

## **SECTION 33 31 23 – TESTING SANITARY SEWER SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes the Work necessary to test gravity sewer pipe, force main pipe, manholes and appurtenances.
- B. Related sections:
  - 1. Section 33 39 17 – Polymer Concrete Manholes
  - 2. Section 33 41 20 – Solid Wall PVC Gravity Sewer Pipe, Water Pipe, and Fittings

#### **1.2 GENERAL**

- A. General Requirements: See Division 01, GENERAL REQUIREMENTS, which contains information and requirements that apply to the work specified herein and are mandatory for this project.

### **PART 2 - PRODUCTS (NOT USED)**

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. The contractor is responsible for supplying all equipment required to conduct testing and all testing shall be conducted by the Contractor.
- B. All testing shall be conducted in the presence of the Engineer.

#### **3.2 GRAVITY SEWER TESTING**

- A. The Contractor shall verify water tightness by air testing.
- B. Gravity Sewers – Air Testing:
  - 1. After gravity sanitary sewer and service pipe have been laid, all newly laid sewer main pipe shall be subject to an air pressure test to determine watertightness from air loss.
  - 2. Test Equipment:
    - a. All necessary equipment to perform the air test in accordance with this specification shall be provided by the Contractor. The test gauge shall have incremental divisions of 0.10 psi and have an accuracy of at least plus or minus 0.04 psi. In no case shall a test gauge be used which has incremental divisions of greater than 0.25 psi. The gauge shall be of sufficient size to determine accuracy.
  - 3. Procedure:
    - a. As each section of sewer is completed between manholes, each section shall be air tested. When practical, house connections in each section shall be completed. Air test shall be low-pressure air test based on the principal of air-pressure loss per time period. Contractor shall prepare a log of testing and submit this to the Engineer as each section is completed and tested. All tests shall be accomplished in the presence of the Engineer.
    - b. The test section of the sewer line is plugged at each end. One of the plugs used at the manhole must be tapped and equipped for air inlet connection for filling the line from the air compressor.

- c. All service laterals, stubs and fittings into the sewer test section shall be properly capped or plugged, and carefully braced against the internal pressure to prevent air leakage by slippage and blowouts.
- d. Connect air hose to tapped plug selected for the air inlet. Then connect the other end of the air hose to the portable air control equipment which consists of valves and pressure gauge used.
  - 1) To control air entry rate to the sewer test section, and
  - 2) To monitor the air pressure in the pipe line.More specifically, the air control equipment includes a shutoff valve, pressure regulating valve, pressure reduction valve and a monitoring pressure gauge having a pressure range from 0-5 psi. The gauge shall have minimum divisions of 0.10 psi and an accuracy of 0.04 psi.
- e. Connect another air hose between the air compressor (or other source of compressed air) and the air control equipment. This completes the test equipment set-up. Test operations may commence.
- f. Supply air to the test section slowly, filling the pipe line until a constant pressure of 4.0 psig is maintained. The air pressure must be regulated to prevent the pressure inside the pipe from exceeding 5.0 psig.
- g. When constant pressure of 4.0 psig is reached, throttle the air supply to maintain the internal pressure between 3.5 to 4.0 psig for at least 5 minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall. If leakage is detected at any cap or plug, release the pressure in the line and tighten all leaky caps and plugs.

Then start the test operation again by supplying air. When it is necessary to bleed off the air to tighten or repair a faulty plug, a new five-minute interval must be allowed after the pipeline has been refilled.
- h. After the stabilization period, adjust the air pressure to 3.5 psig and shutoff or disconnect the air supply. Observe the gauge until the air pressure reaches 3.5 psig. At 3.5 psig commence timing with a stop watch which is allowed to run until the line pressure drops to 2.5 psig at which time the stop watch is stopped. The time required, as shown on the stop watch for a pressure loss of 1.0 psig, is used to compute the air loss.
- i. If the time in minutes and seconds for the air pressure to drop from 3.5 to 2.5 psig is greater than that shown in the table for the designated pipe size, the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued at that time.
- j. If the time in minutes and seconds for the 1.0 psig drop is less than that shown on the table for the designated pipe size, the section of pipe shall not have passed the test; therefore, adequate repairs must be made and the line retested.
- k. Pipe sizes with their respective recommended minimum times, in minutes and seconds, for acceptance by the air test method are as shown below.

Minimum Time For A 1.0 psig Pressure Drop (Min:Secs)										
Distance Between Manholes	Nominal Diameter (inches)									
	8	10	12	15	18	21	24	30	36	42
100'	7:33	9:26	11:20	14:10	17:00	19:50	22:47	35:37	51:17	69:48
150'	7:33	9:26	11:20	14:10	17:00	26:11	34:11	53:25	76:55	104:42
200'	7:33	9:26	11:23	17:48	25:38	34:54	45:34	71:13	102:34	139:37
250'	7:33	9:53	14:14	22:15	32:03	43:38	56:58	89:02	128:12	174:30
300'	7:35	11:52	17:05	26:42	38:27	52:21	68:22	106:50	153:50	209:24
350'	8:51	13:51	19:56	31:09	44:52	61:08	79:46	124:38	179:29	244:19
400'	10:07	15:49	22:47	35:36	51:17	69:48	91:10	142:26	205:07	279:13
450'	11:23	17:48	25:38	40:04	57:41	78:32	102:33	160:15	230:46	314:07
500'	12:39	19:47	28:29	44:31	64:06	87:15	113:57	178:03	256:24	349:01

*Times for distances not listed in the table can be obtained by calculating the straight-line ratio between distances given.*

- l. For testing of long sections or sections of larger diameter pipes, or both, a timed-pressure drop of 0.5 psig may be used in lieu of a 1.0 psig timed-pressure drop as approved by the Owner or Engineer. If a 0.5 psig pressure drop is used, the appropriate required test time shall be exactly one-half the values shown in the table above.
- m. An 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 0.433 psi for each foot the ground water level is above the invert of the pipe.
- n. Height of ground water above sewer pipe shall be determined by a method approved by the Engineer.
- o. Any leaks in the system shall be repaired immediately upon discovery. Costs for repairing faulty work, including excavating and re-backfilling and for making tests, shall be paid for by the Contractor.
4. Safety Precautions:
  - a. The low pressure air test may be dangerous to personnel if, through lack of understanding or carelessness, a line is over pressurized or plugs are installed improperly. It is extremely important that the various plugs be installed to prevent the sudden expulsion of a poorly inflated plug. As an example of the hazard, a force of 250 pounds is exerted on an 8 inch plug by an internal pressure of 5 psi. Observe the following safety precautions.
    - 1) No one shall be allowed in the manholes during the test or when a plugged pipe is under pressure.
    - 2) Gauges, air piping manifolds, and valves shall be located at the top of the ground.
    - 3) Install and brace all plugs securely.
    - 4) Do not over pressurize the lines.

### 3.3 PIPE DEFLECTION TESTING

- A. General
  1. All PVC, FRP, and Ductile Iron gravity sewer lines shall be mandrel tested in accordance with these specifications prior to acceptance.
- B. Allowable Deflection:

1. The maximum allowable pipe deflection shall not exceed 5 percent of the inside diameter.
- C. Mandrel:
1. The mandrel shall be hand-pulled by the Contractor through all PVC, FRP, and Ductile Iron gravity sewer lines no earlier than 30 days after the trench has been completely backfilled. Any sections of the sewer not passing the mandrel shall be uncovered and the Contractor shall rebed, reround, or replace the sewer to the satisfaction of the Engineer. Any repaired section shall be retested after a sufficient time has elapsed to ensure that trench settlement has stopped. This retest time shall be totally dependent upon method of repair. If the trench has been opened, the retest shall have the same requirements as the original installation. If the pipe has been rerounded, retest shall not occur sooner than seven days after rerounding.
  2. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. The contact length of the mandrel's arms shall equal or exceed the nominal diameter of the sewer to be inspected. Critical mandrel dimensions shall carry a tolerance of plus or minus 0.01 inch. The mandrel and all necessary equipment for the mandrel test shall be provided by the Contractor.
  3. The Owner reserves the right to mandrel test any PVC, FRP, or Ductile Iron sewer pipe before acceptance, and also prior to expiration of the first year of operation. If a previously accepted line fails a mandrel test performed during the first year of operation, the defects must be corrected at the Contractor's expense.

### 3.4 TELEVISION INSPECTION

- A. The Contractor shall televise all newly installed sewer mains as follows:
- B. The Contractor shall clean all lines thoroughly prior to the start of televising.
- C. The Contractor shall televise each segment of pipe.
- D. The camera shall be moved through the line in either direction at a uniform slow rate not to exceed 60 feet per minute, by means of cable winches, or similar mechanisms. **Under no circumstances shall the camera be tethered to a hydraulically propelled or high-velocity jet cleaning device while the cleaning device is on.**
- E. The Contractor shall review the video for possible defects in material or workmanship.
- F. The Contractor shall correct any defects discovered during the television inspection at the Contractor's expense.
- G. The Contractor shall deliver to the Engineer final video in DVD format and logs after all defects have been repaired.

### 3.5 INSPECTION OF SERVICE LINES

- A. All building sewer lines shall be installed and tested in accordance with all state, regional, and local plumbing codes.
- B. All building sewer installations shall be inspected and approved by an authorized local governing agency inspector.
- C. Backfill may only be placed on the completed portions of a building sewer following inspection. No approval certificate shall be issued until all portions of a building sewer from the main

connection to the building foundation have been inspected and approved by an authorized inspector. At the time of inspection, the pipe should be in place in the trench and "safed-up", but the top half of the pipe barrel exposed. No approval will be given for building sewers all or a portion of which are covered at the time of inspection.

- D. All building sewers are subject to testing to insure water tightness. All tests must be performed in the presence of the Engineer. Tests shall be:
  - 1. Low Pressure Air Loss Procedure.
- E. If, in the opinion of the Engineer, the line in question is properly installed and free from open joints and breaks, building sewers constructed entirely of cast iron soil pipe may be connected to the sewer without testing.
- F. Low Pressure Air Loss Procedure
  - 1. Plug securely both ends of the line to be tested.
  - 2. Charge the line with air to a pressure of 4.5 psig.
  - 3. Allow at least five minutes for the temperature in the pipe to stabilize.
  - 4. Measure the time required for a one (1.0) psi drop in pressure.
  - 5. The minimum time for a one psi loss is  $28.5 \times d$  seconds where  $d$  = the nominal diameter in inches of the pipe being tested.

### 3.6 MANHOLE TESTING

- A. Testing, Observations and Guarantee Period:
  - 1. The testing required shall be performed by the Contractor at all manholes and documented to the satisfaction of the Engineer.
  - 2. Testing shall not be performed on a specific manhole until all work has been completed for that specific manhole.
  - 3. Any manholes that are observed to be leaking by the Engineer shall be subject to additional repairs and retested by the Contractor at no additional cost to the Owner.
- B. Inflow Testing:
  - 1. All rehabilitated manholes and new manholes shall be dye tested. Manholes shall be dye water tested in the presence of the Engineer. The dye test shall consist of applying a concentrated dye solution around the manhole frame. Dyed water shall be applied for at least ten (10) minutes.
  - 2. Manholes observed to be actively leaking will have failed the test and will not be acceptable. Manholes failing the test will require additional rehabilitation by the Contractor at no additional compensation. The manhole shall then be retested as described above until a successful test is made.
- C. Vacuum Testing:
  - 1. All new and rehabilitated manholes shall be vacuum tested by the Contractor in the presence of the Engineer for sources of infiltration. Testing will be made during high groundwater conditions, wherever possible.
  - 2. Manholes shall be tested after installation with all connections (existing and/or proposed) in place. Drop-connections and gas sealing connections shall be installed prior to testing. The lines entering the manhole shall be temporarily plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop-connections, gas sealing connections, etc. The test head shall be placed inside the frame at the top of the manhole and inflated in accordance with the manufacturer's recommendations. Plate type test heads that rest on top of the frame are also acceptable. A vacuum of 10 inches of mercury shall be drawn, and the vacuum pump will be turned off. With the valve closed, the level of vacuum shall be read after the

required test time. If the drop in the level is less than 1-inch of mercury (final vacuum greater than 9 inches of mercury), the manhole will have passed the vacuum test. After a successful test, the temporary plugs will be removed. The required test time is determined from the table below.

Minimum Time Required for a Vacuum Drop of 1" H <sub>g</sub> (10"H <sub>g</sub> - 9"H <sub>g</sub> ) (min:sec)				
Depth of Manhole (ft.)	Manhole Inside Diameter (inches)			
	48"	60"	72"	96"
8'	:20	:26	:32	:45
10'	:25	:33	:40	1:00
12'	:30	:39	:48	1:07
14'	:35	:46	:57	1:18
16'	:40	:52	1:05	1:29
18'	:45	:59	1:13	1:40
20'	:50	1:05	1:21	1:52
22'	:55	1:12	1:29	2:03
24'	:60	1:19	1:37	2:14
26'	1:05	1:25	1:45	2:25
28'	1:10	1:32	1:53	2:36
30'	1:15	1:38	1:01	2:47
Add for each Additional 2'	:05	:07	:08	:11

3. Manhole vacuum levels observed to drop greater than 1-inch of mercury (Final vacuum less than 9 inches of mercury) will have failed the test and will require additional rehabilitation. The Contractor shall make the necessary repairs at no additional compensation for only those work items completed by the Contractor. The manhole shall then be retested as described above until a successful test is made.

### 3.7 PRESSURE TEST FOR FORCE MAINS

- A. Perform hydrostatic leakage tests for force mains by filling the force main with water and increasing the pressure to a testing pressure of 150% of the working pressure with a minimum of 100 psi.
- B. The duration of the leakage test shall be two hours or as specified by the Engineer.
- C. The force main will not be accepted until the actual leakage is equal to or less than the allowable. In addition, all obvious leaks shall be repaired.
- D. The allowable leakage rate per hour for ductile iron, PVC, FRP or concrete pipe shall be calculated by the following formula:

$$L = \frac{ND \times P^{.5}}{7400}$$

$L$  = Allowable Leakage (gallons per hour)

$N$  = Number of Joints in Pipeline Tested

$D$  = Nominal Diameter (inches)

$P$  = Test Pressure (psi)

### **3.8 SYSTEM COORDINATION**

- A. Maintain existing sewer flow through new connecting manholes until new sewer is approved by Engineer.
- B. Reshape manhole bottom to divert sewer flow into new sewer after new sewer is approved by Engineer.
- C. Locate sewer services before completing the first manhole downstream from the sewer service.

**- END OF SECTION -**