

SECTION 01440

TESTING – COLLECTION AND DISTRIBUTION SYSTEMS

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. All fluid retaining structures/piping in the collection and distribution systems are required to be watertight and shall be tested by the Developer and witnessed by the Authority Engineer. Structures/piping shall be tested with as specified.
- B. All tests shall be conducted in a manner to minimize as much as possible any interference with the Developer's work or progress.
- C. The Developer shall notify the Authority Engineer when the work is ready for testing, and tests shall be made as soon thereafter as soon as possible. Personnel for reading meters, gauges, or other measuring devices and all other labor, equipment, air, water, and materials, including meters, gauges, fuel, bulkheads, and accessory equipment, shall be furnished by the Developer.

1.02 FIELD TESTS

- A. In order to keep leakage and infiltration in sewers and manholes within reasonable limits, it is necessary that special attention be given to specification requirements covering workmanship, materials and testing. Specifications for this installation include the following provisions:

- 1. Infiltration and leakage through manhole walls and pipe joints shall not exceed 20 gallons per 24 hours per inch diameter per 1,000 feet of any type of pipe installed. Surface water leakage through manhole covers will be excluded from these limits. In testing for infiltration, sufficient weir measurements shall be made in manholes to furnish necessary information.
- 2. Where the Engineer determines that groundwater is not sufficiently high at the time of testing to determine the amount of infiltration or leakage, exfiltration tests shall be conducted in which a head of water at least three feet (3') higher than the top of the pipe line in the highest section of the work being tested, is maintained during the period of the test.

Allowable leakage per twenty-four hours per inch of diameter of pipe per 1,000 foot of sewer tested shall not exceed 20 gallons for any type of pipe installed.

Water for such exfiltration tests shall be furnished by the Contractor at no additional expense.

- 3. Length and location of sections to be tested, duration of tests, and other requirements shall be determined by the Engineer.

4. Sewers shall not be tested until at least two weeks after installation. (Installation includes collector sewer and lateral sewer.)
 5. All evident leaks shall be investigated and necessary repairs made, and leakage minimized regardless of total leakage as shown by test.
 6. Lines, which fail to meet tests, shall be repaired and re-tested as necessary until compliance with test requirements. Defective pipe and branch connections shall be removed and replaced. Manholes shall be repaired inside and/or outside, as required. Under no circumstances will pressure grouting be an approved method of repairing leaks in sewer pipe. Any defective pipe must be replaced with new material. The Contractor shall notify the Engineer 24 hours prior to testing and/or repairing so an observer can be present.
 7. The Authority will require TV inspection at the expense of the Owner of all sections of pipe, and if found defective, the Contractor shall replace item at no cost to the Authority or Engineer, even if the Authority or Engineer had previously approved it, and re-TV the line.
- B. In lieu of exfiltration tests, air tests may be used if approved by the Engineer. This method will be used for sewers and laterals whose gradient is such that excessive pressures would develop from use of the water method. The air method may also be used for any test if so directed by the Engineer or preferred by the Contractor. These test shall be conducted in accordance with the following:
1. Air compressors to be used for tests must be equipped to control air entry rate and prevent the pressure from exceeding 5 psig.
 2. Tests will be performed on pipe with a wet inside condition.
 3. All outlets from the section to be tested, fitted with airtight plugs and braced to withstand the applied pressure.
- C. After the pipe has been wetted, air will be slowly admitted to the test section until a constant pressure of approximately 4.0 psig is reached and maintained for at least two minutes to allow for temperature equalization. During this time, all plugs shall be checked for tightness with soap solution. If leaks are found, pressure will be released and plugs tightened to stop the leakage. This procedure will be repeated until all plugged openings are found to be tight.
- D. When air temperature has adjusted and pressure is constant at 4 psig, air supply will be disconnected and gauge observed. When pressure reaches 3.5 psig, a stopwatch will be started and then stopped when pressure has reached 2.5 psig. Due allowance shall be made for various pipe sizes involved in the test section. The pipeline will be considered to have passed the air loss test successfully if the time shown on the stopwatch is not less than amounts shown on the attached Table 2 for the respective pipe diameters.

1.03 LABORATORY TESTS

- A. The materials listed below shall require advance and periodic tests as indicated, and shall be sampled in accordance with the methods of ASTM and as required by the Engineer.

The laboratory conducting the tests shall furnish both the Engineer and Developer with two copies of the reports showing results of such tests, and the report shall be considered as sufficient evidence of the acceptance or rejection of the quality of material tested. Specifications for, and methods of testing will be found under detailed specifications for the particular material involved. All samples shall be properly packed and clearly marked as to source and intended use.

<u>Material</u>	<u>Test Frequency</u>	<u>Sample Size</u>
Concrete (cast-in-place)	Advance, then each 50 cubic yards	4 cylinder per test 2 broken at 7 days and 2 at 28 days

PART 2 PRODUCTS

(Not Used)

PART 3 EXECUTION

3.01 MANHOLES

A. Exfiltration Method

1. The manhole to be tested shall have all sewer openings plugged and then be filled to the top with water.
2. After the concrete has absorbed enough water for a stabilized condition, manhole shall be refilled and water level in the manhole shall be maintained for one hour without more than a 2" drop.
3. If manhole excavation is full of water, it shall be dewatered and kept dry during the test.

B. Vacuum Method

1. Each manhole may be tested immediately after assembly and prior to backfilling at option of the Developers and as provided in Section 01430.
2. All lift holes shall be plugged with an approved non-shrink grout.
3. All pipes entering the manhole shall be plugged, taking care to securely brace the plug from being drawn into the manhole.
4. 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.
5. 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 manholes.

6. 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.

3.02 PRESSURE PIPE

A. General

Where any section of a main is provided with concrete reaction backing (thrust block) for fittings or bases, the hydrostatic pressure test shall not be made until at least seven days after installation of the concrete reaction backing, unless otherwise approved.

B. Test Restrictions

1. Test pressure shall not be less than 1.25 times the working pressure at the highest point along the test section.
2. Test pressure shall not exceed pipe or thrust-resistant design pressures.
3. The hydrostatic test shall be of at least 30-minute duration.
4. Test pressure shall not vary by more than +5 psi (35 mPa or 0.35 bar) for the duration of the test.
5. Valves shall not be operated in either direction at differential pressure exceeding the rated valve working pressure. Use of a test pressure greater than the rated valve pressure can result in trapped test pressure between the gates of a double-disc gate valve. For tests at these pressures, the test setup should include provision, independent of the valve, to reduce the line pressure to the rated valve pressure on completion of the test. The valve can then be opened enough to equalize the trapped pressure with the line pressure, or fully opened if desired.

C. Pressurization

1. After the pipe has been laid, all newly laid pipe or any valved section thereof shall be subjected to a hydrostatic pressure of at least 1.5 times the working pressure at the point of testing. Each valved section of pipe shall be slowly filled with water, and the specified test pressure, based on the elevation of the lowest point of the line or section under test 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 owner. Valves shall not be operated in either the opening or closing direction at differential pressures above the rated pressure. It is good practice to allow the system to stabilize at the test pressure before conducting the leakage test.

D. Air Removal

1. Before applying the specified test pressure, air shall be expelled completely from the pipe, valves, and hydrants. If permanent air vents are not located at all high

points, the contractor shall install corporation cocks at such points so that the air can be expelled as the line is filled with water. After all the air has been expelled, the corporation cocks shall be closed and the test pressure applied. At the conclusion of the pressure test, the corporation cocks shall be removed and plugged or left in place at the discretion of the Authority.

E. Examination

1. Any exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with sound material, and the test shall be repeated until it is satisfactory to the Authority.

F. Backfilling

1. Contractor shall backfill all pipe and provide all reaction blocking before making hydrostatic leakage tests. It shall be the Contractor's responsibility to locate and repair any and all leaks that may develop. The Engineer may direct the Contractor to leave certain joints and connections uncovered until testing has been completed.

G. Leakage defined

1. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe or any valved section thereof to maintain pressure within 5 psi (35 MPa or 0.35 bar) of the specified test pressure after the pipe has been filled with water and the air has been expelled. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

H. Allowable Leakage

1. No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \frac{SDP}{133,200} \quad (\text{Eq. 1})$$

Where:

L	=	Allowable leakage, in gallons per hour
S	=	length of pipe, in feet
D	=	nominal diameter of the pipe, in inches
P	=	average test pressure during the leakage test, in pounds per square inch (gauge)

This formula is based on an allowable leakage of 11.65 gpd/mi./in. of nominal diameter at a pressure of 150 psi.

2. Allowable leakage at various pressures is shown in the attached Table 1.

3. When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gph/in. (0.0012 L/h/mm) of nominal valve size shall be allowed.
4. When hydrants are in the test section, the test shall be made against closed hydrant valves.

I. Acceptance of Installation

1. Acceptance shall be determined based on allowable leakage. If any test of laid pipe discloses leakage greater than that as specified above the Developer shall, at his own expense, locate and make approved repairs as necessary until the leakage is within the specified allowance.
2. All visible leaks are to be repaired, regardless of the amount of leakage.

3.03 SEWER PIPE

- A. Includes gravity sewer lines and other pipes intended to be watertight but not under pressure.
- B. The Developer shall furnish all labor, tools, materials including water and equipment including mirrors, flashlights or other artificial lighting, weirs, pump, compressors, stopwatch, gauges, and meters, subject to the approval of the Authority Engineer for testing in accordance with these specifications.
- C. All branch fittings and ends of lateral stubs shall be securely plugged to withstand the internal test pressures. The section of line being tested shall also be securely plugged at each manhole. All stoppers shall be adequately braced when required.
- D. Air shall be slowly supplied to the plugged pipeline until the internal air pressure reaches 5.0 pounds per square inch. At least two minutes shall be allowed for temperature stabilization before proceeding further.
- E. The rate of air loss shall then be determined by measuring the time interval required for the internal pressure to decrease by 1.0 pound per square inch.
- F. The line shall be considered acceptable if the time, T, in minutes; required for the 1.0 psi pressure drop is not less than 10 minutes.

3.04 DEFLECTION TEST OF PVC PIPE

- A. General
 1. Deflection testing shall be performed on all portions of the PVC sewer system. This test shall be performed in sections between manholes, not less than 30 days after final grading has been placed.
- B. Maximum Deflection
 1. The maximum allowable deflection for all installed PVC sewer pipe shall not exceed 5% of the pipe's original internal diameter.

C. Testing Apparatus

1. Deflection testing shall be performed with a “go, no-go” mandrel, which shall have a diameter not less than 95% of the base inside diameter or average inside diameter of the pipe as specified in the ASTM Specification. The pipe shall be measured in compliance with ASTM D 2122 Standard Test Method of Determining Dimensions of Thermoplastic Pipe and Fittings. The test shall be performed without mechanical pulling devices.

D. Deflection Testing Procedure

1. Completely flush the line making sure the pipe is clean of any mud or debris that would hinder the passage of the mandrel.
2. During the final flushing of the line, attach a floating block or ball to the end of the mandrel pull rope and float the rope through the line.
3. After the rope is threaded through the line, connect the pull rope to the mandrel and place the mandrel in the entrance of the pipe.
4. Connect a retrieval rope to the back of the mandrel to pull it back if necessary.
5. Remove all the slack in the pull rope and place a tape marker on the rope at the ends of the pipe.
6. Draw mandrel through the sewer line. If any irregularities or obstructions are encountered in the line, those areas shall be replaced or corrective action taken to correct the condition to the satisfaction of the Authority.
7. If a section of excessive deflection is found, that section of the pipe shall be replaced to the satisfaction of the Authority.

END OF SECTION

TABLE 1 - ALLOWABLE LEAKAGE PER 1000 FT OF PIPELINE *

NOMINAL PIPE DIAMETER - IN.

<i>Avg. Test Pressure Psi (bar)</i>	3	4	6	8	10	12	14	16	18	20	24	30	36	42	48	54
450 (31)	0.48	0.64	0.95	1.27	1.59	1.91	2.23	2.55	2.87	3.18	3.82	4.78	5.73	6.69	7.64	8.60
400 (28)	0.45	0.60	0.90	1.20	1.50	1.80	2.10	2.40	2.70	3.00	3.60	4.50	5.41	6.31	7.21	8.11
350 (24)	0.42	0.56	0.84	1.12	1.40	1.69	1.97	2.25	2.53	2.81	3.37	4.21	5.06	5.90	6.74	7.58
300 (21)	0.39	0.52	0.78	1.04	1.30	1.56	1.82	2.08	2.34	2.60	3.12	3.90	4.68	5.46	6.24	7.02
275 (19)	0.37	0.50	0.75	1.00	1.24	1.49	1.74	1.99	2.24	2.49	2.99	3.73	4.48	5.23	5.98	6.72
250 (17)	0.36	0.47	0.71	0.95	1.19	1.42	1.66	1.90	2.14	2.37	2.85	3.56	4.27	4.99	5.70	6.41
225 (16)	0.34	0.45	0.68	0.90	1.13	1.35	1.58	1.80	2.03	2.25	2.70	3.38	4.05	4.73	5.41	6.03
200 (14)	0.32	0.43	0.64	0.85	1.06	1.28	1.48	1.70	1.91	2.12	2.55	3.19	3.82	4.46	5.09	5.73
175 (12)	0.30	0.40	0.59	0.80	0.99	1.19	1.39	1.59	1.79	1.98	2.38	2.98	3.58	4.17	4.77	5.36
150 (10)	0.28	0.37	0.55	0.74	0.92	1.10	1.29	1.47	1.66	1.84	2.21	2.76	3.31	3.86	4.41	4.97
125 (9)	0.25	0.34	0.50	0.67	0.84	1.01	1.18	1.34	1.51	1.68	2.01	2.52	3.02	3.53	4.03	4.53
100 (7)	0.23	0.30	0.45	0.60	0.75	0.90	1.05	1.20	1.35	1.50	1.80	2.25	2.70	3.15	3.60	4.05

* If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

TABLE 2 – TIME REQUIREMENTS FOR AIR TESTING *

NOMINAL PIPE DIAMETER - IN.

PIPE DIAMETER (inches)	TIME	
	(minutes)	(seconds)
4	2	32
6	3	50
8	5	6
10	6	22
12	7	39
14	8	56
15	9	35
16	10	12
18	11	34

* Air pressure correction is required when the prevailing ground water is above the sewer line being tested. Under this condition, the air test pressure must be increased .433 psi for each foot the ground water level is above the invert of the pipe.