SECTION 38 - STORM DRAIN CONSTRUCTION
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SECTION 38 STORM DRAIN CONSTRUCTION

38-1 GENERAL

Storm drain construction shall conform to the details shown on the Plans and these Specifications. The Contractor shall furnish and install sanitary sewer and drain pipe of the materials shown or specified in the Contract. Where alternate pipe materials are listed in the Bid, the Contractor shall bid only one of the alternates shown. Substitution of alternate pipe material after bid is not permitted.

38-2 MATERIALS

Storm drain pipe shall be of the type, class and size as shown or specified in the Contract, and shall conform to the requirements of Section 50, "Construction Materials", of these Specifications for each respective type and class of pipe. All storm drain materials shall be inspected for compliance with these Standard Specifications prior to installation by the Contractor, and clearly marked and identified if found to be out of compliance. Contractor is to schedule material inspection with the City inspector forty-eight (48) hours prior to placement of pipe. HDPE pipe is not allowed for improvements in existing or future roadways.

38-2A

Causes for Rejection. Inspection of pipe as may be deemed necessary by the City will be made. Proposed methods to repair pipe identified by the City and marked "reject" must be specified in writing to the engineer for review by the contractor. Repaired pipe may not be deemed as conforming to specifications. Pipe may be rejected for any of the following reasons:

1) A piece of any size broken out of the pipe.

2) Defects that indicate imperfect mixing or molding.

3) Any crack extending entirely through the wall of the pipe and having a longitudinal or transverse length greater than the wall thickness of the pipe.

4) Any shattering or flaking of concrete at a crack.

5) A deficiency greater than ¼" from the specified wall thickness of pipe 30 inches or smaller in diameter, or a deficiency greater than 5 percent from the specified wall thickness of pipe larger than 30 inches in internal diameter, except that the deficiency may be 7 percent adjacent to the longitudinal joint, provided that additional deficiency does not lie closer than 20 percent of the internal diameter to the vertical axis of the pipe and does not extend along the circumference for a distance greater than 20 percent of the internal diameter. The deficiencies in wall thickness permitted herein do not apply to gasket contract surfaces in gasketed joint pipe. Dimensions and tolerances of such contact surfaces shall be submitted for approval.

6) Internal diameter of the pipe exceeds the variation from a true circle of the specified diameter by more than 1 percent.

7) The roundness of the pipe varies from a true circle of the actual internal diameter by more than once percent at any location along the barrel.

8) Rock pockets and water pockets in any pipe.

9) Exposure of any reinforcement arising from misplacement thereof.

10) Evidence of cage twist or misplacement of reinforcement.

11) Delamination of the concrete.

12) Surface defects indicating honeycomb or open-texture.

13) Separations or "blisters".

14) Slumped or sagged concrete.

15) Any continuous crack or concrete separation having a surface width of 0.010 inch or more and extending for a length of 12 inches or more, regardless of depth or position in the wall of the pipe.

16) The pipe fails the D-load bearing strength test, if requested by the City.

17) The pipe was backfilled prior to City inspection.

The imperfections and variations as causes for rejection in storm drain pipe, as specified herein, shall apply to all pipe for which design details are indicated on the Plans as well as for pipe which is specified by D-load.

Pipe shall be considered ready for installation at the project site when it conforms to the specified requirements for curing, testing and inspection.

38-3 EXCAVATION AND BEDDING

Trench excavation and bedding for all storm drain pipe construction shall conform to Section 19, "Trench Excavation, Bedding and Backfill", of these Specifications.

The Contractor shall expose the end of existing pipe to be extended, and verify alignment and elevation for the City, prior to trenching for any pipe that may be affected.

38-4 LAYING PIPE

Pipe laying shall proceed after the trench for the pipe has been brought to the proper line and grade. Pipe laying shall proceed upgrade with the bell or groove end of the pipe placed upstream. Each section of pipe shall be laid true to line and grade and in such a manner as to form a watertight, concentric joint with the adjoining pipe. The interior of the pipe shall be cleared of all dirt and debris as the work progresses. Pipe shall not be laid when the condition of the trench or the weather is unsuitable, in the opinion of the City, because of water or mud that may interfere with proper jointing. All open ends of pipe and fittings shall be closed whenever the work is discontinued. For remedial maintenance or improvement projects in established areas, the Contractor shall coordinate the work so that storm drain systems are fully operational at the end of each Working Day. No runoff shall be allowed to flow uncontained through any trenches or excavations without approval of the City.

Circular reinforced concrete pipe with elliptical reinforcement shall be placed with the minor axis of the reinforcement in a vertical position.

All pipe shall be laid in strict conformity to the prescribed line and grade with grade bars set and each pipe length checked to the top grade line. Three consecutive points on the same grade of slope shall be used at all times to detect any variation from a straight grade. In case any discrepancy exists, the work shall be stopped and the discrepancy immediately reported to the City. In addition, when requested by the City, a string line shall be used in the bottom of the trench to insure a straight grade and alignment of the pipe.

The Contractor may elect to furnish a laser beam system for grade and alignment control. Such laser beam shall have a minimum accuracy of ± 0.01 foot per one hundred feet (100') on line; and a minimum visible range of one thousand feet (1000'), and shall comply with OSHA requirements. The laser system shall have good visibility when used with suitable target material. The laser system shall be of the self-leveling type so that the laser beam is automatically compensated for small grade disturbances. The laser system shall also have an early warning system that warns when the laser is off grade.

Grade tolerance of the flow line of pipe shall not exceed ± 0.03 feet. In addition, the total variation plus and minus from flow line grade shall not exceed 0.03 feet in any twenty-five-foot (25') length. Contractor to verify in the presence of the Inspector.

Mortar or brick plugs shall be installed in existing manholes as directed by the City in order to prevent surface water, ground water, and debris from entering existing sewer or storm drain systems during construction. Inflatable plugs will be considered on a case by case basis. Care shall be exercised

in installing plugs to avoid interrupting service to existing sewer or storm drain services. Plugs shall be removed upon completion of testing as provided in Section 38-10, "Testing of Pipe", in this Section of these Specifications.

The Contractor is responsible for avoiding all utility, service, or other conflicting lines that are not in direct physical conflict with the facility under construction. The Contractor may arrange with the owner of the utility to temporarily disconnect house service lines or other facilities along the line of work for the Contractor's convenience. The Contractor is responsible for all costs for disconnecting and restoring such utilities.

Utility or other lines which are in direct physical conflict with the structural section of the facility being constructed or appurtenant structures, and which cannot be avoided by rerouting the facility being constructed, or for which relocation is not provided in the Plans and Specifications, will be relocated by the owner of the utility prior to or during construction in accordance with Section 42, "Relocation and Maintenance of Utility Facilities", of these Specifications.

Should it become necessary to reroute the facility being constructed to avoid an existing utility or other obstruction and such rerouting is ordered by the City, compensation for the installation of such rerouted line shall be made at the unit price bid for the installation of said facility and no additional compensation will be made except as provided in Section 9, "Changes and Claims", of these Specifications. Reroute sewer service in accordance with Standard Drawing 7-13.

When indicated on the Plans or directed by the City, storm drain pipes and structures shall be abandoned in conformance with Section 15-1.04, "Abandonment of Pipes and Manholes", of these Specifications.

38-5 STORM DRAIN INLET LATERALS

Unless otherwise indicated on the Plans or in the Special Provisions, storm drain inlet laterals shall be a minimum of fifteen inches (15") in diameter. Unless otherwise indicated in the Contract, materials for inlet laterals shall conform to requirements of Section 50, "Construction Materials", of these Specifications for each respective type and class of pipe. Connections of laterals to manholes and inlets shall be water and soil tight, and shall conform to Section 39, "Manholes", and Section 27-13, "Drop Inlets and Catch Basins", of these Specifications.

All inlet laterals shall be inspected by lamping conforming to Section 38-10.05, "Lamping of Storm Drain Inlet Laterals", in this Section of these Specifications or television inspection. When the radius or length of the lateral exceeds 30', a television inspection is required conforming to Section 38-10.04, "Television Inspection", in this Section of these Specifications. Other proposed methods of inspection may be approved by the City.

38-6 PIPE JOINTS

Joints in pipe shall conform to the requirements of Section 50, "Construction Materials", of these Specifications for the type of pipe being installed.

Care shall be used to prevent chipping or cracking of either end of the pipe during installation.

All joints for concrete pipe shall be rubber gasketed joints. All joint surfaces shall be cleaned before joints are made.

38-7 PROTECTIVE COVERING

38-7.01 Storm Drain Pipe

Unless otherwise shown in the Contract, storm drain pipe laid in trenches at such an elevation that the top of the pipe bell has less than twenty-four (24") inches of cover shall be protected with a concrete cap, as shown on Standard Drawing SD-6, "Storm Drain Trench Detail". The cover shall be measured from the top of a rigid pavement or the bottom of a flexible

pavement. Unless otherwise shown in the Contract, the concrete used in making the cap shall be Class "B-1" concrete conforming to Section 50-5, "Portland Cement Concrete", of these Specifications.

38-8 BACKFILLING PIPE TRENCHES

Backfill of all sewer and storm drain pipes shall conform to the requirements in Section 19, "Trench Excavation, Bedding and Backfill", of these Specifications. Bedding and backfill for drain pipes shall be in accordance with Standard Drawing 9-1.

38-9 TESTING OF PIPE

After laying, backfilling and compacting of drain pipe, and before placing the aggregate base, the pipes shall be tested for obstructions and leakage and the television inspection performed, unless otherwise specified in the Special Provisions.

Obstruction or leakage tests for storm drain shall be required when required by the Contract or when visual inspection by television or lamping indicates that there may be obstructions or leaks in the pipe.

38-9.01 Tests for Obstructions

Unless otherwise indicated in the Contract, balling and flushing or other approved methods for cleaning storm drains will be required.

38-9.02 Tests for Leakage

All leakage tests shall be completed and approved at finished subgrade and prior to placing the aggregate base.

When leakage or infiltration exceeds the amount allowed by the Specifications, the Contractor shall locate the leaks and make necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits, at the Contractor's expense. Any individually detectable leaks shall be repaired, regardless of the results of the tests.

Leakage tests for storm drains shall be required when indicated in the Contract, when inferior materials or construction methods are used, or when visual inspection by television or lamping indicates a potential for leakage. All or any sections of sewer lines, including storm drains and force mains which the City may select, shall be tested by the Contractor by the following methods:

38-9.02.A Air Test for Leakage - Storm Drain

Only lines tested after backfilling to final grade will be considered for acceptability. However, this test may also be used by the installer as a presumptive test to determine the condition of the line prior to backfilling.

The Contractor shall furnish all the necessary equipment and be responsible for conducting all low-pressure air tests. In addition, the Contractor is responsible for any necessary repair work on sections that do not pass the test. No sealant shall be used in any newly installed storm drain without the prior approval of the City. Using sealant in a storm drain is not the equivalent of a sound storm drain pipe. Proper structural repair work may be required by the City.

The City will witness all low-pressure air tests and verify the accuracy and acceptability of the equipment utilized.

38-9.02.A.(1) Plug Restraint

Restraints must be provided for plug to prevent blowouts of the plug. As an example of the hazard, a force of two hundred fifty (250) pounds is exerted on an eight-inch (8") plug by an internal pipe pressure of five pounds per square inch, gauge (5 psig), and a force of two thousand two hundred fifty (2,250) pounds is exerted on a twenty-four-inch (24") plug by an internal pressure of five pounds per square inch, gauge (5 psig). Sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be very dangerous. For this reason, it is recommended that every plug be positively braced against the manhole walls, and that no one be allowed in the manhole adjoining a line being tested so long as pressure is maintained in the line.

It is further recommended that no internal pressure of more than nine pounds per square inch, gauge (9 psig) be permitted except for leak location equipment where the plugs are firmly tied together.

38-9.02.A.(2) Relief Valve

All pressurizing equipment used for low-pressure air testing shall include a regulator or relief valve set no higher than nine pounds per square inch, gauge (9 psig) to avoid over-pressurizing and displacing temporary or permanent plugs. As an added safety precaution, the pressure in the test section should be continuously monitored to make certain that it does not at any time exceed nine pounds per square inch, gauge (9 psig). (Note: It may be necessary to apply higher pressure at the control panel to overcome friction in the air supply hose during pressurization.)

38-9.02.A.(3) Equipment

38-9.02.A.(3)(a) Plug Design

Either mechanical or pneumatic plugs may be used. The Contractor shall internally restrain or externally brace the plugs to the manhole wall as a safety precaution throughout the test. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again.

38-9.02.A.(3)(b) Singular Control Panel

To facilitate test verification by the City, all air used shall pass through a single, above ground control panel.

38-9.02.A.(3)(c) Equipment Controls

The above ground air control equipment shall include a shut-off valve, pressure regulating valve, pressure relief valve, input pressure gauge and a continuous monitoring pressure gauge having a pressure range from zero (0) to at least ten (10) pounds per square inch (psi). The continuous monitoring gauge shall be no less than four inches (4") in diameter with minimum divisions of 0.10 psi and an accuracy of ± 0.04 psi.

38-9.02.A.(3)(d) Separate Hoses

Two separate hoses shall be used: (1) to connect the control panel to the sealed line for introducing low-pressure air, and (2) a separate hose connection for constant monitoring of air pressure build-up in the line. This requirement greatly diminishes any chance for over-pressurizing the line.

38-9.02.A.(3)(e) Pneumatic Plugs

If pneumatic plugs are utilized, a separate hose shall also be required to inflate the pneumatic plugs from the above ground control panel.

38-9.02.A.(4) Line Preparation

38-9.02.A.(4)(a) Laterals, Stubs and Fittings

During storm drain construction all laterals, stubs and fittings into the storm drain test section shall be properly capped or plugged so as not to allow for air loss that could cause an erroneous air test result. It may be necessary and is always advisable to restrain gasketed caps, plugs or short pipe lengths with bracing stakes, clamps and tie-rods or wire harnesses over the pipe bells.

38-9.02.A.(4)(b) Pipe Wetting

Air may pass through some porous pipe materials. If such materials are used, the pipe walls may be wetted to temporarily reduce the porosity of the material. Non-porous pipe materials need not be wetted.

38-9.02.A.(5) Test Procedure

38-9.02.A.(5)(a) Plug Installation and Testing

After a manhole-to-manhole reach of pipe has been backfilled to final grade, prepared for testing and the specified waiting period has elapsed, the plugs shall be placed in the line at each manhole and secured.

It is advisable to seal test all plugs before use. Seal testing may be accomplished by laying one length of pipe on the ground and sealing it at both ends with the plugs to be checked. The sealed pipe should be pressurized to nine pounds per square inch, gauge, (9 psig). The plugs shall hold against this pressure without bracing and without any movement of the plugs out of the pipe. No persons shall be allowed in the alignment of the pipe during plug testing.

It is advisable to plug the upstream end of the line first to prevent any upstream water from collecting in the test line. This is particularly important in high groundwater situations.

When plugs are being placed, the pipe adjacent to the manhole shall be visually inspected to detect any evidence of shear in the pipe due to differential settlement between the pipe and the manhole. A probable point of leakage is at the junction of the manhole and the pipe, and this fault may be covered by the pipe plug, and thus not revealed by the air test.

38-9.02.A.(5)(b) Line Pressurization

Low pressure air shall be slowly introduced into the sealed line until the internal air pressure reaches four pounds per square inch, gauge, (4 psig) greater than the average back pressure of any groundwater above the pipe, but not greater than nine pounds per square inch, gauge, (9 psig). If groundwater is present, refer to Section 38-10.02.C.(6), "Determination of Ground Water Elevation and Air Pressure Adjustment", in this Section of these Specifications.

38-9.02.A.(5)(c) Pressure Stabilization

After a constant pressure of four pounds per square inch, gauge, (4.0 psig) greater than the average groundwater back pressure is reached, the air supply shall be throttled to maintain that internal pressure for at least two (2) minutes. This time permits the temperature of the entering air to equalize with the temperature of the pipe wall.

38-9.02.A.(5)(d) Timing Pressure Loss

When temperatures have been equalized and the pressure stabilized at four pounds per square inch, gauge, (4.0 psig) greater than the average groundwater back pressure, the air hose from the control panel to the air supply shall be shut off or disconnected. The continuous monitoring pressure gauge shall then be observed while the pressure is decreased to no less than three and one-half pounds per square inch, gauge (3.5 psig) greater than the average back pressure of any groundwater over the pipe. At a reading of three and one-half pounds per square inch, gauge (3.5 psig), or any convenient observed pressure reading between three and one-half pounds per square inch, gauge (3.5 psig) and four pounds per square inch, gauge, (4.0 psig) greater than the average groundwater back pressure, timing shall commence with a stopwatch or other timing device that is at least ninety-nine and eight-tenths percent (99.8%) accurate.

38-9.02.A.(5)(e) Determination Of Line Acceptance

If the time shown in Table 38-1 for the designated pipe size and length elapses before the air pressure drops one pound per square inch, gauge (1 psig); the section undergoing test shall have passed and shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even though the one pound per square inch, gauge (1 psig) drop has not occurred.

38-9.02.A.(5)(f) Determination Of Line Failure

If the pressure drops one pound per square inch, gauge (1 psig) before the appropriate time shown in Table 38-1 has elapsed, the air loss rate is considered excessive and the section of pipe has failed the test.

38-9.02.A.(5)(g) Line Repair Or Replacement

If the section fails to meet these requirements, the Contractor shall, at his own expense, determine the source, or sources, of leakage, and repair or replace all defective materials and/or workmanship to the satisfaction of the City. The extent and type of repair that may be allowed, as well as results, shall be subject to the approval of the City. The completed pipe installation shall then be retested and required to meet the requirements of this test.

38-9.02.C.(6) Determination Of Groundwater Elevation and Air Pressure Adjustment

38-9.02.C.(6)(a) Applicability

The requirements of this Section shall only apply where groundwater is known to exist or is anticipated above the storm drain to be tested.

38-9.02.C.(6)(b) Pipe Nipple Installation

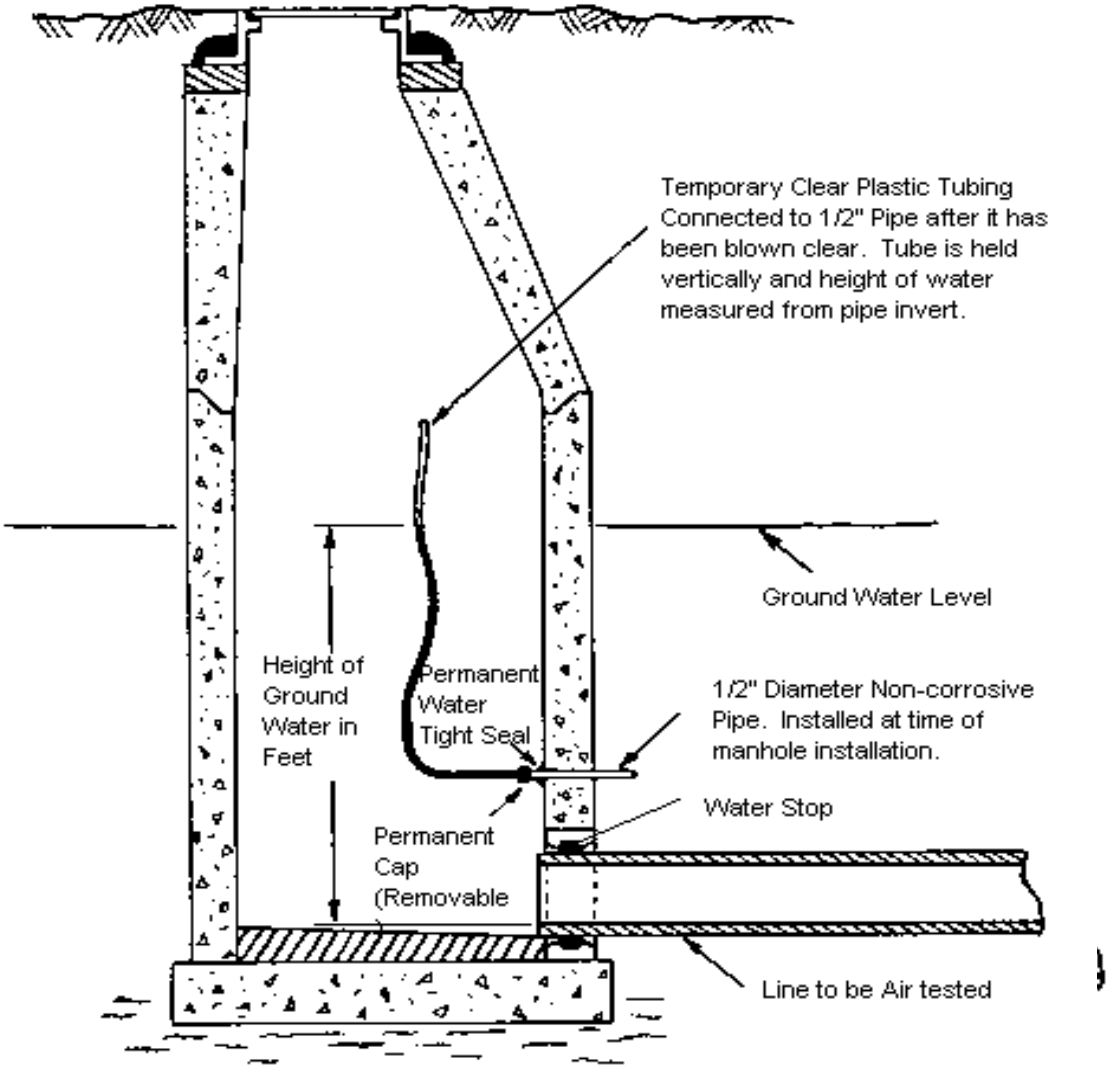
During manhole installation, a one-half inch (1/2") diameter threaded pipe nipple shall be installed through the manhole wall directly on top of one (1) of the storm drain pipes entering the manhole. The threaded end of the nipple shall extend no more than two inches (2") on the inside of the manhole. The total length of the nipple shall exceed the manhole wall thickness by no less than four inches (4"). The pipe nipple shall be non-corrosive and resistant to chemicals common in domestic sewage. Special attention shall be given to providing a permanent, watertight seal around the pipe nipple at the manhole wall. The pipe nipple shall be sealed with a threaded one-half inch (1/2") cap. Not every manhole need have a pipe nipple. A few key manhole locations should be sufficient to establish a groundwater profile for the test area. The City will assist the Contractor in selecting appropriate manholes for pipe nipple installation.

38-9.02.C.(6)(c) Groundwater Elevation

Immediately before air testing, the groundwater level shall be determined by removing the threaded cap(s) from the nipple(s) nearest the section to be tested, blowing air through the pipe nipple(s) to remove any obstructions, and then connecting clear plastic tube(s) to the pipe nipple(s). Each plastic tube shall be held vertically to allow groundwater to rise in it. After the water level in the tube has stopped rising, a measurement of the height in feet of water over the invert of the storm drain pipe shall be taken. (See Figure 38A below.) If the section to be tested is not immediately adjacent to an installed pipe nipple, the groundwater height shall be estimated based upon nearby height readings and the pipe's invert elevation.

FIGURE 38A

MANHOLE CROSS-SECTIONAL VIEW OF THE PROPER METHOD FOR DETERMINING GROUND WATER HEIGHT



38-9.02.A.(6)(d) Air Pressure Adjustment

The air pressure correction, which must be added to the three and one-half pounds per square inch, gauge (3.5 psig) normal test starting pressure, shall be calculated as follows:

(Average vertical height, in feet, of groundwater above the invert of the storm drain pipe to be tested) divided by 2.31.

The result gives the air pressure correction in pounds per square inch to be added. (For example, if the average vertical height of groundwater above the pipe invert were 2.8 feet, the additional air pressure required would equal 2.8 divided by 2.31, or 1.2 psig. This would require a minimum starting pressure of 3.5 plus 1.2, or 4.7 psig.). The allowable pressure drop of one pound per square inch, gauge (1.0 psig) and the timing in Table 38-1 are not affected and shall remain the same.

38-9.02.A.(6)(e) Maximum Test Pressure

In no case should the starting test pressure exceed nine pounds per square inch, gauge (9 psig). If the average vertical height of groundwater above the pipe invert is more than twelve and seven tenths feet (12.7'), the section so submerged may be tested using nine pounds per square inch, gauge (9 psig) as the starting test pressure. The nine pounds per square inch, gauge (9 psig) limit is intended to further ensure worker safety and falls within the range of the pressure monitoring gauges normally used.

38-9.02.A.(6)(f) Re-sealing Of Pipe Nipples

After the groundwater height has been determined, each pipe nipple shall be recapped and sealed to prevent any future infiltration.

38-9.02.A.(7) Test Times

38-9.02.A.(7)(a) Test Time Criteria

The test time criteria requires that no test section shall be accepted if it loses more than 0.0015 cubic feet per minute per square foot of internal pipe surface area for any portion containing less than six hundred twenty-five (625) square feet internal pipe surface area. The total leakage from any test section shall not exceed 0.9375 cubic feet per minute.

38-9.02.A.(7)(b) Test Time Calculation

All test times shall be calculated using the following equation:

Where:
T = 0.085(DK/Q)
T = Shortest time, in seconds, allowed for the air pressure to drop 1.0 psig, K = 0.000419 DL, but not less than 1.0,
Q = 0.0015 cubic feet/minute/ square feet of internal surface, D = Nominal pipe diameter in inches, and
L = Length of pipe being tested in feet.

For more efficient testing of long test sections and/or sections of larger diameter pipes, a timed pressure drop of one-half pound per square inch, gauge (0.5 psig) may be used in lieu of the one pound per square inch, gauge (1.0 psig) timed pressure drop. If a one-half pound per square inch, gauge (0.5 psig) pressure drop is used, the appropriate required test times shall be exactly half as long as those obtained using the equation for T cited above.

38-9.02.A.(7)(c)Testing Main Storm Drains With Lateral Connectors

It is often convenient to include connected lateral storm drains when testing storm drain mains having lateral connectors. If lateral storm drains are included in the test, their lengths may generally be ignored for computing required test times. This can be done because in practice, ignoring the

branch or lateral storm drains will normally increase the severity of the air test whenever the tested surface area is less than six hundred twenty-five (625) square feet so that the total rate of rejection may only be increased about two percent (2%). If the total tested surface area is greater than six hundred twenty-five (625) square feet, ignoring the lateral storm drains will only slightly decrease the severity of the test.

In the event a test section, having a total internal surface area less than six hundred twenty- five (625) square feet, fails to pass the air test when lateral storm drains have been ignored; the test time shall be recomputed to include all lateral storm drains using the following formula:

$$T = \frac{0.085\,[D_1L_1 + D_2L_2 + \ldots + D_nL_n\,](K / Q)}{D_1L_1 + D_2L_2 + \ldots + D_nL_n}$$

Where:
T = Shortest time, in seconds, allowed for the air pressure to drop 1.0 psig, K = $0.000419\,(D_1L_1 + D_2L_2 + \ldots + D_nL_n)$, but not less than 1.0,
Q = 0.0015 cu.ft./min./sq.ft. of internal surface,
D_1, D_2, etc. = Nominal diameters of the different size pipes being tested, and
L_1, L_2, etc. = Respective lengths of the different size pipes being tested.

If the recomputed test time is short enough to allow the section tested to pass, then the section shall be presumed to be free of defects and comply with this Specification.

38-9.02.A.(7)(d) Specified Time Table

To facilitate the proper use of this recommended practice for air testing, Table 38-1 is provided, which contains the specified minimum times required for a one pound per square inch, gauge (1 psig) pressure drop from a starting pressure of at least three and one-half pounds per square inch, gauge (3.5 psig) greater than the average back pressure of any groundwater above the pipe's invert. The table also includes easy-to-use formulas for calculating required test times for various pipe sizes and odd lengths. All costs for this work are to be included in the prices paid for the items involved.

TABLE 38-1
MINIMUM SPECIFIED TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP FOR SIZE AND LENGTH OF PIPE INDICATED FOR Q = 0.0015

Pipe Dia. (in.)	Length for Minimum	Time For Longer	Specified Time For Length (L) Shown								
			(min: sec)								
Min. Time (min)		**Time (ft)**	**Length (sec)**	**100**	**150**	**200**	**250**	**300**	**350**	**400**	**450**
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07	86:32	100:57	115:22	129:38
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02	106:50	124:38	142:26	160:15
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12	153:50	179:29	205:07	230:46

38-9.02.B Hydrostatic Test for Leakage – Storm Drain

If, in the opinion of the Inspector, excessive groundwater is encountered in the construction of a section of the storm drain, the exfiltration test for leakage shall not be used.

The end of the storm drain 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) Calendar Days, after which the section shall be tested for infiltration.

The infiltration into each individual reach of storm drain between adjoining manholes shall not exceed five hundred (500) gallons per inch of internal diameter per mile per day.

The allowable infiltration for any portion of the storm drain system shall be measured by a weir or current meter placed in the appropriate manhole.

38-9.02.B.(1) Water Exfiltration Test

The allowable water exfiltration for any length of the storm drain pipe between manholes shall be measured and shall not exceed five hundred (500) gallons per inch of internal pipe diameter per mile of pipe per day. The maximum testing pressure at any joint shall be five pounds per square inch (5 psi) or eleven and one-half feet (11.5') of head. If it is not possible to test the pipe to five pounds per square inch (5 psi), the system shall be tested to the surface of the lowest manhole or inlet rim in the section tested. In lieu of water exfiltration testing, the Contractor may perform air testing as described below.

The Contractor is responsible for providing all equipment, materials, water and labor for performing infiltration and exfiltration tests and making measurements. Payment for these items will be included in the bid items for pipes and manholes. All tests shall be made in the presence of the Inspector.

38-9.03 Tests for Deflection

38-9.03.A Storm Drain

When indicated in the Contract, or when inferior products or construction methods are used or visual inspection by television or lamping indicates a potential for excessive deflection, the following test method shall be used:

> Where PVC pipe is installed as drain pipe, a deflection test shall be made by the Contractor upon completion and acceptance of all backfill operations and prior to placement of the finished surface, if any. Deflection testing shall be conducted no sooner than thirty (30) Calendar Days following completion and acceptance of all backfill operations, unless otherwise approved by the City.

The deflection testing shall be witnessed by the Inspector and shall be conducted by the Contractor at the Contractor's expense. Unless otherwise shown on the Plans or in the Special Provisions, one-hundred percent (100%) of all mainline PVC drain pipe installed shall be deflection tested for excessive vertical deflection using a pre-sized, rigid mandrel or "Go-No-Go" device approved by the City. The mandrel size shall be clearly labeled and shall be sized so as to provide a diameter of at least 92.5% of the "Base Internal Diameter" per ASTM D 3034 for PVC. Base inside diameters for larger diameters of PVC pipe may be found in ASTM F 679.

The Contractor shall remove, replace, and retest any pipe section through which the mandrel is unable to pass. The use of any rerounding device or similar method to correct or reduce over deflection will not be permitted. Re-tests for deflections shall be made at the Contractor's expense.

38-9.04 Television Inspection – Storm Drains (for sanitary sewer, refer to CSD-1 requirements)

A closed circuit television (CCTV) inspection shall be conducted prior to new storm drain pipeline acceptance and prior to and after completion of pipeline rehabilitation projects. The CCTV inspection shall document and verify the following:

1. the overall condition of the host pipeline,
2. line and grade,
3. a minimum of 2 per 300' of pipe installed, per manhole run,

4. cleanliness, and
5. that post-installation per the Contract has taken place.

The CCTV inspection shall be documented in an electronic report (Inspection Report) and digital video recording as specified herein. It is the Contractor's responsibility to verify that the indexing, report and video documentation format is in the latest, most up-to-date format required by the City. Contractors shall comply with the Contract regarding specific information, indexing, and documentation requirements.

CCTV inspection of new construction shall be performed after all required testing specified in this Section is satisfactorily completed. Cleaning storm drains shall be performed prior to the television inspection in a separate operation. Unless otherwise shown or specified in the Contract, the Contractor shall perform a television inspection on all storm drains between manholes and all storm drain inlet laterals.

38-9.04.A Safety

Safety and traffic control procedures shall be maintained at all times in accordance with the requirements of Sections 6-11, "General Safety Requirements"; 6-12, "Public Convenience and Safety"; 6-13, "Public Safety and Traffic Control"; and 10-10, "Confined Space Entry", of these Specifications, and any other applicable procedures or requirements.

The CCTV inspection shall be conducted from above ground. Prior to opening a manhole cover or a confined space area, a gas monitor shall be used to detect the oxygen level, presence of explosive or flammable gases, vapors, or mist in excess of 10% of the (LEL/LFL), and toxic gases in excess of the permissible exposure levels (Hydrogen Sulfide, Carbon Monoxide.)

Manhole entry, if required, shall be conducted in strict accordance with permit required confined space entry regulations as specified in Section 10-10, "Confined Space Entry", of these Specifications.

38-9.04.B Sample Video and Inspection Report

Prior to any CCTV inspection, the Contractor shall submit a sample video and Inspection Report to the City for review in accordance with Section 5-8, "Contractor's Submittals", of these Specifications. The sample video and Inspection Report shall represent the quality of video inspection and text to be provided by the Contractor in compliance with the Contract.

38-9.04.C Equipment

CCTV equipment shall include video cameras, a color video monitor, video recording equipment, sound and voice recording capabilities, gauging tool, cables, power sources, and all equipment necessary to perform a CCTV inspection in accordance with this Section and the Contract. The Contractor shall submit a complete list and operational information for all CCTV inspection equipment to be used in accordance with Section 5-8, "Contractor's Submittals", of these Specifications.

38-9.04.C.(1) Camera

The camera shall be a pan and tilt camera system with pipe grade verification system (inclinometer), and shall be specifically designed and constructed for the sewer or storm drain environment. The camera shall include: a solid state color TV camera with a panning and rotational camera head, remote adjustable optical focus and automatic light compensation iris with remote override, camera controller with remote focus, iris and auto centering control and camera lighting system.

There shall be no geometrical distortion of the image. The camera and monitor shall be able to produce a minimum 460 lines of horizontal resolution and 400 lines of vertical resolution. Focal distance shall be adjustable through a range of 1 inch to infinity. The camera shall be mounted on skids or a tractor suitably sized for each pipe diameter to be investigated. The camera shall move through the pipeline in a downstream direction whenever possible at a maximum uniform rate of 45 feet per minute. Maximum allowable error for all the TV footage counters shall not exceed 0.05% (1/2 foot per 100 feet).

The inclinometer shall detect and record variations in pipe grade angle from true horizontal. The inclinometer shall be capable of detecting pipe grade variations of +/- 5 degrees from true horizontal (+/- 8.7% grade) with a maximum error of +/- 0.1 degree with readings taken at a minimum of one/tenth foot (0.1') intervals. The inclinometer shall include a vertical sensing, single axis, precision sensor mounted internally to the camera. Inclinometer data shall be capable of being displayed in either a numerical or graphical format, or both, that can be printed or exported to an external database. Inclinometers with external electronic modules towed behind the camera will not be allowed.

(Graduated gauging tools of 1" or 1 ½" dia. are to be used, with clearly visible markings every 0.25" from outside center.)

38-9.04.C.(2) Computer System

The computer system shall be capable of recording, indexing, and processing data and printing pipeline Inspection Reports and graphics in accordance with Section 38-10.04.F, "CCTV Inspection Report and Video", of these Specifications, and the Contract. The system shall also be capable of recording, storing, and playing video and images of defects and other related significant visual information using City-selectable defect codes to identify standard defects.

The data shall be indexed and recorded in color on a digital video disc (DVD) in digital format. The DVD shall be of such quality that all videos, graphics, and reports are high-resolution. The disc shall be presented in a plastic protective case. The digital information shall be compatible with a 32bit Windows NT/2000 standard MPG-1 format.

The computer system shall be able to produce graphic and tabular reports to include pipe graphics showing all observation points/pertinent data and pipe inclination data in an intuitive graphic format. All graphic and tabular reports shall be recorded and printed in color to match the defect severity codes.

38-9.04.C.(3) Lighting

Illumination sensitivity shall be 3 lux or less. During inspection, lighting intensity shall be adjusted to minimize glare. Lighting and picture quality shall be adjusted to provide a clear, in- focus picture of the entire periphery of the pipeline for all conditions encountered. Lighting shall be adjusted according to the size of the pipe.

38-9.04.D Pre-Rehabilitation CCTV Inspection

The report shall be clearly labeled as "Pre-Rehabilitation CCTV Inspection". During the pre-rehabilitation CCTV inspection, the camera shall stop at all significant observations to ensure a clear and focused view of the pipe condition. Only significant observations shall be code documented on the video and voice recording. The observations shall also be noted on the inspection report. At a minimum, the report shall contain the following:

a. A clear view of a minimum of 75% of the pipe wall.
b. A list of "significant observations", including, but not limited to: services, blockages, medium to large cracks, medium to large roots, medium to heavy grease, medium to large offsets, inflow or infiltration, changes of material and any significant structural decay.
c. An incliometer survey.

If the camera cannot pass through the entire section of pipeline (blockage, etc.), the Contractor shall reset the equipment at the downstream manhole and attempt to inspect the section of pipe from the opposite direction. If the camera again fails to pass through the blocked section, the video inspection shall be temporarily suspended and the City notified. The Contractor shall clear the obstruction as directed by the City, and then resume the inspection. The finished Inspection Report shall run from centerline of manhole to centerline of manhole.

The cost of each CCTV set-up and inspection shall be paid at the unit cost per foot of pipe as specified in the Contract.

38-9.04.D.(1) Pre-lining Video

An inspection shall be performed focusing on conditions that may prevent a successful lining of the pipe including sources of possible inflow and infiltration. Prior to CCTV inspection for pre-lining the

following is required:

a. All sand, debris, grease and roots shall be removed from the line.
b. The operator shall have a clear view of 100% of the pipe wall.
    1. A plug shall be used at the upstream location and monitored; or
    2. A bypass shall be used in order to ensure that no upstream flow is present at the time of inspection. Extreme care shall be taken to avoid flooding any upstream property. In case of any overflow, the Contractor shall immediately notify the engineer. The Contractor is financially responsible for all costs incurred due to the overflow, including any fines.
c. Each service connection shall be panned and viewed in detail.

38-9.04.E Post Rehabilitation and Newly Constructed Sewer and Drain Pipelines CCTV Inspection (for sanitary sewer, refer to CSD-1 requirements)

A CCTV inspection shall be performed to determine if the rehabilitation or new installation was performed per the Contract. The report shall be clearly labeled as "Post Rehabilitation CCTV Inspection" or "Newly Constructed Sewer or Drain Pipelines", as appropriate, and be on a separate DVD from the pre-rehabilitation or preconstruction Inspection Report. The inspection shall also verify that all live laterals and service connections have been re- established per the Contract.

During the post installation CCTV inspection, the Contractor shall have a clear view of a minimum of seventy-five percent (75%) of the pipe wall. The camera shall stop at all significant observations to ensure a clear and complete view of the pipe condition. Each observation encountered shall be documented by coded text and voice recording to the video. The observations shall also be noted on the Inspection Report for each segment. A video capture picture shall be taken of every significant observation described as large, heavy or severe. If there is movement (I & I) or the camera needs to move or the lens needs to pan to capture the observation, a video clip shall also be taken. The screen text shall not obscure the critical portions of the video captured pictures or video clips. Each service connection shall be panned and viewed in detail and an inclinometer survey shall be performed. If an obstruction (debris, collapse, etc.) is encountered during the post installation video inspection, the Contractor shall remove the obstruction or repair the pipe (at the Contractor's cost) prior to final video inspection.

38-9.04.F CCTV Inspection Report and Video

Upon completion of the video inspection, the Contractor shall provide the City with an Inspection Report in electronic format that includes, at a minimum, the following:

1. Summary list of all pipline segments inspected (i.e. manhole to manhole, stub, flusher branch or drain inlet).
2. Inspection Reports (log sheets) of each segment.
3. Video of each segment.
4. All joints panned to be shown.
5. Photographs and video clips of major defects for each pipeline segment.
6. An inclinometer survey of each pipeline segment.

The Inspection Report shall be indexed and coded for easy location of each line segment, video clips, images captured and inclinometer surveys.

The videos and captured images shall be clear and sharp. Voice recordings on the video shall be clear, complete, and distinct. A vocal description shall be recorded at the beginning of each inspection while the "Initial Screen Text" is displayed. A voice recording shall also be performed during each observation and at the conclusion of each inspection. Poor picture quality, extended periods of inactivity, inappropriate language or idle chatter are not acceptable and shall be grounds for rejection by the City.

The DVD shall become the property of the City upon completion of the televised inspection. The DVD shall be given to the City Inspector by the TV company upon completion of televising and evaluation or as requested by the Inspector.

38-9.04.F.(1) Procedure

Mainlines shall be televised from upstream manhole to downstream manholes whenever possible, except for flusher branches/stub lines/drain inlets. All lines televised against the flow direction shall be noted "Reverse Set-up" on the report form. The recording shall begin at the street surface. Video manhole barrels and shelves completely and include the camera set footage. The focal point of the camera shall be the point at which all footages are measured.

Footage counter verification shall be completed prior to the start of, and every two weeks during TV operations. The Contractor shall verify accuracy of all TV footage counters. Camera set footage (footage counter set) shall be noted as from the centerline of the manhole to the focal point in the direction of camera travel. The camera shall travel at a maximum speed of 45 feet per minute with slow downs at joints. The camera shall stop at all service connections and possible defects. The picture shall be clear and bright enough to allow a photograph of a section to be made. The footage counter shall appear on the screen at all times. User defined electronic codes shall be placed at each of the following observation points and the camera shall stop, pan and tilt and inspect at each of the following:

1. Inside each service connection
2. Inside each drain lateral connection
3. Joint separation
4. Offset joints
5. Alignment problems and elbows
6. Cracked or damaged pipe, including lined or point repaired pipe
7. Debris in the line
8. Identifiable sags or high points in the line
9. Root intrusion
10. In-flow or infiltration
11. Grease
12. Corrosion

38-9.04.F.(2) Timing

The Contractor shall coordinate with the City to have the City Inspector on site at the time of the television inspection, where practicable.

Television inspection may proceed as specified in the Contract or, for new sewer or storm drain pipeline, only after compaction of street subgrade and prior to placement of the AB roadbase. The following items must be complete:

1. All underground facilities, utility piping, conduits and access structures are installed, backfilled, and trench backfill compacted.
2. Final air test has been completed.
3. The pipelines have been balled and flushed.

38-9.04.F.(3) Schematic

The manholes, stubs, flusher branches and drain inlets shall be numbered on a plan provided to the City, and the televised segments tied to the assigned numbers. The Contractor shall obtain the numbers by submitting an overall plan to the appropriate office as follows:

The sanitary sewer system numbers can be obtained at the Water Quality Department Customer Service office at 10545 Armstrong Ave. Suite 101, Mather, CA. 95655, phone (916) 876-6100.

38-9.04.F.(4) Initial Screen Text and Audio Information

Each pipe segment (manhole to manhole/flusher branch/stub/drain inlet) shall be identified with an initial screen text and voice recording.

38-9.04.F.(4)(a) Video Information

The following items shall be recorded as screen text on the first 15+/- seconds of the disc:

1. Upstream and downstream manhole numbers and direction of camera's travel

2. Purpose of the CCTV inspection (Pre-Rehab, Post-Rehab, etc.)
3. Location and/or subdivision name
4. Date
5. Job number
6. TV company name, operator's name, and evaluator's name
7. Note all tape and inside drop connections in the manhole using clock positions (camera direction of travel being 12 o'clock).

38-9.04.F.(4)(b) Audio Information

The following items shall be voice recorded during actual televising:

1. Date of inspection
2. Verbal confirmation of upstream and downstream manhole numbers
3. Verbal descriptions of pipe size, type and pipe joint length
4. Verbal description and location of each defect
5. Verbal description and location of each service connection in accordance with clock position (top of pipe being 12 o'clock).
6. Verbal description and location of each line connection or service connection including inside drops entering manholes according to clock position (camera travel being 12 o'clock).

Audio capability will not replace the required written report.

38-9.04.F.(5) Running Screen Text and Ending Screen Text

During the CCTV inspection, the running screen shall show the following information on the screen away from the central focus of the main:

1. Running footage (distance traveled)
2. Date
3. Time of day

A gauging tool, e.g. ¾ -inch cylinder (size of cylinder shall be indicated on the label) shall proceed the camera for gauging offsets.

38-9.04.F.(6) CCTV Recording Labels

Each DVD of the CCTV inspection data may contain one or more pipeline segments. The DVD shall have a label affixed to the top surface and inserted in the plastic protective case. Both labels shall be printed. Each label shall contain the following information:

1. City Name
2. Project Name and Contract Number
3. List of pipeline segment(s) listed from the upstream to the downstream manhole numbers.
4. Contractor's name, address and phone number.

38-9.04.G Non-Conforming CCTV Inspection

If the quality of the video Inspection Report and/or video recording are not in compliance with these Specifications and/or the Contract, the pipeline shall be re-televised or the Inspection Report revised at the Contractor's expense.

38-9.05 Lamping of Storm Drain Inlet Laterals

Each storm drain inlet lateral shall be inspected for obstructions, cracks, grade consistency, joint continuity, alignment, and other defects by lamping. If the radius of the alignment precludes the effective use of lamping or the length of the lateral is greater than thirty feet (30'), a television inspection is required conforming to Section 38-10.04, "Television Inspection".

Lamping shall be accomplished by using an appropriate bright light source and a mirror. After the manhole lid is removed, the light source shall be directed onto a mirror that is held at the end of the lateral within the manhole or inlet at an angle that allows the Contractor to see the length of the pipe. The mirror may be mounted on a pole to avoid entering the inlet or manhole to carry out this procedure. The light source and mirror shall be rotated to inspect the entire inside circumference of the

pipe for its entire length. Defects detectable by lamping include offset joints, poor grade, poor alignment, excessive deflection, obstructions, and other irregularities.

A record of each lateral shall be made by the Contractor. The record shall include the following information:

Date
Name
Company Name
Inlet Type
Inlet Location
Manhole Type
Manhole Location
Lateral Diameter
Lateral Material
Lateral Length
Description of defects (pass or fail)
Corrective action (if needed)
Follow up inspection results (if corrective action required)

Any defects or obstructions detected by lamping shall be corrected at the Contractor's expense.

38-9.06 Pipeline Acceptance Criteria

All new storm drain pipeline shall be inspected in accordance with the requirements of Sections 38-9.4, "Television Inspection", unless otherwise specified in the Contract. The recorded DVD shall be delivered to the appropriate City no later than 2 (two) Working Days after completion of the inspection. The DVD shall become the property of the City. The City will review the CCTV inspection records within ten (10) Working Days and will notify the Contractor if:

1. The review revealed a satisfactory installation, or
2. The review revealed deficiencies.

The following deficiencies in storm drain installation that are identified by the Inspector or by television inspection shall be corrected by the Contractor at no cost to the City:

1. Joint separation greater than one-half inch (1/2").
2. Offset joints greater than one-half the pipe wall thickness.
3. Joint deflection of more than seventy-five percent (75%) of manufacturer's recommended maximum.
4. Cracked or damaged pipe, including liner pipe.
5. Debris in the line.
6. Identifiable sags or high points in the line greater than ¾ inches in pipes 6" and larger.

All other criteria as set by the City of Elk Grove Standard Specification and/or special conditions shall apply for storm drain pipes.

The Contractor will be notified in writing of any deficiencies revealed by the television inspection that will require repair. The Contractor may request a review of the video with the City. A video report form will be needed.

Upon completion of the required corrective actions, the storm drain will be re- televised in accordance with this Section 38-9.04. This process shall be repeated until the review of the recorded television inspection reveals a satisfactory installation.

The storm drain will be ball and flushed at the end of the warranty period.

38-10 RESTORATION OF SURFACES

Restoration of existing paved surfaces shall conform to Section 14, "Restoration of Surfaces", of these Specifications.

38-11 MEASUREMENT AND PAYMENT

The quantity of storm drain construction of the sizes, grades, and types of pipes listed in the Contract is the slope length designated by the City, measured along the centerline of the pipe from manhole to manhole, and includes the straight run of all wyes and tees where used. The prices paid per linear foot for the sizes, grades, and types of pipes listed in the Contract include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in storm drain construction, complete in place, including furnishing pipe, excavation and backfill, removing obstructions, removing and replacing utilities, bedding, placing and jointing the pipe, testing pipe lines, connecting to existing manholes or pipes, as shown or specified in the Contract, in these Specifications, and as directed by the City. Full compensation for wye or tee fittings placed in a main sewer or storm drain in connection with storm drain services is included in the price paid per linear foot for the main storm drain pipe and no additional compensation will be paid.

The quantity of storm drain services of the sizes, grades, and types of pipes listed in the Contract will be measured by the unit constructed in place. The unit prices paid for the storm drain services of the respective sizes, grades, and types of pipes listed in the Contract include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in furnishing and placing all service pipe from the wye or the fitting in the main storm drain to the property line, complete in place, including furnishing and placing other necessary bends and stoppers to construct the service, as shown or specified in the Contract, as specified in these Specifications, and directed by the City.