

EXHIBIT "E"

TESTS FOR LEAKAGE AND INFILTRATION AFTER CONSTRUCTION
OF SEWER LINES

Pursuant to Section 5.03 of these Rules and Regulations, unless deemed unnecessary by the District Engineer, each section of newly constructed or replaced sewer line between two successive manholes shall be tested for leakage and/or infiltration before probationary acceptance of the line. The contractor shall furnish all materials required for the tests. Tests shall be made in the presence of the District Engineer.

If, in the opinion of the District Engineer, heavy compaction equipment or any of the operations of the contractor or others may have damaged or affected the required water-tight integrity of a previously tested line, a retest may be required.

If the leakage and/or infiltration rate as shown by the test exceeds allowable amounts, the pipe joints shall be repaired or, if necessary, the pipe shall be removed and relaid by the contractor.

The contractor may at his option air test or water test for leakage except where (a) in the opinion of the District Engineer excessive groundwater is encountered, so that the infiltration test shall be required, or (b) where the difference in elevation between the invert of the upper structure and the invert of the lower structure is more than 10 feet, in which event the air test shall be utilized.

I. Leakage Tests:

A. Exfiltration:

Gravity concrete and clay sewer lines shall permit not more than two-hundred (200) gallons of infiltration per day, per mile of pipe, per inch nominal diameter. PVC sewer lines shall permit not more than fifty (50) gallons of infiltration per day, per mile of pipe, per inch nominal diameter.

In areas where the groundwater level is less than one foot (1') above the pipe, the contractor shall perform an exfiltration or leakage test. After capping and blocking all wyes or tees, the pipe between successive manholes shall be filled with water, including the upstream manholes.

The water depth above the pipe invert at the lower end shall be at least to the elevation of the ground surface,

unless otherwise specified. The maximum depth at the lower end shall not exceed 25 feet, and the minimum depth at the upper end shall be at least five feet (5') above the crown of the pipe or five feet (5') above groundwater elevation, whichever is higher. The amount of water added during the test period from the section under test to maintain the water level shall be measured and it shall not exceed a rate of two hundred (200) gallons exfiltration per day, per mile of pipe, per inch nominal diameter for concrete and clay pipe and shall not exceed a rate of fifty (50) gallons exfiltration per day, per mile of pipe, per inch nominal diameter for PVC pipe.

For purposes of determining maximum allowable leakage, nominal diameter and depth of manholes shall be included. The exfiltration tests shall be maintained on each reach for at least two (2) hours and as much longer as necessary, in the opinion of the District Engineer, to locate all leaks.

The contractor shall provide, at his own expense, all necessary piping between the reach to be tested and the source of water supply, and all labor, equipment, and materials required for the tests. The methods used and the time of conducting exfiltration tests shall be acceptable to the District Engineer.

The contractor shall take all necessary precautions to prevent any joints from separating, or other damage to the pipe lines or their appurtenances or to any structures, while the tests are being performed.

The length of house connection shall not be used in computing the length of sewer main being tested.

All tests must be completed before street or trench is resurfaced, unless otherwise directed by the District Engineer.

B. Low Pressure Air Testing:

Low pressure air testing may be used in lieu of exfiltration testing for 24-inch diameter and smaller PVC sewer pipe. Air testing shall not be used for manholes.

Low pressure air testing shall comply with ASTM C828 for PVC pipe. The schedule of testing shall be submitted to and accepted by the District Engineer prior to starting the tests.

The pipe to be tested shall first be cleaned by propelling a snug fitting, inflated rubber ball through

the pipe with water. All pipe outlets shall be plugged with suitable test plugs and each plug shall be braced securely. If pipe to be tested is submerged in ground water, insert a pipe probe by boring or jetting into the backfill material adjacent to the center of the pipe and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to ground water submergence over the end of the probe. All gauge pressures in the test should be increased by this amount. If a test pressure greater than 10 psi results, air testing shall not be used and exfiltration or infiltration testing will be required.

Air shall be added slowly to the portion of the pipe being tested until the internal air pressure is raised to four (4) psig. The compressor used to add air to the pipe shall have a blow-off valve set at 10 psi to assure that at no time the internal pressure in the pipe exceeds 10 psi.

After an internal pressure of four (4) psig is obtained, allow at least two (2) minutes of air temperature to stabilize, adding only the amount of air required to maintain pressure. When the pressure decreases to three and one-half (3-1/2) psig, start the stop watch. Determine the time in seconds that is required for the internal air pressure to reach two and one-half (2-1/2) psig.

Minimum permissible pressure holding times for runs are calculated using the following formula:

$$T = .000183 D^2L$$

T = Test time in minutes

D = Inside diameter of pipe in inches

L = Distance between successive manholes in feet

If the pressure drop from 3.5 psi to 2.5 psi occurs in less time than the above calculated values, the pipe shall be overhauled and, if necessary, replaced and relaid, at the contractor's expense, until the joints and pipe shall hold satisfactorily under this test.

This air test may be dangerous if, because of ignorance or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. Inasmuch as a force of two hundred and fifty pounds (250 lbs.) is exerted on an eight-inch (8") plug by an internal pipe pressure of five (5) psig, it should be realized that sudden expulsion of a poorly installed plug, or of a plug that is partially deflated before the

pipe pressure is released, can be dangerous. As a safety precaution, pressurizing equipment should include a regulator set at perhaps ten (10) psi to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

C. Infiltration Test:

If, in the construction of a section of the sewer between structures, excessive groundwater is encountered, the test for leakage described in the exfiltration test shall not be used; instead, the end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least three (3) days after which the section shall be tested for infiltration. The infiltration for concrete and clay lines shall not exceed 200 gallons per inch of nominal diameter per mile of sewer line per day of main-line sewer being tested, or as indicated in Table I, and for PVC lines, the infiltration shall not exceed 50 gallons per inch of nominal diameter per mile of sewer line, per day of main-line sewer being tested, or as indicated in Table II, and does not include the length of house laterals entering that section.

Where any infiltration in excess of this amount is discovered, the line shall be immediately uncovered and the amount of infiltration reduced to a quantity within the specified amount of infiltration before the sewer is accepted, at the expense of the contractor.

Should, however, the infiltration be less than the specified amount, the contractor shall stop any individual leaks that may be observed when ordered to do so by the District Engineer. The contractor shall furnish all labor and materials for performing the tests required. All tests must be completed before street or trench is resurfaced, unless otherwise directed by the District Engineer.

TABLE I

ALLOWABLE LIMITS OF INFILTRATION
 FOR CONCRETE AND CLAY PIPE
 200 Gal./Inch Dia./Mi./Day
 or 0.16 Gal./Inch Dia./100'/Hr.

<u>Diameter of Sewer (Inches)</u>	<u>Infiltration Gal./Hr./100' (Gallons)</u>
8	1.3
10	1.6
12	1.9
15	2.4
18	2.8
21	3.3
24	3.8
27	4.3
30	4.8
36	5.7

ALLOWABLE LIMITS OF INFILTRATION
 FOR MANHOLE STRUCTURES

<u>Diameter of Manhole (Inches)</u>	<u>Infiltration Gal./Vertical (Ft./Hour)</u>
41	0.07
48	0.08
60	0.10
72	0.12

TABLE II
 ALLOWABLE LIMITS OF INFILTRATION
 FOR PVC PIPE
 50 Gal./Inch Dia./Mi./Day
 or 0.04 Gal./Inch Dia./100'/Hr.

Diameter Sewer (Inches)	Infiltration Gal./Hr./100' (Gallons)
8	0.32
10	0.40
12	0.48
15	0.60
18	0.72
21	0.84
24	0.96
27	1.08
30	1.20
36	1.44

II. Tests for Alignment and Grade, and Damaged or Defective Pipe in Place

After the pipe has been installed, tested for leakage, backfilled, manhole raised to grade, and the trenches reinforced, the District Engineer will "lamp" all lines. All defective portions of the new facilities will be noted to the contractor after the lamping operation is complete. All lines should be flushed and manholes cleaned by the contractor prior to "lamping". At the request of the District Engineer, the line will be "balled" to remove dirt, rocks or other foreign matter not removed during the flushing operation. No flushed water or material shall be discharged to existing sewer lines.

In case there is still some question as to the condition of the sewer line, the District Engineer may require that pictures be taken of the interior of that part of the sewer line under question. After the pictures have been interpreted by the contractor and the District Engineer, should the sewer line be interpreted to be defective, the cost of taking the pictures shall be borne by the contractor. Should the sewer line be interpreted as being a good sewer line, the cost of taking the pictures shall be borne by the District. However, the District reserves the right to require pictures be taken of any curved line approved for installation. In all such cases, the pictures will be taken at the expense of the contractor and will become the property of the District after interpretation.

Probationary acceptance of the lines will not be granted by the District until all tests are successful, all items listed for correction by the District Engineer have been accomplished, and all other requirements of the District for probationary acceptance have been completed.