pipe shall meet all of the manufacturing requirements specified herein. They pipe shall be coupled and sealed against infiltration and exfiltration by means of rubber rings seated in the integral bell. Pipe that has an integral bell as a part of the pipe with a single gasket will be approved. All integral bells shall have a seating depth recommended by the manufacturer. The male ends of the pipe shall be fabricated at the factory for ease of entry into the coupling.
- 2.2.2 The manufacturer shall deliver the pipe to the job site by means which will adequately support it and not subject it to undue stress. The load shall be so supported that the bottom rows of pipe are not damaged by crushing. The pipe shall be carefully unloaded and stored on the project at a site prepared and furnished by the Contractor.
- 2.2.3 All gasketed joints shall be lubricated as recommended by the pipe manufacturer and as approved by the City.
- 2.3 Polyvinyl Chloride (PVC) Plastic Force Main Pipe: Polyvinyl chloride (PVC) pipe and fittings shall be manufactured from Class 12454B, Polyvinyl chloride compounds having a hydrostatic design basic rating of 2000 psi for water at 73.4 degrees F. The pipe shall be extruded from Type I, Grade I polyvinyl chloride compound conforming to ASTM D-1784-99A. The pipe shall be precision extruded from new polyvinyl chloride material. It shall be homogenous and free from cracks, holes, foreign inclusions or other defects. The pipe shall have a minimum hydrostatic pressure class of 160 pounds per square inch, with a SDR rating of 26 or better.
- 2.3.1 The joints used shall have the same pressure rating as the pipe or fittings of which they are a part.
- 2.4 Concrete and Reinforcing Steel: All concrete and reinforcing steel used in the construction of the pipe encasements, concrete foundations and slabs, and other miscellaneous structures as described in this section shall comply with the requirements of the SECTION: CONCRETE.
- 2.5 Steel Encasement Pipe: Steel encasement pipe shall be used for encasing the sanitary sewer force main and sanitary sewer gravity pipe which crosses under roadways or for stream crossings as shown on the Plans and shall conform to the following requirements:

Steel encasement pipe shall be electric welded steel pipe of the size (outside diameter) as shown on the Plans, and shall conform to the requirements of ASTM Designation: A-53 or American Petroleum Institute API-5L Designation, Grade B. The minimum wall thickness for 12-inch diameter steel encasement pipe shall be 0.25 inches and for 20 inch diameter steel encasement pipe shall be 0.375 inches.

The manufacturer shall furnish a certificate which states that the materials met the Specifications.

3. **CONSTRUCTION REQUIREMENTS:**

3.1 Trenching and Backfilling: Trenching and backfilling shall conform to the SECTION: EXCAVATION, TRENCHING AND BACKFILLING FOR SANITARY SEWER CONSTRUCTION.

3.2 Fittings shall be subject to inspection at the factory, trench, or other point of delivery by the City. The purpose of the inspection shall be to cull and reject pipe and fittings that, in the opinion of the City, fails to conform to the requirements of these Specifications.

3.2.1 All accepted pipe and fittings shall be plainly marked by the City in such a manner, and with such material, that the acceptance marks or symbols will be plainly visible after installation in the trench and that they will not become faded by weather or handling. Rejected pipe and fittings shall be removed from the site of the work immediately and permanently.

3.3 Handling Pipe and Fittings: All pipe, fittings and specials shall be delivered, unloaded, stockpiled, hauled, distributed, installed and otherwise handled in a manner which will prevent breakage or other damage thereto and which will insure the delivery and installation thereof in a sound and acceptable condition.

PVC pipe and fittings shall be stored in the original containers in a cool, dark place. Rubber gaskets shall be kept away from oil and grease, sunlight, heat and ozone producing equipment.

3.4 Cutting of PVC Pipe: Cutting of pipe shall be done in a neat and workmanlike manner without damage to the pipe. Unless otherwise authorized by the City, cutting shall be done by means of an approved type of power saw with a fine tooth blade. Pipe shall be cut square and the burrs removed inside and outside with a knife or coarse file.

3.5 Location and Grade of Sewers: Sewers and structures appurtenant thereto shall be located as shown by the Plans and as staked by a licensed surveyor. The grade and alignment of each gravity sewer shall be determined and maintained by the use of a line parallel to the grade and line of the sewer, this line to be supported above the ground surface on batter boards spaced not to exceed 30 feet apart and rigidly anchored to and supported by substantial posts. Not less than four (4) batter boards shall be installed and maintained in proper position at all times as a check on the accuracy of the grade line. The City shall be immediately notified of any misalignment of batter boards set in accordance with the cuts or elevation furnished to the Contractor. The elevations of batter boards and the alignment of the grade line will be determined from the elevations and

alignments of offset points located along the trench, except where established directly by means of surveying instruments. The Contractor may utilize a laser beam device to maintain line and grade of the pipelines in lieu of the batter board method.

- 3.6 Sewer Pipe Installation: Pipe laying shall commence at the lower end of the section and proceed upgrade. Pipe shall be laid so that the spigot or tongue end points in the direction of flow.
- 3.6.1 All sewer pipe shall be installed to exact line and grade and special care shall be taken to avoid disturbing line and grade of pipe already jointed and laid. All pipe shall be graded and bedded as provided in the general excavation and trenching specifications. When pipe is installed and jointed in trench, it shall form a true and smooth line of sewer, and pipes shall not be trimmed or cut except for closures. Any pipe not making a good fit shall be removed. Permissible defects as specified hereinbefore shall be placed in the top of the sewer or as otherwise directed by the City. Pipe shall be kept in a clean condition before being installed in the trench and then installed shall have all interior surfaces of the pipe sockets and exterior surfaces of pipe joints clean and dry before any jointing is performed. When necessary in the opinion of the City, a suitable swab of drag shall be pulled through each joint of pipe as it is laid and jointed. All sewers constructed under each product must be kept thoroughly clean. When the trench is left at night or the pipe laying stopped, the upper end of the pipe must be closed by using an end board closely fitting the socket end of the last pipe. This end board shall have several small holes bored near the center to prevent the trench filling with water and to keep out sand and earth from the sewer, but in no case shall the end board be inserted and water allowed to enter until the City is satisfied that the sewer will not be injured by water coming into contact with the pipe joints, pipe backfill and subgrade.
- 3.6.2 Installation of PVC Pipe: Polyvinyl Chloride (PVC) pipe for gravity sewer lines shall be installed in accordance with the recommended practice of ASTM Designation: D 2321.
- 3.6.3 Polyvinyl Chloride (PVC) pipe and fittings shall be inspected for defects or damage prior to lowering into the trench. Any defective, damaged, or unsound pipe shall be repaired or replaced and all foreign matter and soil should be removed from the interior of the pipe and fittings before lowering into the trench.
- 3.6.4 The pipe shall be carefully bedded with bed holes excavated to insure that each pipe shall rest firmly upon its bed for its full length, and shall be laid true to the lines and grades shown on the Plans. Except there necessary in making connections with outer lines, or as authorized by the City, pipe shall be laid with the bells facing the direction of laying.

3.7 Pipe Joints:

3.7.1 Polyvinyl Chloride (PVC) Pipe: All instructions and recommendations of the pipe manufacturer, relative to gasket installation and other jointing operations, shall be followed by the Contractor. Lubricants shall be applied in accordance and of the type recommended by the pipe manufacturer and approved by the City. Each pipe end and coupling shall have tapered edges to facilitate assembly. Proper jointing may be verified by rotation of the spigot by hand or with a strap wrench. If unusual joining resistance is encountered or if the insertion mark does not reach the flush position, disassemble the joint, inspect for damage, reclean the joint components and repeat the assembly steps.

3.7.1.1 Before assembly, the gasket, grooves, coupling, and the pipe ends to be assembled shall be thoroughly cleaned. The rubber gaskets should be placed inside the coupling grooves with holes facing center. After placing, snap the gasket at the four quarters of the circumference to ensure that the gasket is properly seated in the groove.

3.7.1.2 The pipe ends shall be thoroughly clean before lubricating. The lubricant should be applied by a two-inch flat paint brush, glove, cloth paid, or by hand to the entire pipe end and to the rubber gaskets. No dry spots shall remain, and lubricated pipe ends and coupling shall be kept clean after lubricated.

3.8 Concrete Embedment and Encasement of Sewer Pipe: Concrete embedment or encasement of sewer pipe shall be installed where and as shown by the Plans; also where, in the opinion of the City, such pipe reinforcement is necessary of any unforeseen condition encountered in the work.

3.8.1 Concrete used in pipe embedment or encasement shall be furnished, placed and compacted in conformity with the SECTION: CONCRETE - TYPE-B. Reinforcement steel shall be provided as required in the standard details.

3.8.2 Concrete embedment or encasement of sewer pipe shall be preceded by the following preliminary steps:

3.8.3 Each length of pipe shall be installed on a suitable block or other support located close to the pipe bell, and the pipes brought to exact line and grade by means of wedges placed on each side of the pipe.

3.8.4 Each length of pipe shall be rigidly held in lateral alignment by means of either struts between the pipe barrel and the trench bank installed at the spring line or pipe launch, or by means of wedges placed beneath and on each side of the pipe after the top anchorage described in the following subparagraph three (3) is in place. Such lateral supports shall be installed immediately back of the bell of

each pipe. All lateral bracing of the pipe shall be done prior to filling the pipe joints with the jointing material.

- 3.8.5 Each pipe shall be anchored, to prevent flotation by means of a vertical strut placed immediately back of each bell, such strut being securely attached to, or wedged beneath, a cross brace or member preferably anchored to a horizontal plank on each side of the trench, although such struts may be wedged between vertical bracing planks. In any case, cleats shall be nailed across the tops of the cross member and into the side planks to properly resist upward thrust. The cross brace and side planks shall be kept above the top of the concrete fill, with the bottom edges of the cross braces preferably at the top elevation of the concrete as a guide in the placement thereof to the proper thickness above the top of the pipe barrel.
- 3.8.6 Pipe joints shall be filled or otherwise sealed with the same materials and in the same manner as other joints in the same line of sewer.
- 3.8.7 All loose material shall be removed from the trench prior to placing any concrete therein. The concrete as installed shall have a continuous and uniform contact with undisturbed trench excavation material on both sides and the bottom of the trench except (1) where side forms are indicated or permitted by the Plans or (2) where sheeting is left in place in the trench, in which case the concrete is to be poured directly against the sheeting.
- 3.9 **Thrust Blocking:** Fittings shall be supported so their weight is independent of the pipe. All fittings at bends in the line shall be firmly wedged against the vertical face of the trench in order to prevent the fittings from being blown off the lines when under pressure. This wedging shall be done by pouring concrete in the opening between the fitting and the solid undisturbed trench face. This wedging or thrust blocking shall be required at all points along the sewer force main where the pipe changes direction as shown on the Plans.
- Thrust blocks shall be constructed by pouring concrete between the fittings and the trench wall. The concrete shall conform to the requirements of the SECTION: CONCRETE bound herein. The thrust blocks should be constructed so the bearing surface is in direct line with the major force created by the pipe or fitting. The earth-bearing surface shall be undisturbed and only the simplest of forms shall be required.

**4. WYE BRANCHES:** Wye branches shall be located at the points shown on the Plans or as designated by the City. The Contractor shall be sure that wye branch locations have been marked in advance of the construction of any sewer serving any property which will require sewer service and, in case such locations have not been so designated, shall stop the sewer construction until the necessary wye branch location or locations have been obtained. Wye branches shall be so installed that the lower lip of the branch is not

more than two (2) inches below the outside top of the pipe. All wye branches shall be cocked to a 45 degree angle to the plane of the sewer line. After installation, wye branches shall not be covered with backfill until determination and record has been made by the City of the location of each with reference to the nearest manhole downstream therefrom, and the direction in which the wye faces. In addition, each wye branch shall be marked with a 6 FOOT STEEL POST and braced with 2x4 extending from the wye branch or sanitary sewer service line vertically.

- 4.1 All such markers shall be securely anchored and maintained in a proper vertical position until backfilling has been completed. Wye branches or sanitary sewer service lines shall be capped.
- 4.2 Sanitary Sewer Service Line Riser Pipe: The Contractor shall install sanitary sewer riser pipe when the service line tee connection is greater than 8.0 feet below the existing ground line. The sanitary sewer service riser pipe shall extend to not less than 7.0 feet of the existing ground line. The sanitary sewer riser pipe shall be sealed by an acceptable stopper as herein mentioned and as shown on the construction plans.
- 4.3 Existing Sanitary Sewer Services Line: The Contractor shall not connect any existing sanitary sewer service lines to the new sanitary sewer pipe. This work shall be performed by others after the completion and acceptance of the sanitary sewer lateral and interceptor construction.
- 4.4 Damaged Sanitary Sewer Lines: The Contractor shall repair and/or maintain any existing sanitary sewer septic tanks which are exposed or damaged during construction of this project. The City shall review any lateral field piping which is damaged to verify the need to repair. The piping shall be repaired so as to not affect the operations of the household plumbing.

**5. EXISTING SEWER LINE CONNECTION:** Sewer service line connections made to the sewer main prior to backfilling shall not be installed in the pipe trench as vertical risers, but shall be laid on a slope of not to exceed one foot vertical to one foot horizontal cutback into the trench bank in such a manner that the sewer service line connection pipe will have a solid bearing on undisturbed earth as stipulated for pipe sewers. The sewer pipe shall make such a horizontal angle with the sewer line that a proper connection with the tee or wye branch is obtained without trimming the pipe and with no danger of jointing material being forced into the sewer. The first length of pipe shall not make a total angle with the tee or wye branch greater than four inches in two feet, and the wye shall be installed in such a manner as to fit the alignment of the sewer service line as closely as possible. Existing sanitary sewer service lines shall be connected to the new sanitary sewer main when approved by the City and with an acceptable material. The new sewer connection shall be constructed as described above to connect with the existing sewer service line. Where necessary, the use of reducers, fittings, couplings and adapters applicable to make a watertight connection between the new and existing sewer lines, may be used when approved by the City. No connection to an existing sewer line will be permitted until so approved in writing by the City.

**6. SEWER LINES TO BE KEPT CLEAN:** All sewer lines must be kept thoroughly clean. Where a connection has been made to an existing manhole, the downstream end of the newly constructed sewer line shall be sealed so that no water or dirt can enter the existing pipe. During construction, the water level in any part of the newly constructed sewer system shall not be permitted to exceed 1.5 feet in depth. Upon completion of the new construction work, all sewer lines shall be thoroughly cleaned and accepted by the City before a permanent connection is made by removing the seal.

**7. ACCEPTANCE TESTS:** All sewer lines shall undergo and pass tests to determine the soundness and workmanship regarding alignment grade, infiltration, exfiltration and/or pressure. Sewer lines which do not conform to the requirements shall be repaired and/or replaced along with all appurtenant work necessary to complete the entire work and shall be retested until the sewer line is of a condition meeting the requirements. Results of each tests shall be recorded by the CITY. The transcripts shall include sufficient information to readily identify the type of test, location tested, dated, person(s) performing the test, and the test results.

**8. FIELD TESTING:**

8.1 Pressure Tests:

- a. The Contractor shall furnish all pumps, piping, labor and other materials and services necessary to bring the piping up to the specified test pressure.
- b. All pipes shall be pressure tested. Pipes which will be pressurized under normal operating conditions shall conform to the requirements of the hydrostatic pressure test. All other piping shall meet the requirements of the air leakage test.
- c. Pipe in the sections to be tested shall be backfilled or center loaded, with thrust blocks installed and completely backfilled.

8.2 Hydrostatic Pressure Test:

- a. Test connections shall be made and the pipe filled with water. Unless otherwise specified, a pressure of not less than 1.5 times the normal operating pressure (for the lowest point on the pipe line) but not less than 150 pounds per square inch (psi) or not more than the rated working pressure for the pipe shall be used for testing.
- b. After air removal, water shall be pumped in to bring the pipe to the specified pressure. After two hours, additional water shall be drawn from a container of known volume. The amount of water required to return the system to the specified pressure shall not exceed the amount determined by the following formula:

$$Q = SD(P)^{1/2}/133000,$$

Where

- Q – Total allowable leakage in two hours, gallons.
- S – Length of section tested, feet.

D – Nominal pipe diameter, inches.  
P – Test pressure, psi

- c. All exposed pipe, fittings, and joints shall be inspected and all evidence of moisture appearing on the surface of the ground during the test shall be investigated by the Contractor by excavation where the pipe has been covered with backfill. Should the leakage test results exceed allowable leakage, the test pressure shall be maintained for an additional period of time as directed by the Engineer to facilitate location of leaks.
- d. All pipe fittings, pipe joints, and other materials which are found to be defective when the pipe line is tested shall be removed from the line immediately and replaced with new and acceptable material by and at the expense of the Contractor. The pressure test shall be repeated after repairing leaks and other defective work until the pipe line installation conforms to specified requirements and is accepted by the Engineer.

8.3 Air-Leakage Test:

- a. Contractor may perform air tests for all pipe sizes.
- b. Air leakage testing shall be performed on lines as specified and on the following lines:
  - Sanitary Sewer Lines
- c. Furnish all facilities required including necessary piping connections, test pumping equipment, pressure gauges, bulkheads, regulator to avoid overpressurization, and all miscellaneous items required.
  - 1. The pipe plug for introducing air to the line shall be equipped with two taps. One tap will be used to introduce air into the line being tested, through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. An additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.
  - 2. The pressure test gauge shall meet the following minimum specifications:

Size (diameter)	4-1/2 inches
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Pressure Range	0-15 P.S.I.
Figure Intervals	1 P.S.I. Increments
Minor Subdivisions	0.05 P.S.I.
Pressure Tube Accuracy	Bourdon Tube or diaphragm +0.25% of maximum scale Reading
Dial	White coated aluminum with Black lettering, 270° Arc and Mirror edge
Pipe Connection	Low male ½ “ N.P.T.

Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification and calibration data will be available to the Engineer whenever air test are performed.

- d. Test each reach of sewer pipe between manholes after completion of the installation of pipe and appurtenances and the backfill of sewer trench
- e. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that intrnal pressure does not exceed 5.0 psig. After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supply air. After temberature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the time, in seconds, for the air pressure to decrease from 3.5 isg to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Pipe Size	Required Time per 100 LF	Maximum Required Time
8”	70 sec.	227 sec.
10”	110 sec.	283 sec.
12”	158 sec.	340 sec.

15"	249 sec.	425 sec.
18"	356 sec.	510 sec.
21"	485 sec.	595 sec.
24"	634 sec.	680 sec.
27"	765 sec.	765 sec.
30"	851 sec.	851 sec.

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired. Prior to acceptance, all constructed sewer lines shall satisfactorily pass the pressure air test.

- f. In areas where ground water is known to exist, install a one-half inch diameter capped pipe nipple, approximately 10" long, through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer line is installed. Immediately prior to the performance of the line acceptance test, ground water level shall be determined by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertically and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

#### 8.4 Vacuum Testing of Manholes:

- a. Each manhole shall be tested immediately after assembly and prior to backfilling.
- b. All lift holes shall be plugged with an approved non-shrink grout.
- c. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.
- d. The test head shall be placed at the inside of the top of the cone section and the seal inflated in accordance with the manufacturers' recommendations. Test head shall be as manufactured by PA Glazier, Inc. of Worcester, Massachusetts, or equal.
- e. A vacuum of 10 inches of mercury shall be drawn and the vacuum pump shut off. With the valves closed, the time shall be measured for the vacuum to drop to 9 inches. The manhole shall pass if the time is greater than 60 seconds for 48" diameter, 75 seconds for 60", and 90 seconds for 72" diameter and larger manholes.
- f. If the manhole fails the initial test, necessary repairs shall be made with a non-shrink grout while the vacuum is still being drawn. Retesting shall proceed until a satisfactory test is obtained.

Inspection of pipe and fittings will be conducted by the Engineer as soon as practical after delivery to the job site.

- 8.5 Deflection Tests:
- a. Deflection test shall be performed on all flexible sewer pipe by the Contractor using a mandrel pull. The mandrel pull cannot be performed any sooner than 30 days after the reach being tested has been installed and final backfill has been placed.
  - b. A section of sewer line reach shall be deemed as failed when the mandrel cannot be moved through it with reasonable force. The tests shall be performed without mechanical pulling devices.
  - c. At the conclusion of the mandrel pull, the Contractor, at his expense, shall be required to remove and replace all pipe which fails the test.
  - d. The mandrel diameter shall be based on 95% of the actual inside pipe diameter.

- 8.6 Field Testing Low Pressure Sewer System:
- a. Leakage Tests: a leakage test shall be performed on all low pressure sewer forcemains prior to acceptance.
  - b. Pressure tests shall be made only after the completion of backfilling operations and after the concrete thrust blocks have set for at least thirty-six (36) hours.
  - c. The duration of pressure tests shall be a minimum of one (1) hour unless otherwise directed by the Engineer. Test pressure shall be fifty pounds per square inch (50 lbs. Psi) minimum, with a recommended pressure two and one-half (2-1/2) times the maximum system operating pressure. All tests are to be conducted under the supervision of the Engineer.
  - d. The pipe line shall be slowly filled with water. The specified pressure measured at the lowest point of elevation shall be applied by means of a pump connected to the pipe in a manner satisfactory to the Engineer.
  - e. During filling of the pipe and before applying the specified pressure, all air shall be expelled from the pipeline by making taps at the point of highest elevation. After completion of the test, the taps shall be tightly plugged at the main.

**9. Visual Internal Inspection:** The visual inspection of each reach of completed sewer line shall be made between manholes of gravity systems, by use of mirrors deflecting sunlight into the sewer line, or lighting systems, or when possible, a physical inspection by crawling through the sewer line. Visual inspection shall be made only after all backfill has been properly placed. The inspection is to ensure that the sewer line is clean and free of obstructions, dirt or other matter not intended to be within the system

and that it has been installed to uniform grade and proper alignment. Poor alignment, non-uniform grade, infiltration, displaced joints, obstructions and/or other defects shall be corrected and/or repaired and the line then reinspected.

9.1 All sanitary sewer pipe shall be laid in a straight alignment between manholes. The alignment shall be tested by using a laser beam or lamping.

9.2 Deflection Test: All polyvinyl chloride (PVC) gravity sewer lines shall be tested by pulling a mandrel through the entire length of sewer pipe. The test shall be conducted not less than one (1) month after backfill has been properly installed. The maximum allowable deflection shall not exceed five (5) percent of the pipe's internal diameter. Any section of pipe found not conforming to these requirements shall be replaced by the Contractor at no additional cost to the City, and shall then be retested. The City may, prior to the end of the warranty period, conduct another deflection test with City personnel. Any pipeline found not conforming to these requirements shall be replaced by the Contractor and the Contractor shall provide an additional warranty for not less than one (1) year for that portion of pipeline so replaced.

9.3 Infiltration Testing: Infiltration tests shall be performed whenever gravity sewer lines are below the groundwater table. Infiltration of groundwater into newly constructed gravity sewer lines shall not exceed the rate of 200 gallons per inch of nominal pipe diameter per mile of sewer per 24-hour day. Where evidence of infiltration is discovered by the City, the Contractor shall install weirs or other suitable flow rate measuring devices adequate to determine to the satisfaction of the City that the specified infiltration limit is not exceeded for the reach of gravity sewer where evidence of infiltration is discovered. A reach is between any to (2) consecutive manholes. Where the specified infiltration limit is exceeded, the Contractor shall repair or replace the defective reach of sewer line. Following repair of defective reaches of sewer line, the Contractor shall remeasure infiltration flow rates and make additional repairs until the infiltration flow rate is achieved.

9.4 Exfiltration Tests: An exfiltration test shall be conducted on all new constructed sewer lines by the Contractor using the method as set forth below:

9.4.1 Low Pressure Air Testing of Gravity Systems: Air testing may be used in lieu of exfiltration testing. Air testing shall comply with ASTM Designation: C 828. Procedures for air testing shall be submitted to the City for review before testing is started. Manholes shall be tested with water as specified in the SECTION: SANITARY SEWER MANHOLES.

9.4.1.1 Leakage shall not exceed 0.003 cfm per square foot of internal pipe wall surface area at an average pressure of 3 psi. The time elapsed for a 1 psi drop in air pressure shall not be less than:

T = 0.472D; where T= time in minutes  
 D= pipe diameter in inches

9.4.1.2 Leaks shall be located by air testing short sections of line.

Leaks shall be repaired and the reach of sewer line retested.

9.4.2 Pressure Test of Force Mains: After the force mains have been laid and partially backfilled, the entire section shall be subjected to a hydrostatic pressure of 150 pounds per square inch. The main shall be slowly filled with water and the specified test pressure, based on the elevation of the lowest point of the line and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe in a manner satisfactory to the City. The pump, pipe connection, and all necessary apparatus including gauges shall be furnished by the Contractor.

9.4.2.1 Testing shall be done in accordance with the provisions of AWWA C600-82 and the additional provisions contained herein. All air shall be expelled from the line prior to beginning the test. The test shall consist of pumping water into the section being tested. The pressure shall be maintained for fifteen (15) minutes, to allow the system to stabilize. The line shall then be repressured to the test pressure and closed for two (2) hours.

9.4.2.2 At the end of the two hour test period, the Contractor shall repressure the line, measuring the volume of water required to restore the test pressure. The method of measuring the volume of water required to repressure the line shall be approved in advance by the City.

9.4.2.3 The maximum amount of water that may be used to restore the pressure test shall be calculated by the most restrictive of the following formulas.

L	= $\frac{SDP}{133,200} \frac{1}{2}$	All Pipes
L	= $\frac{NDP}{3,700} \frac{1}{2}$	Mechanical Joint or Push-On
L	= $\frac{NDP}{7,400} \frac{1}{2}$	P.V.C. Pipe

L= Allowable Leakage in Gallons/Hour

N=Number of Joints in Test Section

S=Length of Test Section in Feet

D=Nominal Pipe Diameter in Inches

P=Test Pressure in P.S.I.G.

9.4.2.4 The test pressure, water required to repressure the line and the test location shall be recorded. Any section not meeting

these test requirements shall be prepared and retested until the minimum test requirements are met.

**10. INSTALLATION OF SEWERS IN PIPE ENCASEMENTS:** The sanitary sewer gravity and force main under the highways, or as designated by the City, shall be installed inside of a steel encasement pipe of the diameter specified on the Plans placed by boring or jacking in accordance with the SECTION: EXCAVATING, TRENCHING AND BACKFILLING FOR SANITARY SEWER.

- 10.1 After installation of encasement pipe, polyvinyl plastic force main pipe or gravity sewer pipe shall be installed to line and grade in the encasement pipe in accordance with details shown on the Plans. When the sanitary sewer force main is installed and one end of the encasement pipe has been sealed around the sewer, as shown on the Plans, the void space in the encasement pipe shall be completely backfilled by blowing sand and the other end of the encasement shall then be sealed.

**11. METHOD OF MEASUREMENT:** The installation of gravity sanitary sewer lines, sanitary sewer service lines, and sanitary riser pipe shall be measured by the linear foot of the various sizes and types of pipe. Measurement shall be along the centerline of the pipe completed in place from the end of pipe to the inside face of walls of manholes and other structures.

- 11.1 Concrete encasement of the various sizes will be measured and paid for in accordance with the requirements specified in the SECTION: CONCRETE.
- 11.2 Steel encasement pipe shall be measured by the linear foot of the various diameters of pipe specified. Measurement shall be along the centerline of the pipe complete in place from one end to the other. No measurement will be made for sanitary sewer carrier pipe, sanitary sewer line blocking end seals and other encasement pipe accessories for the sanitary sewer force main or sanitary sewer gravity pipe in the encasement pipe, for filling the annular voids outside the steel encasement pipe with pressure cement grouting or sand filling inside the encasement pipe, for sealing the ends of the steel pipe encasement.
- 11.3 Sanitary sewer force mains shall be measured by the linear foot of the various size and types pipe to be constructed.

**END OF SECTION**