

CONSTRUCTION STANDARDS

SECTION CS 9

SANITARY SEWER

CS 9-01 GENERAL: Sanitary sewer system improvements shall be constructed in conformance with the City Standard Specifications and Standard Drawings.

Nothing in the City Standard Specifications shall relieve the Contractor from conforming to the manufacturer's recommendations. If a conflict between the City Standard Specifications and the manufacturer's recommendations arises, the more stringent requirement shall apply.

All testing requirements of the ASTM and AWWA standards and other provisions of these City Standard Specifications for the materials and equipment furnished shall be conducted by the manufacturer or its representative unless otherwise stated. A certificate of compliance conforming to these City Standards must be furnished and submitted to the Director of Public Works by the manufacturer through the Contractor. The certification must be approved by the Director of Public Works prior to installation of the materials or equipment. Such certification shall reference and specifically identify the materials and equipment delivered to the job site. All other testing requirements required by these City Standard Specifications shall be performed by the Contractor at its own expense unless otherwise noted.

CS 9-02 ALLOWABLE PIPE MATERIALS: The pipe material shall be furnished as specified on the Project Plans and/or Special Provisions and shall conform to the following:

A. VITRIFIED CLAY PIPE (VCP) for gravity flow only

VCP as specified for all sizes of gravity Service Laterals, Collection and Trunk Mains and shall conform to the following:

1. Specifications: – Vitriified clay pipe and fittings shall conform to the requirements of ASTM Designation: C 700, "Standard Specification for Vitriified Clay Pipe, Extra Strength, Standard Strength, and Perforated" vitriified clay sewer pipe. A certification of compliance with these requirements must be furnished by the pipe manufacturer.

a. For all pipe diameters 12-inches and less, the pipe shall be marked "Extra Strength", unless designated on the Project Plans for "High Strength".

b. For all pipe diameters greater than 12-inches, the pipe shall be marked "High Strength".

- c. All “High Strength” pipe shall withstand the minimum 3-edge bearing test loads as specified in **Table CS 9-1** carried out in accordance with ASTM C 301.

TABLE CS 9-1

Nominal Size Inches	Load Lb/Linear Ft	Nominal Size Inches	Load Lb/Linear Ft
4	2200	24	5300
6	2200	27	5700
8	2400	30	6100
10	2600	33	6400
12	2900	36	6900
15	3400	39	7300
18	4000	42	7700
21	4600		

- 2. **Joints:** - Joints for VCP and fittings shall be compression type joints which conform to ASTM Designation C 425.

B. DUCTILE IRON PIPE (DIP) for gravity and pressure flow

DIP as specified for all sizes of gravity and pressure (force main) Service Laterals, Collection and Trunk Mains and shall conform to the following:

- 1. **Specifications:** – Ductile iron pipe for sizes 4-inch through 12 inch shall conform to AWWA C151 for a minimum pressure class 350 unless otherwise noted on the Project Plans or specified in the Special Provisions. Sizes 18 inches and larger shall conform to AWWA C151 and the pressure class shall be as noted on the Project Plans or as specified in the Special Provisions.
 - a. The class or nominal thickness, net weight without lining, and casting period shall be clearly marked on each length of pipe. Additionally the manufacturer’s mark, country where cast, year in which the pipe was produced, and the letters “DI” shall be cast or stamped on each length of pipe.
 - b. The laying length shall be the manufacturer’s standard length, unless a shorter length is required for one specific length of pipe to conform to the requirements of the Project Plans.
 - c. The exterior surface of the pipe shall have a standard asphaltic coating. The exterior surface of all piping, fittings and valves shall be polyethylene wrapped in accordance with AWWA C105.
 - d. The interior surface of the pipe and fittings for **gravity sewers** shall be lined with a Ceramic Epoxy as specified below in paragraph f.

- e. The interior surface of the pipe and fittings for **force mains** shall be lined with cement mortar in accordance with AWWA C 104 except where the Project Plans specify Ceramic Epoxy or other lining.
- f. Ceramic Epoxy lining shall be Protecto 401 or approved equal. The Ceramic Epoxy shall consist of amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by the documentation of the following properties and a certification of the test results:
 - i. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.
 - ii. An abrasion resistance of no more than three (3) mils loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.
 - iii. The following test must be run on coupons from factory lined DIP:

ASTM B-117 Salt Spray (scribed panel)- Results to equal 0.0 undercutting after two (2) years.

ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F. Results equal to 0.17 disbondment for average of three (3) samples after 30 days.

ASTM D-714-87 for Immersion Testing:

20% Sulfuric Acid – No effect after two (2) years.

140°F 25% Sodium Hydroxide – No effect after two (2) years.

160°F Distilled water – No effect after two (2) years.

120°F Tap water (scribed panel) -0.0 undercutting after two (2) years with no effect.

2. Pipe and Fitting Joints:

- a. **Pipe:** – Pipe joints for sewers shall be bell and spigot or mechanical joint (MJ) and shall conform to AWWA C111 with rubber gaskets unless otherwise specified. Joints for pressure (force) mains shall be of the type indicated on the Project Plans.
- b. **Fittings:** Fittings shall be Ductile Iron push-on or mechanical joint for gravity flow sewers, and mechanical or flanged for pressure flow sewers. Fittings for push-on and mechanical joints shall conform to AWWA C153. Flange fittings shall be ductile iron and conform to AWWA C110. The coating and lining requirements shall be the same as specified for the pipe. All flange bolts, nuts and washers shall be Type 304 stainless steel. Nylon washers shall be inserted between the dissimilar metal point of contact for flange nuts and bolts. Anti-seize compound or Teflon coated bolts and tie rods shall be used on bolt and tie rod threads.
- c. **Thrust Restraint:** – Pressure flow pipe and fittings shall require thrust restraint conforming to the following requirements. Thrust restraint shall be provided at all bends and valves as well as at designated lengths of pipe upstream and downstream of each bend or valve to accommodate the thrust restraint requirements in accordance with Section 6 of the Sanitary Sewer System Design Standards.

Restrained Joints shall be one of the following types:

- i. Bell Joint Restraint Type: Push-on type joint meeting applicable requirements of AWWA C111, with restraint provided. Joints shall be American Lok-ring, Clow Super-Lock, U.S. Pipe TR Flex, EBAA series 1700 with Mega bond coating or approved equal.
- ii. Single Gasket Push-On Type: Single gasket push-on type joint with stainless steel locking segments vulcanized into the gasket. Joints shall be U.S. Pipe Field Lok 350 Gaskets, or approved equal.
- iii. MJ pipe bells shall be restrained with EBAA series 1100 with Mega bond coating, MJ Field Lok®, or approved equal.
- iv. Thrust blocks may only be used when they are specifically noted on the Project Plans. Where designated on the Project Plans, thrust blocks shall be installed per Standard Construction Drawings 5-02, 5-03, & 5-04. The dimensions for thrusts blocks for pipe sizes less than eight inches shall conform to the details designated on the Project Plans.

C. POLYVINYL CHLORIDE (PVC) C 900 pipe for pressure flow

PVC pipe for pressure flow service laterals and force mains for diameters up to and including 12 inches in diameter shall conform to the following requirements:

- 1. Specifications:** - The pipe shall be manufactured in accordance with AWWA C900 for polyvinyl chloride (PVC) pressure pipe for water. The pipe shall have cast-iron pipe equivalent outside diameter and shall have a dimension ratio of 18 (Class 150) unless a higher class of pipe is specified on the Project Plans or in the Special Provisions.
 - a. The pipe shall be installed with detectable metallic underground warning tape, green in color, lettered to read “Buried Force Main Below”. This tape is available from USA Bluebook. The tape shall be installed 12 inches above the pipe.
 - b. The pipe and gaskets shall be kept clean and protected against sunlight and heat damage. Sun or heat damaged pipe may be rejected at the Inspector’s discretion.
 - c. Pipe manufactured more than 18 months prior to its installation will not be permitted.
 - d. Rejected pipe shall be immediately removed from the job site.
 - e. The beveled end of the pipe shall be cut off squarely before insertion into a mechanical joint. The cut end shall be de-burred such that it does not cut the elastomeric gasket when it is slipped over the cut end of the pipe.
 - f. The pipe shall have a factory produced pipe stop indicated on the barrel that will accurately position the pipe end within the joint. When PVC pipe is to be connected to a fitting with an elastomeric gasket joint, a new insertion line must be marked on the pipe prior to installation. The reference mark or stab line on the spigot end must be flush with the bell end and visible for inspection.
 - g. The pipe shall be clearly marked in accordance with AWWA C900. Additionally, the pipe shall be manufacturer date coded and the City shall be provided the manufacturer’s coding for translation. The pipe shall be installed with the manufacturing label showing on the top.
- 2. Joints:** – The pipe joint shall be an integral wall thickened bell end, with an elastomeric gasket seal ring groove and employing an elastomeric gasket seal which conforms to ASTM F477. Lubricant shall be as recommended by the pipe manufacturer.

3. **Fittings** Fittings shall be Ductile Iron mechanical joint and conform to AWWA C153. The interior surface of valves and fittings shall be protected with ceramic epoxy lining of Protecto 401 or an approved equal in accordance with Section CS-9-02B.1.c of these City Standard Specifications. The exterior surfaces of valves and fittings shall be polyethylene wrapped in accordance with AWWA C105.
4. **Joint Restraint:** - Pressure pipe, fittings, and valves shall require thrust restraint conforming to the following requirements. Thrust restraint shall be provided at all bends and valves as well as at designated lengths of pipe upstream and downstream of each bend or valve to accommodate the thrust restraint requirements in accordance with Section DS 6 of the Sanitary Sewer System Design Standards.
 - a. Restrained joint devices shall meet the requirements of ASTM F1674 and shall be subject to the approval of the Director of Public Works.
 - b. Restrained Joints shall be one of the following types:
 - i. Restraint devices for pipe bells shall be EBAA Iron Series 1500 Harness with Mega bond coating for PVC pipe or approved equal.
 - ii. Restraint devices for mechanical joint fittings and valves shall be EBAA Iron Series 2000 PV with Mega bond coating, MJ Field Lok®, or approved equal.
 - iii. Thrust blocks may only be used where they are specifically noted on the Project Plans. Where designated on the Project Plans, thrust blocks shall be installed per Standard Drawings 5-02, 5-03, & 5-04. The dimensions for thrusts blocks for pipe sizes less than eight inches shall conform to the details designated on the Project Plans.

D. POLYVINYL CHLORIDE (PVC) SDR 26 for gravity flow only

PVC for gravity flow Service Laterals and Collection Mains for diameters up to and including 12 inches in diameter shall have a minimum wall thickness of SDR 26 unless a greater wall thickness of pipe is specified on the Project Plans or in the Special Provisions. PVC pipe for gravity flow shall conform to the following requirements:

1. **Specifications:** - ASTM D 3034 “Standard Specification for Type PSM (Poly Vinyl Chloride) (PVC) Sewer Pipe and Fittings”
 - a. All pipe shall have a minimum pipe stiffness that equals or exceeds 115 lbs/in/in.

- b. All pipe shall be marked in accordance with the applicable ASTM standard specifications at intervals not to exceed five (5) feet. Additionally, the pipe shall be manufacturer date coded and the City shall be provided the manufacturer's coding for translation. The pipe shall be installed with the manufacturing label showing on the top.
 - c. The pipe shall be made of PVC plastic having a cell classification of 12454 or 12364 in conformance with ASTM D 1784. Compounds that have different cell classifications, because one or more properties are superior to those of the specified compounds, are also acceptable.
 - d. The Contractor shall not install any pipe that is more than 18 months old from the date of manufacture.
 - e. The pipe and gaskets shall be kept clean and protected against sunlight and heat damage. Sun or heat damaged pipe shall be rejected at the sole discretion of the Inspector.
 - f. Rejected pipe shall be immediately removed from the job site.
 - g. The beveled end of the pipe shall be cut off squarely before insertion into a mechanical joint. The cut end shall be de-burred such that it does not cut the elastomeric gasket when it is slipped over the cut end of the pipe.
 - h. The pipe shall have a factory produced pipe stop indicated on the barrel that will accurately position the pipe end within the joint. When PVC pipe is to be connected to a fitting with an elastomeric gasket joint, a new insertion line must be marked on the pipe prior to installation. The reference mark or stab line on the spigot end must be flush with the bell end and visible for inspection.
- 2. Joints:** All PVC pipe joints shall be gasketed, bell-and-spigot, push-on type conforming to ASTM D3212, "Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals." Since each pipe manufacturer has a different design for push-on joints, gaskets shall be part of a complete pipe section and furnished as such. Gaskets shall be installed as recommended by the pipe manufacturer. Lubricant shall be as recommended by the pipe manufacturer.
- 3. Fittings:** Fittings for gravity PVC sewer pipe shall be fabricated from pipe meeting the respective ASTM PVC pipe standard or molded PVC. The wall thickness of the waterway and bell of molded fittings shall be no less than the respective minimum thickness for the equivalent pipe. Solvent welded fitting shall not be permitted.

All fittings shall be compatible with the pipe to which they are attached.

CS 9-03 TRANSITION JOINTS AND FITTINGS: Transition joints between different pipe materials shall be made as follows:

- A. Service Lateral** transitions between different pipe materials shall be made with a flexible rubber coupling with a proper bushing sized to the pipe and a stainless steel shear band as manufactured by Mission, Fernco, or approved equal.
- B. Collection Main and Trunk Sewers** transitions between PVC and other pipe materials shall be made at a manhole. All other transitions between other approved pipe materials shall be made with a flexible rubber coupling with a proper bushing sized to the pipe and a stainless steel shear band as manufactured by Mission, Fernco, or approved equal.

CS 9-04 PIPE LAYING:

- A. GENERAL** Sewer pipe shall be laid in strict conformance with the line and grade indicated on the Project Plans. The maximum deviation from grade shall not be greater than one (1) inch per 400 feet of pipe between consecutive manholes.
 - 1. Pipe laying shall proceed from “downstream” to “upstream”, with the bell ends of the bell and spigot pipe placed upstream in such a manner as to form a watertight, concentric joint with the adjoining pipe.
 - 2. Pipe shall not be laid when the condition of the trench or the weather is unsuitable in the opinion of the Inspector.
 - 3. The Contractor shall be responsible for dewatering the trench where ground water is present. Dewatering shall continue until backfilling has progressed to a sufficient height to prevent flotation of the pipe. Water shall be disposed of in such a manner that no property damage or hazard to public health occurs. The location of the disposal of the groundwater is subject to approval of the Inspector.
 - 4. All pipe, fittings, and accessories shall be carefully lowered into the trench by suitable equipment in such a manner prevent damage to the materials. Under no circumstances shall these materials be dropped or dumped into the trench. The pipe, fittings, and accessories shall be inspected for visible defects prior to lowering into the trench. Any visible defect or unsound material shall be replaced and removed from the project site.

5. The interior of the pipe shall be cleared of all dirt and debris and excess joint sealing material as the work progresses.
6. All joint surfaces shall be cleaned before the pipes are connected.
7. All open ends of sewer pipe and fittings shall be adequately and securely closed whenever the work is discontinued at the end of each day.
8. The Contractor shall expose the end of the existing pipe to be extended for verification of alignment and elevation by the Inspector, prior to trenching for any pipe which may be affected.
9. All PVC pipe entering or leaving a new concrete structure or manhole shall have a water tight rubber gasket, as supplied by the pipe manufacturer, firmly clamped around the pipe exterior and cast into the structure base or the structure wall as a water stop.
10. Trench excavation, bedding and backfill shall conform to Section CS 2 and Section CS 3 of the City Standard Specifications.

B. PIPE JOINT DEFLECTION: The Contractor shall submit a table of maximum deflections allowed for the combination of pipe and fittings necessary to complete the installation of the sewer facilities based upon the most stringent requirements between the manufacturer's specifications and the following criteria outlined below:

The pipe shall be laid true and uniform to line and grade, with no visible change in alignment at any joint unless curved alignment is called for on the Project Plans; in which case the allowable joint deflection is dependent upon the pipe diameter size and joint type as follows:

1. **DIP** – The allowable deflection per joint shall not exceed 70% of the manufacturer's maximum deflection for the joint type and pipe and/or fitting size. If there is a difference in the manufacturer's recommendation between the pipe and fitting, the smallest deflection shall govern. Deflections in excess of 70% of the manufacturer's recommendations must be made with a fitting per AWWA C153.
2. **PVC** – The fittings and deflection allowances for the joints shall conform to the following requirements:
 - a. No deflections shall be allowed at a pipe bell to spigot joint.
 - b. Curved alignments shall be constructed by manually bending the pipe.

- c. Minimum pipeline radii for uniformly bending the pipe are as follows:

R = 290 feet for 8-inch diameter pipe

R = 450 feet for 10-inch diameter pipe

R = 525 feet for 12- inch diameter pipe

- 3. **VCP** - The allowable deflection per joint shall not exceed 80% of the National Clay Pipe Institute's maximum deflection for the joint type and pipe and/or fitting size.

CS 9-05 FINAL CLEANING: Upon completion of construction and prior to performing any testing in accordance with Section CS 9-06, Testing for Sanitary Sewers, of these City Standard Specifications, the Contractor shall clean the entire new pipeline of all dirt and debris. Pipes up to and including 24 inches in diameter shall be cleaned by the controlled balling method. Pipes over 24 inches in diameter shall be cleaned as approved by the Director of Public Works. Temporary plugs shall be installed and maintained during cleaning operations at points of connection to existing facilities to prevent water, dirt and debris from entering the existing facility. Installation and removal of temporary plugs shall be conducted under the supervision of the Inspector. Only clean water from the cleaning operations shall be discharged into any downstream facility.

CS 9-06 TESTING FOR SANITARY SEWERS: All new gravity flow sewer lines shall be air tested and television inspected in accordance with the provisions of these City Standard Specifications. Pressure flow sewers shall be pressure tested in accordance with the provisions of these City Standard Specifications. A mandrel test for deflection allowances shall be conducted on gravity flow PVC piping in accordance with these City Standard Specifications. All testing, cleaning and repairing shall be done to the satisfaction of the Inspector at the Contractor's expense.

- A. **TIMING** – The Contractor is encouraged to conduct deflection testing during pipe installation as described in ASTM D 3839 to ensure adequate compaction and pipe support. However the mandatory Deflection Testing shall be conducted on all PVC gravity flow piping no sooner than 30 days after completion of the trench backfill and testing for compaction. The Initial Testing must be conducted and pass the specified test requirements prior to placement of Asphalt Concrete or all weather permanent paving. The air test and television inspection of gravity flow PVC, DIP, and VCP sewers shall be conducted after the installation of curb, gutter and sidewalk, placement of 80% of the roadway Aggregate Base Rock, and the completion of the pipe cleaning.

B. DEFLECTION TESTING (Mandrel): Mandrel testing shall be conducted on PVC gravity flow Collection and Trunk Main piping and Service Laterals six (6) inches in diameter and larger. The mandrel testing shall be performed even though the sewer has been placed in service.

1. The PVC pipe shall be cleaned and then mandrel tested for obstructions, such as, but not limited to, deflections, joint offsets, and service lateral pipe intrusions.
2. A rigid mandrel conforming to ASTM D 3034 “Average Inside Diameter” shall be pulled through the pipe by hand to ensure that vertical deflection does not exceed the maximum allowable deflection. The maximum allowable deflection shall be governed by the mandrel requirements stated herein and shall be 5% for testing of the maximum inside diameter (ID) of the pipe. The maximum (max) average ID shall be equal to the average outside Diameter (OD) per the applicable ASTM Standard minus two minimum wall thicknesses per applicable ASTM Standards. Manufacturing and other tolerances shall not be considered. The max Average pipe ID and the max pipe ID for 5% deflection is shown in **Table CS 9-2**.

TABLE CS 9-2

PVC Pipe Dimensions at 5% maximum Deflection		
SDR 26 max Average Pipe Diameters per ASTM 3034		
Pipe Size	Pipe max Average I.D.	5%
6	5.764	5.476
8	7.715	7.329
10	9.644	9.162
12	11.480	10.906

3. The dimensions for the mandrel shall conform to the details shown on Exhibits A and B of these City Standard Specifications and shall:
 - a. Be a rigid, nonadjustable, and consist of nine (9) legs
 - b. Be fabricated of steel
 - c. Be furnished by the City.

4. All obstructions encountered by the mandrel shall be corrected by the Contractor. Obstructions due to deflection shall be corrected by replacement of the over-deflected pipe. Mechanical re-rounding shall not be permitted. Any pipe subject to any method or process other than removal, which attempts, even successfully, to reduce or cure any over deflection, shall be removed and replaced with new pipe from manhole to manhole. The removed pipe shall be disposed of off the project site.
5. If a section of pipe fails to meet the mandrel test and is reinstalled and fails the second time, said section(s) of pipe shall be replaced with an approved rigid pipe material.
6. The Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the City.
7. Any piping that fails to pass the mandrel test shall be replaced at the expense of the Contractor. Any repair shall include replacement of the backfill material and paving with new material in accordance with the City Standard Specifications.

C. AIR TEST – An Air Test shall be conducted on gravity flow piping only.

1. The testing method shall properly consider the existing groundwater elevations during the test. When the prevailing groundwater is above the sewer being tested, the air pressure shall be increased 0.43 psi for each foot the water table is above the flow line of the sewer. The pressure for the PVC pipe shall not exceed a total of 9 psi regardless of the depth of ground water.
2. If the test is not passed, the leak shall be found and repaired to the satisfaction of the Inspector and the length of repaired line retested. If the test section fails the test for excessive leakage, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the City.
3. Sewer laterals from the cleanout to main shall be considered part of the main to which they connect and no adjustment of test time shall be allowed to compensate for the smaller diameter of laterals.
4. The pressure gauge used for acceptance testing shall be calibrated and supplied by Contractor. The test pressure gauge full range shall measure and read from 0 to 10 psi. A current certification of calibration shall also be provided by the Contractor upon request from the Inspector.
5. The air testing equipment shall be set up such that the pressure gauge is at ground level during the test.

6. The air test procedure shall be as follows:
 - a. The length of line tested at one time shall be limited to the length between adjacent manholes.
 - b. Pressurize the test section to 4.0 pounds per square inch (psi) and hold above 3.5 psi for not less than five (5) minutes.
 - c. Add air, if necessary, to keep the pressure above 3.5 psi. At the end of the five (5) minute stabilization period, note the pressure and begin the time period.
 - d. If the pressure drop is more than 1.0 psi in the time given in the following **Table CS 9-3 and Table CS 9-4**, the section of pipe shall have failed the test.

TABLE CS 9-3

Minimum Test Time for Various VCP and DIP Sizes

Nominal Pipe size, inches	T (time), min/100 ft	Nominal Pipe size, inches	T (time), Minutes/100 ft
8	1.2	27	4.2
10	1.5	30	4.8
12	1.8	33	5.4
15	2.1	36	6.0
18	2.4	39	6.6
21	3.0	42	7.3
24	3.6		

7. The air test for PVC gravity flow piping shall be conducted in accordance with ASTM F1417 “Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air” with the exception that **Table CS 9-4** shall be used for the 1 psi pressure drop.

TABLE CS 9-4

Minimum Test Time for Various PVC Pipe Sizes

Nominal Pipe Size in Inches	Min. Time Minutes	Length for Min. Time, ft.	100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft
8	7.34	298	7.34	7.34	7.34	7.34	7.36	8.52	10.08
10	9.26	239	9.26	9.26	9.26	9.53	11.52	13.51	15.49
12	11.20	199	11.20	11.20	11.24	14.15	17.05	19.56	22.47

D. HYDROSTATIC PRESSURE TESTING FOR PRESSURE FLOW (FORCE MAINS)

The Hydrostatic pressure test shall be performed after the pipe has been installed, joints completed and restrained, the trench has been backfilled and compacted as specified, the concrete curb, gutter and sidewalk is installed, after the placement of 80% of the roadway Aggregate Base Rock, and the completion of the pipe cleaning.

The pipe shall be filled with water and all air shall be expelled. The Contractor may use a City potable water source with an approved back flow prevention device to fill the sewer pipe to be tested under the condition that a Certified Distribution System Operator of the Department of Public Works is present and controlling the valve for the potable water source.

The pipeline shall be subjected to a test pressure of 150 psi, or the service pressure plus 50 psi, whichever is greater, for a period of four hours. All tests shall be witnessed by the Inspector. The Contractor shall locate and stop all leaks or the defective pipe, fittings, or valves shall be replaced immediately. The allowable leakage shall not exceed 0.0919 gallons per hour per inch diameter per 1000 feet of main tested.

E. CLOSED CIRCUIT TELEVISION INSPECTION (CCTV) – All new gravity flow sewer main pipe installations shall be inspected by closed circuit television subject to the following conditions and requirements:

- 1.** The entire sewer system as shown on the Project Plans is ready for television inspection when the following work has been completed:

- a. All structures are in place, all channeling is complete, and pipelines are accessible from structures.
 - b. All other underground facilities, utility piping and conduits are installed.
 - c. Pipelines to be inspected have been cleaned and flushed and in the case of PVC pipe, mandrel tested.
 - d. Final air test has been completed.
 - e. Laterals have been completed.
2. The Contractor shall inform the Inspector 48 hours in advance of performing the television inspection. The Inspector shall have the right to witness the CCTV inspection as it occurs. The CCTV inspection shall be video recorded in color with digital video disk (DVD) format. A DVD disk of the television inspection shall be produced and delivered to the Inspector together with a typed log of the inspection. However, at the discretion of the City, the Director of Public Works may perform its own CCTV Inspection in lieu, of or in addition to the Contractor's CCTV Inspection.
3. The following observations from CCTV inspection will be considered defects in the construction of sewer pipelines and will require correction subject to the approval of the Director of Public Works prior to paving:
- a. Low spot (1 inch or greater)
 - b. Joint separation (3/4 inches or greater opening between pipe sections)
 - c. Cocked joints present in straight runs, or on the wrong side of pipe curves.
 - d. Chips in pipe ends more than 1/4 inch deep
 - e. Cracked or damaged pipe or evidence of the presence of an external object bearing upon the pipe (rocks, roots, etc.)
 - f. Dropped or offset joints
 - g. Infiltration
 - h. Debris or other foreign objects
 - i. Other obvious deficiencies

4. The Inspector shall notify the Contractor in writing of any deficiencies revealed by the CCTV inspection that will require repair. If corrective work is indicated and viewing of the DVD is desired, the City shall be contacted to set a time for the viewing with the Contractor.
5. All corrective work shall be completed by the Contractor. The Contractor shall test and perform a television inspection of all the repair work from manhole to manhole.
6. CCTV inspection of new work and correction of observed defects will not relieve the Contractor of his responsibility for the one-year guarantee period. The City may inspect and/or test portions of any new sewer installation during said guarantee period.

CS 9-07 CONCRETE MANHOLES:

- A. **GENERAL** – Manholes shall be constructed of precast Portland Cement Concrete components unless engineered design conforming to paragraph H, Cast in Place Option, of this section of the City Standard Specifications is included on the Project Plans or has been submitted by the Contractor and approved by the Director of Public Works. Manholes shall consist of cylindrical sections, all with joints and base construction as detailed on Standard Drawing 6-01 and shall conform to the following requirements specified in this section of the City Standard Specifications.
- B. **SPECIFICATIONS** – Precast manhole barrels, risers, cones, flat tops and grade rings shall conform to ASTM Designation C478, with the additional requirement that the cement used shall be Type II or Type V.
- C. **MANHOLE BASE** - Manhole bases may be precast or cast-in-place. The manhole excavation shall be dewatered before installing or pouring the base.
- D. **CONES** - Standard eccentric cones conforming to ASTM Designation C478 shall be used on all manholes shown on the plans unless otherwise specified. Where depth is insufficient for cones, flat slab tops shall be used.
- E. **JOINTS** – All joints in the precast manhole sections shall be made with preformed self-bonding, self-sealing plastic gasket such as “Ram-Nek”, or approved equal. The gasket shall be installed in full compliance with the manufacturer’s current recommendations. All joint surfaces shall be thoroughly cleaned prior to placing the sealing compound. The exterior joints shall be mortared and allowed to cure prior to backfilling. The interior joints shall be mortared just prior to the final cleaning and vacuum testing.

F. FRAMES AND COVERS – Manhole frames and covers shall conform to Standard Drawing 6-02 of these City Standards unless otherwise specified on the Project Plans, on the Special Provisions, or in the following requirements.

1. Castings for manhole frames and covers, cleanout frames and covers, and other purposes, shall be gray iron, free from cracks and other defects.
2. The seating faces of manhole covers and frames shall be machined as shown on the drawings to assure a tight fit and prevent rocking.
3. The Contractor shall provide the City if requested, the frame and cover manufacturer's test results stating that the material has been sampled, tested and inspected in accordance with the provisions of the latest issue of ASTM A-48, Gray Iron Castings.
4. Manhole frames and covers shall conform to Standard Drawing 6-02, unless otherwise specified on the Project Plans or in the Special Provisions.
5. Manhole covers of 36 inches in diameter and larger shall be provided at flow metering manholes, large diameter sewers, and other locations where required by the Director of Public Works. Covers shall be 2-piece and have a cast iron frame and cast iron outer cover with a concentric 24-inch cast iron inner cover, suitable for H-20 highway loading.
6. A ductile iron hinged frame and cover with a locking device shall be provided on all manholes located outside of a paved area. The cover shall be hinged and incorporate a 90-degree blocking system to prevent accidental closure and shall come complete with a hinge infiltration plug. The cover shall be operable by one person and capable of withstanding a test load of 120,000 pounds. The cover shall include the identification marking "Sewer". The cover shall also be either vented or non-vented as shown on the Project Plans. Frames shall be circular and shall incorporate a seating ring. The frame and cover shall be a Pamrex model as manufactured by CertainTeed Pam covers or approved equal. The locking device shall consist of a stainless steel locking system with opening tool approved for use by the manufacturer of the frame and cover. The Contractor shall furnish the City with only one opening tool for each project. The locking device shall be a model PL 101 as manufactured by Titus Industrial Group or approved equal. The Contractor shall notch the top grade ring of the manhole immediately below the hinge to the depth and width recommended by the manufacturer to allow for drainage and clearance of debris collected in the area of the hinge assembly.

G. FLOW CHANNELIZATION – Unless otherwise indicated on the Project Plans or in Section CS 9-07H, “Cast in Place Option”, of these City Standard Specifications, flow channels shall be provided in the sanitary sewer manhole base as shown on Standard Drawing 6-01.

H. CAST IN PLACE OPTION – The Contractor may, at his option, cast the lower portion of the manhole in place subject to the following conditions:

1. The cast in place portion shall be a minimum of six (6) inches above the outside tops of the main incoming and outgoing pipes.
2. Steel reinforcement shall be furnished and placed in the cast portion of the manhole and shall be subject to inspection by the Inspector.
3. The slab and wall section of the base shall be connected with integrally poured concrete to create a watertight joint. The flow channels shall be constructed in such a manner that changes in pipe size or grade shall be made gradually and changes in direction by smooth curves.
4. The Contractor shall furnish the Inspector a submittal for review and approval by the Director of Public Works that satisfies all the requirements of these City Standard Specifications and the City Standard Drawings. This submittal must be approved by the Director of Public Work prior to the Contractor commencing trenching for pipe or excavation for the manhole.

I. INTERIOR WATERPROOF SEAL – Any time that a waterproof seal is applied to the interior of a sanitary sewer manhole it shall be sealed with XYPEX Admix, Tegraproof or an approved equal, and it shall be applied in accordance with the manufacturer’s recommendations.

J. VACUUM TEST – The Contractor shall perform a vacuum test for each manhole consisting of the following requirements:

1. The test shall be performed after, completion of the manhole assembly, including mortaring of exterior joints, backfilling, and compaction, and just prior to placing Asphalt Concrete, installing the manhole frame and cover and concrete collar. The test may also be performed at the Contractor’s option prior to installation of grade rings unless otherwise required on the Project Plans.
2. The Contractor shall furnish the materials and equipment necessary to conduct the test.
3. All lift holes shall be filled with non-shrink grout prior to testing.
4. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the plugs to prevent being sucked into the manhole during testing. Unused channels shall be permanently plugged and eliminated with mortar. The plug shall not affect the flow characteristics of the remaining channel(s).

5. A vacuum of ten (10) inches of mercury (or 5.0 psig) shall be drawn and the vacuum pump shall be shut off to start the test. The valve on the vacuum line of the test head shall be closed. The amount of time required to drop to nine (9) inches of mercury (or 4.5 psig) shall be measured. The manhole shall pass the test if the elapsed time is equal to or greater than the minimum test times shown in **Table CS 9-5**.

Table CS 9-5

Minimum Test Time for Manhole Vacuum Test

Depth of Manhole in feet measured from the top of the rim.	Manhole Diameter	
	48 Inches	60 Inches
Minimum Test Time in Seconds		
≤24	60	78
26	64	85
28	69	91
30	74	98

6. If the manhole fails the test, repairs shall be made as necessary. Retesting shall proceed until the elapsed times are satisfactory.
7. After passing the vacuum test all interior joints shall be mortared.

CS 9-08 ADJUST MANHOLES TO GRADE:

- A. The adjustment of manholes shall conform to adjacent surface elevations and may be made by utilization of precast grade rings.
- B. The method for adjusting manholes shall conform to Section 15-2.05A of the State Specifications except as modified by these Construction Standards.
- C. Adjusting manholes to grade within marked traffic lanes shall be completed, including placing concrete around and to the level of the ring and cover, by the end of the same day on which work is started.

CS 9-09 CLEANOUTS: Cleanouts shall be constructed as shown on the Standard Drawing 6-06 of these City Standards.

CS 9-10 SERVICE LATERALS:

A. INSTALLATION –Service laterals shall be installed as detailed on Standard Drawings 6-05 and 6-07 and at the locations shown on the Project Plans.

1. Unless otherwise specified, laterals shall be four (4) inches in diameter and constructed to the property line or easement line.
2. A regularly manufactured “wye” fitting shall be used for each sewer lateral and shall be inclined upwards at an angle of 45° from the horizontal.
3. The ends of all sewer laterals shall be securely sealed by stoppers in such a manner that the stoppers can be removed for extending the lateral without damage to the pipe.
4. Unless otherwise noted on the plans, the depth of cover of the sewer lateral at the easement or property line shall be a minimum of three (3) feet below the bottom surface of the gutter flowline.
5. With the exception of terminal manholes such as in a cul-de-sac bulb, sewer service laterals connecting at manholes shall be set with the invert of the lateral no lower than the crown of the outgoing pipe. Sewer service laterals connecting at terminal manholes shall be set with the invert of the lateral no lower than the invert of the outgoing sewer main invert.
6. Internal drops in excess of one (1) foot shall be made using an Internal Drop Connection per Standard Drawing 6-04 unless otherwise approved by the Director of Public Works. External drop connections shall not be allowed.

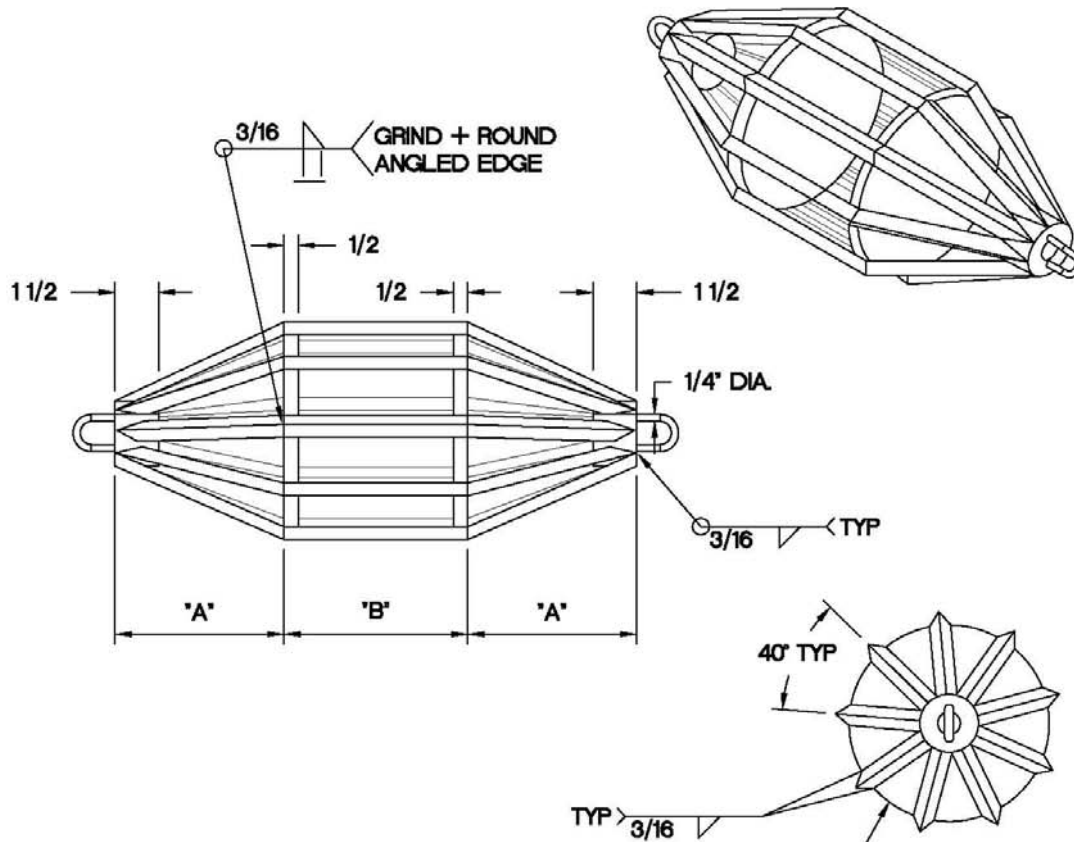
B. CONNECTION TO EXISTING MAIN – When a proposed sewer service lateral is to be connected to an existing sewer main, the installation shall conform to Standard Drawing 6-07 unless the Director of Public Works requires that a Wye fitting be cut in.

C. CLEANOUTS – Unless otherwise noted on the plans, cleanouts shall be provided for all sewer laterals as per Standard Drawing 6-06. The cleanout shall be located one (1) to three (3) feet from the back of the sidewalk where the sidewalk is attached to the curb and gutter. The cleanout shall be located one (1) to three (3) feet behind the face of curb where the sidewalk is not attached to the curb. A concrete box shall be set over the cleanout and at finish grade of the adjacent surface.

D. LOCATION MARKER – In improved areas, the location of each service shall be permanently indicated by inscribing the letter “S” in the face of curb directly above the line.

E. TELEVISION INSPECTION –Sewer Service Laterals may be Television inspected in accordance with Section CS-9-06.E of these City Standard Specifications at the sole discretion of the Inspector.

DWG File: G:\CIP\600's\653\12AFRC05\Sewer Standard Drawings\Exh_A_Mandrel.dwg



NOTE: MACHINE PLATE TO CALCULATED OD.
RECHECK AND ADJUST FINISHED ID AFTER WELDING.

DIMENSIONS FOR 5% DEFLECTION MANDREL ARE SHOWN IN INCHES

PIPE SIZE	AVERAGE ID	'A'	'B'	MANDREL OD	PROVING RING ID
6"	5.764	6	6	5.50	5.54
8"	7.715	6	6	7.36	7.40
10"	9.644	8	8	9.20	9.25
12"	11.480	8	8	10.96	11.00

EXHIBIT 'A'
9 SKID MANDREL

DWG File: C:\CIP\600\653\12APR05\Sewer_Standard_Drawings\Exh_B_Mandrel_Top.dwg

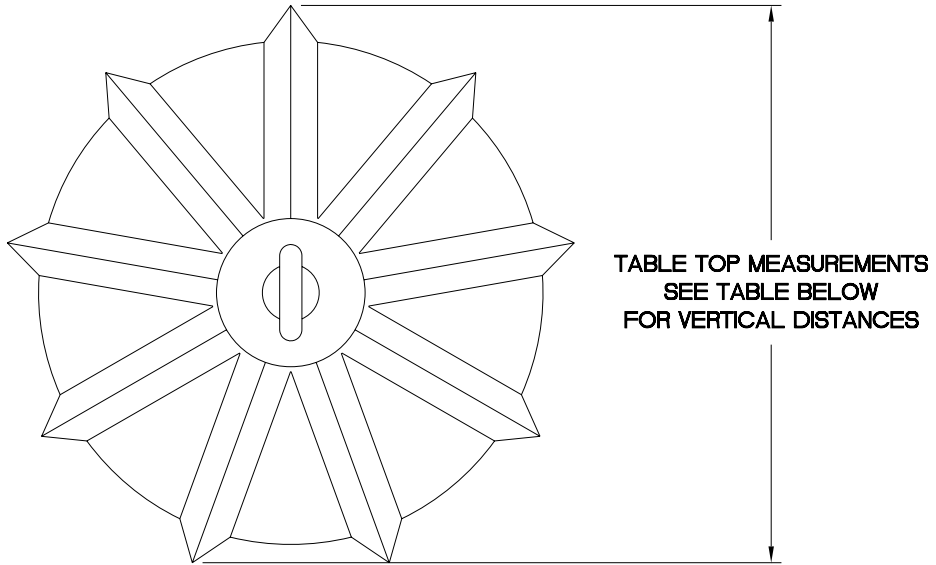


TABLE TOP MEASUREMENTS FOR
5% DEFLECTION MANDREL ARE SHOWN IN INCHES

PIPE SIZE	AVERAGE ID	TABLE TOP MEASUREMENTS
6"	5.764	5.34
8"	7.715	7.15
10"	9.644	8.93
12"	11.480	10.63

EXHIBIT "B"
9 ROD MANDREL TABLE TOP MEASUREMENTS METHOD