

SECTION 9

SEWER/DRAINAGE LINES

9.1 GENERAL

This section covers the requirements for piping materials and installation in the Cedar Hills City sewer and drainage collection system. All materials and workmanship shall strictly comply with the Utah State Plumbing Code and the Utah State Health Department criteria.

9.2 PIPE LAYING

All sewer pipe installations shall proceed up grade on a stable foundation with joints closely and accurately fitted. Gaskets shall be fitted properly in place and care shall be taken in joining the pipe units to avoid twisting of gaskets. Joints shall be clean and dry and a joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating joint surfaces to facilitate easy positive joint closure.

All sewer laterals shall tie into the sewer main lines unless approved by the City Engineer.

If adjustment of position of a pipe length is required after being laid, it shall be removed and rejoined as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with tight fitting stoppers to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

9.3 SEWER GRADES

Unless otherwise approved by the City Engineer, all sewer grades shall be established by the use of an approved laser beam method. An above ground method shall not be used. Tolerance shall be $\pm 0.05'$ of actual grade. Above ground methods may be acceptable for storm drain lines with the required tolerance of $\pm 0.05'$ of actual grade being adhered to. Sewer lines shall be designed and constructed according to Utah State Admin Code R317-3-2 and according to the table on page 9-2:

Size of Pipe	Minimum Grade %
4"	2.0%
6"	1.0%
8"	.40%
10"	.30%
12"	.25%
15"	.20%
18"	.15%

9.4 NON-REINFORCED CONCRETE SEWER PIPE

Concrete sewer pipe may only be used upon written approval of the City Engineer. Concrete pipe, if approved, shall be for 18 inch size and smaller applications. Pipe shall be Class Three pipe manufactured to comply with the requirements as set forth in ASTM Designation C14. Joints shall be of the bell and spigot rubber gasket design with joints and gaskets conforming to the requirements of ASTM Designation C443. Pipe joints shall be so designed as to provide for self-centering, and when assembled, to compress the gasket to form a water-tight seal. The gasket shall be confined in a groove on the spigot, so that pipe movement or hydrostatic pressure cannot displace the gasket.

9.5 REINFORCED CONCRETE PIPE

If approved in writing by the City Engineer, reinforced concrete pipe may be used for sanitary sewers and storm drains of size larger than 18 inches. Reinforced concrete pipe shall comply with the requirements of ASTM C-76 (Class III) with bell and spigot rubber gasket type joints for sanitary sewers and the alternate option of tongue and groove mortar joints for storm drain lines.

9.6 CORRUGATED METAL PIPE

For use in storm drainage facilities as approved by the City Engineer, CMP shall conform to AASHTO M36 and shall have a minimum plate thickness of No. 14 gage. Pipe shall be galvanized and asphalt dipped where required by the City Engineer. Aluminum CMP will not be approved. Corrugated metal pipe may only be used in storm drainage facilities upon written approval of the City Engineer.

9.6.1 PIPE INSTALLATION (covering concrete and corrugated metal pipes - Sections 9.4 - 9.6) All pipe installation shall precede upgrade on a stable foundation, with joints closely and accurately fitted. Rubber gaskets shall be fitted properly in place, and care shall be taken in joining the pipe units to avoid twisting of gaskets. Joints shall be clean and dry and a joint lubricant as recommended by the pipe supplier shall be applied uniformly to the mating joint surfaces to facilitate easy positive joint closure.

Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells.

Select material shall be compacted around the pipe to firmly bed the pipe in position. If adjustment of position of a pipe length is required after being laid, it shall be removed and rejointed as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight fitting stopper to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

9.6.2 GRAVEL FOUNDATION FOR PIPE Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, and/or where groundwater must be drained, the subgrade shall be excavated to such depth as may be necessary and replaced with gravel compacted into place.

Gravel for concrete pipe foundation shall be clean gravel with 100% passing a 1-1/2-inch screen and 5% passing a 3/4-inch sieve. Pea gravel shall not be accepted.

9.6.3 INSTALLATION REQUIREMENTS FOR LINE AND GRADE All concrete and CMP pipe shall be installed accurately to the defined line and grade with the following limits:

All sewer and storm drain lines within Cedar Hills shall be installed by means of laser beam method as approved by the City Engineer. Variance from established line shall not be greater than 1/8 inch in ten feet, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one sixty-fourth (1/64) inch per inch of pipe diameter, or one-half (1/2) inch maximum. Grade tolerance shall be $\pm 0.05'$ of actual grade.

9.6.4 PIPE BEDDING All pipe sewers and drains shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded.

A groove shall be excavated in the bottom of the trench to receive the bottom quadrant of the pipe. Before preparing the groove, the trench bottom shall be excavated or filled and compacted to an elevation sufficiently above the grade of the pipe so that, when completed, the pipe will be true to line and grade. Bell holes shall be excavated so that only the barrel of the pipe receives bearing from the trench bottom.

Pipe bedding materials placed at any point below the mid-point of the pipe shall be deposited and compacted in layers not to exceed six (6) inches in uncompacted depth. Deposition and compaction of bedding materials shall be done simultaneously and uniformly on both sides of the pipe. Compaction shall be accomplished with hand or

mechanical compactors. All bedding materials shall be placed in the trench with hand tools or other approved method in such a manner that they will be scattered alongside the pipe and not dropped into the trench in compact masses. Bedding materials shall be loose earth, free from lumps, sand or gravel, free from rocks larger than three-inch diameter; with all materials free from roots, sod, or other organic matter.

In the event trench materials are not satisfactory for pipe bedding, modified bedding will be required. Modified bedding shall consist of placing compacted granular material on each side of and to the level of twelve (12) inches above the top of the pipe.

Modified bedding material shall be graded as follows: 100% passing a one-inch screen and no more than 5% passing a No. 4 sieve.

9.7 PVC PLASTIC SEWER PIPE

This specification covers rigid polyvinyl chloride pipe and fittings, hereinafter called PVC pipe and PVC fittings. The pipe and fittings shall meet or exceed all of the requirements of ASTM Specification D-3034 Type PSM for SDR 35 pipe, and be supplied in maximum 20-foot lengths. PVC sewer and storm drainage pipe may be used for all sanitary and storm sewers up to and including 18 inch. PVC sewer lines 18 inch and larger may only be approved for use by the City Engineer.

Samples of pipe, physical and chemical data sheets shall be submitted to and approved by the City Engineer before pipe is purchased.

This pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform as commercially practical, and white or green in color.

All PVC sewer pipe shall be made from clean, virgin, Type 1, Grade 1, PVC conforming to ASTM resin specification D-1784. All pipe joints shall be bell and spigot type with rubber ring gasket conforming to ASTM D-1869, to permit expansion and contraction. Pipe and fittings must be assembled with nontoxic lubricant. Four-inch and six-inch diameter pipe may be the solvent weld type provided an expansion joint is provided if the length of run exceeds 100 lineal feet. All pipe shall be less than 20 feet in length.

Spigot ends will have 15 degree tapered ends with memory mark around the diameter of the pipe to indicate proper insertion depth.

Wyes shall be of the same material as the pipe, and in no case shall have thinner walls than that of the pipe furnished. Sample wyes must be submitted for the City Engineer's approval, and his approval must be obtained before purchase of the wyes.

All polyvinyl chloride (PVC) -- gravity sewer pipe shall be tested for deflection by the Contractor. Testing shall be accomplished by using a deflectometer which will produce a

continuous record of pipe deflection or by pulling a mandrel go/no-go device approved by the City Engineer, through the pipeline. The diameter of the go/no-go device shall be 95 percent of the undeflected inside pipe diameter as determined by the nominal diameter.

All pipe exceeding a maximum ring deflection of five (5) percent of the vertical internal pipe diameter shall be considered to have failed. Such pipe shall be relayed or replaced between manholes where such failure occurred by the Contractor.

Each section which has been relayed or replaced due to failure of the deflection test shall be retested by the Contractor.

9.7.1 FITTINGS Fittings shall be made of PVC plastic conforming to ASTM D-1784, have a cell classification as outlined in ASTM D-3034, and carry the IAPMO UPC Seal of Approval.

9.7.2 PIPE INSTALLATION All pipe installation shall proceed up grade on a stable foundation with joints closely and accurately fitted. Installation requirements of the manufacturer shall be rigidly adhered to.

Rubber gaskets shall be fitted properly in place and care shall be taken in joining the pipe units to avoid twisting of gaskets. Joints shall be clean and dry and a joint lubricant, as recommended by the pipe supplier, shall be applied uniformly to the mating jointing surfaces to facilitate easy positive joint closure.

Pipe shall be installed with uniform bearing under the full length of the barrel, with suitable excavations being made to receive pipe bells.

Select material shall be compacted around the pipe to firmly bed the pipe in position. If adjustment of position of a pipe length is required after being laid, it shall be removed and rejoined as for a new pipe. When laying is not in progress, the ends of the pipe shall be closed with a tight-fitting stopper to prevent the entrance of foreign material.

In addition to the above requirements, all pipe installation shall comply with the specific requirements of the pipe manufacturer.

9.7.3 GRAVEL FOUNDATION FOR PIPE Wherever the subgrade material does not afford a sufficiently solid foundation to support the pipe and superimposed load, it shall be excavated to such depth as may be necessary and replaced with crushed rock or gravel compacted into place. Gravel foundation material for pipe shall be placed only when, and to the depth, requested by the City Engineer or specified on the Drawings.

Gravel for PVC pipe foundations shall be clean crushed rock or gravel with 100% passing a 1 1/2-inch screen and maximum of 5% passing a 3/4-inch sieve.

9.7.4 INSTALLATION REQUIREMENTS FOR LINE AND GRADE All sewer and storm drain lines within Cedar Hills shall be installed by means of laser beam method as approved by the City Engineer. Variance from established line shall not be greater than 1/8 inch in ten feet, provided that such variation does not result in a level or reverse sloping invert; provided also that variation in the invert elevation between adjoining ends of pipe, due to non-concentricity of joining surface and pipe interior surfaces, does not exceed one sixty-fourth (1/64) inch per inch of pipe diameter, or one-half (1/2) inch maximum. Grade tolerance shall be ± 0.05 feet of actual grade.

9.7.5 PIPE EMBEDMENT All pipe shall be protected from lateral displacement and possible damage resulting from impact or unbalanced loading during backfilling operations by being adequately bedded in suitable embedment material.

The bottom of the trench shall be of stable materials. In general, coarse-grained soils, free of rocks and stones, such as graded crushed rock, gravel, sand, and other granular materials, are considered stable materials. A stable material shall be placed and compacted under the pipe haunches and up to the springline in uniform layers not exceeding six (6) inches in depth. When bedding is required, the same material should be used for both bedding and haunching. Stable material, free of rocks and stones, shall be used to backfill the trench from the springline of the pipe to a point at least twelve (12) inches above the top of the pipe. Each six (6)-inch layer of bedding, haunching and initial backfill shall be placed, then carefully and uniformly compacted to 95% of AASHTO T-180 (ASTM D-1557) density. Extra-fine sand, clay, silt, or large soil lumps shall not be allowed as bedding, haunching or initial backfill material.

The remaining backfill over the top of the initial backfill shall be placed in accordance with Section 4.

No bedding material shall be used unless accepted by the City Engineer. Samples of the materials shall be submitted by the Contractor a sufficient time in advance of intended use to enable its inspection and testing. Bedding material shall be one of the following, at the Contractor's option:

Sand: Sandy bedding shall be a clean sand-gravel mixture free from organic matter and conforming to the following gradation when tested in accordance with ASTM D-422.

U.S. Standard Sieve Size	Percent Passing by Wt.
3/4"	100
3/8"	70-100
#4	55-100
#10	35-95
#20	20-80
#40	10-55

#100	0-10
#200	0-3

Gravel-Sand:

U.S. Standard Sieve Size	Percent Passing by Wt.
1-1/2"	100
3/4"	30-75
1/2"	15-55
1/4"	0-40
#200	0-3

Crushed Rock: Crushed rock bedding shall be a clean mixture free from organic material and conforming to the following gradation when tested in accordance with ASTM D-422.

U.S. Standard Sieve Size	Percent Passing by Wt.
5/8"	100
1/4"	50-65
#40	8-23
#200	0-10

9.8 CORRUGATED HIGH DENSITY POLYETHYLENE PIPE

Corrugated High Density Polyethylene Pipe (CPEP) may be used for storm drain lines from 12 inch up to and including 24 inch diameter unless otherwise specifically designated in these specifications or on the approved drawings. CPEP shall meet the requirements of AASHTO M252, M-294, and ASTM F405. CPEP couplings and fittings shall comply with all the requirements of AASHTO M-294-881. Couplings shall be split couplings with gaskets. All pressure fittings shall meet the requirements of ASTM F-1336 and all O-ring gaskets shall meet the requirements of ASTM F-477. CPEP shall be installed per the pipe manufacturers' recommendations in accordance with ASTM D-2321.

9.9 SUBSURFACE DRAIN PIPE

9.9.1 GENERAL Buried drain pipe with open joints or perforated pipe shall be provided for the drains in the locations shown on the drawings and as approved by the City Engineer. The Contractor shall furnish and lay the drain pipe.

9.9.2 MATERIAL Drain pipe may be perforated PVC pipe (ASTM D-1784), perforated or non-perforated concrete pipe. Corrugated polyethylene piping per ASTM F-405-77a may also be used if installed with direct burial laser grade control equipment

Non-perforated pipe shall be extra-strength non-reinforced concrete pipe. The pipe shall be furnished with bell-and-spigot. Laying lengths of the pipe shall not exceed four (4) feet. To ensure open joints between lengths of pipe, spacer lugs approximately 1/8-inch high located on the 1/3 or 1/4 points around the perimeter shall be provided at each joint between lengths of drain pipe. The lugs may be cast on one end of the pipe during manufacture, or may be gasket-type lugs of plastic, metal, or other suitable material cemented to the pipe by the Contractor and approved by the City Engineer.

Perforated pipe shall be PVC, extra-strength non-reinforced concrete pipe (ASTM C-14) or reinforced concrete pipe (ASTM C-76). All of which shall have 1/4 inch diameter perforations or as approved by the City Engineer. Concrete pipe shall be furnished with bell-and-spigot. Laying lengths of pipe shall not exceed five (5) feet.

9.9.3 LAYING PIPE When an open joint or perforated drainage system is utilized, a gravel backfill shall be placed under and over the pipe to the minimum depth as shown on the drawings. Approved filter fabric shall be used to separate the gravel liner from the native material. This fabric must entirely enclose the gravel and provide a complete overlap at the top of the pipe section. The pipe shall be laid carefully on the gravel in a workmanlike manner and to the lines and grades shown on the drawings or established by the City Engineer.

The maximum allowable departure from grade shall not exceed 0.05 feet. The finished bed for all pipe shall be made smooth, including removal of material under the bell, so that the full length of pipe will be evenly and uniformly supported. The pipe shall be laid and completed with adjacent ends closely abutted and with the bell ends up grade. Where necessary, as determined by the City Engineer, mechanical means shall be used to hold the pipe in place. Any pipe which is broken, cracked, or otherwise unsuitable, as determined by the City Engineer, shall be removed and replaced at the Contractor's expense. The water level in the trench area where the pipe is being laid shall be held to a minimum. During placement of the pipe the water level in the trench shall not exceed 50 percent of the diameter of the pipe above the invert of the pipe. Water may be removed by permitting the water in the trench to flow down the previously installed drain pipe, provided that a screen cover is kept continuously in place over the exposed end of the pipe at all times, except when additional pipe is actually being placed. The screen used for this purpose shall be approved by the City Engineer and shall have maximum mesh openings of 1/8 inch. The pipe shall not be covered with backfill until it has been inspected and approved by the City Engineer. Unless otherwise approved by the City Engineer, the pipe shall not be covered with backfill except in the presence of a duly authorized City inspector. After approval, the trench shall be backfilled as prescribed in Section 5.

The Contractor shall keep the pipe drain and manholes free from deposits of mud, sand, gravel, or other foreign matter and in good working condition until the construction is complete and accepted. All sewer mains shall be video taped and a copy of the video tape of all sections accompanied by an operator's report including a map and diagram are to be submitted to the Cedar Hills Public Works Department. Any obstruction or defects found in the drain shall be removed by the Contractor without cost to the City. Any methods used by the Contractor to remove deposits of mud, sand, gravel, or other foreign matter from the drains, such as use of water or air pressure, shall be subject to the approval of the City Engineer.

9.10 MANHOLES/BOXES

9.10.1 GENERAL The Contractor shall furnish and install watertight cast-in-place or precast concrete manholes at the locations shown on the Drawings approved by the City Engineer. Manholes shall be furnished complete with cast iron rings and covers and ladder rungs. Manhole spacing shall not exceed 400 lineal feet unless otherwise approved by the City Engineer.

9.10.2 FOUNDATION PREPARATION Dewatering of the site shall conform to the requirements for sewer trench dewatering in these specifications. Adequate foundation for all manhole structures shall be obtained by removal and replacement of unsuitable material with stabilization material; or by tightening with coarse ballast rock, or by such other means as provided for foundation preparation of the connected sewers, or as required by the City Engineer. Where water is encountered at the site, all cast in place bases shall be placed on a one-piece waterproof membrane, so placed as to prevent any movement of the water into the fresh concrete. Precast base sections shall be placed on a well graded granular bedding course conforming to the requirements for sewer bedding but not less than eight (8) inch in thickness and extending either to the limits of the excavation or to a minimum of twelve (12) inches outside the outside limits of the base section. In the latter case, the balance of the excavated area shall be filled with select material well tamped to the level of the top of the bedding to positively prevent any lateral movement of the bedding when the weight of the manhole is placed upon it. The bedding coarse shall be firmly tamped and made smooth and level to assure uniform contact and support of the precast elements.

9.10.3 BASES Cast-in-place bases shall be at least nine (9) inches in thickness and shall extend at least six (6) inches radially outside of the outside dimension of the manhole section. Precast bases shall be a minimum of nine (9) inches in thickness. Concrete bases shall be placed upon a minimum of six (6) inches of compacted one-inch minus gravel.

The concrete base shall be constructed so the first section of the precast manhole has a uniform bearing throughout the full circumference of the manhole wall. Sufficient mortar shall be deposited on the concrete base to provide a water tight seal between the base and the manhole wall. Concrete used in the construction of the base shall conform to 6-1/2 bag, 4000 psi concrete as specified in the concrete section of these specifications.

Where sewer lines pass through or enter manholes, the invert channels shall be smooth and semi-circular in cross section carried up vertically to the crown elevation of the various pipes. Changes of direction of flow within the manholes shall be made with a smooth curve with as long a radius as possible. The floor of the manhole outside the flow channels shall be smooth and slope toward the channel at not less than one inch per foot.

The sewer pipe shall be placed through the manhole wall not to exceed four (4) inches and as to form a smooth flow line through the manhole. All sewer lines entering manholes shall be cut or finished with a cement mortar to form a smooth watertight seal between the pipe and the manhole base.

All external connections shall also be finished with a cement mortar to form a smooth watertight seal between the pipe and the manhole base.

Upon written approval of the City Engineer, connecting boots may be used consisting of neoprene compound meeting ASTM C-443 specifications. The boot shall have a wall thickness of 3/8-inch. The boot shall either be "cast-in-place" in the precast base or attached to the precast base by means of an internal expanding band. When the boot is attached to the precast base, a watertight seal between the boot and the precast base must be accomplished.

An external band shall be supplied and used to clamp and seal the boot to the pipe. The band shall be made of 300 series non-magnetic corrosion-resistant steel. After the band has been placed, it shall be completely coated with a bituminous material approved by the City Engineer.

All manholes with four (4) or more pipes entering the base or pipes larger than twelve (12) inches in diameter shall be 60-inch inside diameter; all others shall be 48-inch inside diameter unless otherwise specified by the City Engineer.

Any lateral entering a manhole must have the top of the lateral at the same elevation as the top of the largest main line in the manhole. The flowline of the lateral shall make an abrupt drop of not less than four (4) inches to the flowline of the main to prevent jet nozzles from entering the lateral.

All concrete for manhole bases shall comply with City approved specifications.

9.10.4 WALL AND CONE SECTIONS All manholes shall be precast, sectional, reinforced concrete pipe of either 48-inch or 60-inch inside diameter as specified. Both cylindrical and taper sections shall conform to all requirements of ASTM Designation C-76 for Reinforced Concrete Culvert Pipe with the following exceptions:

- A. The throat section of the manhole shall be adjustable, by use of pipe sections up to 18 inches in height.
- B. The taper section shall be a maximum of three (3) feet in height, shall be of concentric conical design, and shall taper uniformly to 30 inches inside diameter.
- C. The pipe used in the base section shall be furnished in section lengths of one (1), two (2), three (3), and four (4) feet as required.
- D. Reinforcing steel shall consist of a circular cage with a minimum cross sectional area of three-tenths (0.3) of a square inch of steel per foot in both directions.

All joint surfaces of precast sections and the face of the manhole base shall be thoroughly cleaned and wet prior to setting precast sections.

Joints shall be set in mortar consisting of one (1) part cement and one and one-half (1-1/2) parts sand with sufficient water added to bring the mixture to workable consistency, or the joints shall be sealed with a butyl rubber gasket that is permanently flexible and non-shrinking, similar to Brandt No. 95 Cold Weather Vault Sealant.

9.10.5 PIPE CONNECTIONS All pipes entering or leaving the manhole shall be placed on firmly compacted bedding, particularly within the area of the manhole excavation which normally is deeper than that of the sewer trench. Special care shall be taken to see that the openings through which pipes enter the structure are completely and firmly rammed full of mortar to ensure water tightness.

9.10.6 BACKFILL Backfill around the manhole and extending at least one pipe length into each trench shall be hand placed and hand tamped with select material up to an elevation of one foot above the top of each pipe, regardless of the specifications for backfilling the sewer trenches adjacent thereto. The balance of the backfill shall conform to the requirements for trench backfilling.

9.10.7 COVERS AND FRAMES All iron castings shall conform to the requirements of ASTM A 48 (Class 30) for grey iron castings. Rings and covers shall be 30-inch in

diameter with machined bearing surfaces and with minimum cover weight of 150 pounds and minimum ring weight of 233 pounds. Any cover which tends to rock or tip will be rejected. In addition to the foundry name and year of manufacture, the cover shall be marked "SEWER" or "STORM DRAIN" as appropriate.

All manhole rings shall be carefully set to the grade shown on the approved drawings or as directed by the City Engineer. The manhole covers shall be so installed to match the street profile. Where work is in paved streets, not less than six (6) inches or more than 18 inches shall be provided between the top of the cone or slab and the underside of the manhole casting ring for adjustment of the casting ring to street grade.

9.10.8 MANHOLE STEPS All manholes shall be provided with manhole steps as shown on approved drawings. All precast sections shall be ordered to include steps. All steps shall be securely grouted into the wall and shall be watertight and free from appreciable irregularities in the wall surface. Steps shall be uniformly spaced at one (1) foot maximum and shall be polypropylene covered steel steps, of a type approved by the City Engineer.

9.11 CLEANING AND TESTING SANITARY SEWER LINES

9.11.1 CLEANING After the sewer lines have been laid and the trench backfilled, they shall be thoroughly cleaned and tested for leakage and alignment in the presence of the City Engineer or the City Inspector before acceptance by the Owner. Laterals and trunk lines shall be flushed by water to remove all foreign material. Waste water and debris shall not be permitted to enter sewer lines in service, but shall be removed at the lowest manhole of the excavation. The scouring action shall be accomplished by hydraulic or jet cleaning. Other methods may be used upon approval of the City Engineer. After the lines have been thoroughly cleaned, they shall be tested between all manholes for displacement.

9.11.2 DISPLACEMENT TEST The displacement test shall be supervised and conducted by the City Engineer or the City Inspector and shall consist of both of the following: (1) A light will be flashed between the manholes, or if the manholes have not as yet been constructed, between the locations of the manholes, by means of a flashlight or by reflecting sunlight with a mirror. If the illuminated interior of the pipe shows broken, misaligned or displaced pipe, or other defects, the defects designated by the City Engineer shall be remedied by the Contractor; (2) after subbase has been placed and compacted, prior to asphalt placement, the sewer line will be televised. The initial inspection shall be provided at no cost to the City. If the pipeline is found to be unacceptable, the problem shall be corrected by the Contractor and re-televised. The Contractor shall be charged for any of these additional inspection(s). Television inspection must be scheduled at least one (1) week in advance of date inspection is required. Prior to the beginning of the Durability Period and after the paving is completed, the sewer line shall be televised a second time.

9.11.3 LEAKAGE TESTS The Contractor shall test all sanitary sewers by means of ex-filtration and infiltration tests. Length of the line tested at one time shall be limited to the length between adjacent manholes.

9.11.4 EXFILTRATION TEST Each section of the sewer shall be tested between successive manholes by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole with stoppers. The pipe and manhole shall be filled with water to a point approximately four (4) feet above the invert of the sewer at the center of the upper manhole or to four (4) feet above the natural groundwater level, whichever is higher.

The allowable leakage will be computed by the formula: $E = 0.25 (D) (H)$

Where: E is the allowable leakage in gallons per hour per 1000 feet of sewer tested.

D is the internal diameter of the pipe in inches.

H is the difference in elevation in the water surface in the upper manhole and the invert of the pipe at the lower manhole (feet).

If the leakage from the sewer as shown by the test exceeds that allowed by the formula, the Contractor will make the necessary corrections to reduce the exfiltration to within permissive limits.

Where the difference in elevation between inverts of adjacent manholes exceeds 10 feet, the exfiltration leakage test will be modified as directed by the City Engineer.

House surface laterals shall be considered part of the main line sewer to which they are connected and shall be tested with the main line sewer.

9.11.5 ALTERNATE EXFILTRATION TEST Air pressure testing may be used in lieu of the water exfiltration test subject to the approval of the City Engineer. The low pressure air test shall be conducted by the following method under the direction of the City Engineer or City Inspector.

All wyes, tees, or ends of lateral stubs shall be suitably capped and braced to withstand the internal test pressures. Caps shall be easily removable for future lateral connections or extensions.

After a manhole to manhole section of line has been backfilled and cleaned, it shall be plugged at each manhole with pneumatic plugs. One of the plugs shall have three hose connections. Air for inflation of the triple connection pneumatic plug shall be supplied through a factory equipped control panel. There shall be three hose connections from the control panel to the pneumatic plug. One hose shall be used for inflations of the

plug. The second hose shall be used for continuously reading the air pressure in the sealed line. The third hose shall be used for introducing low pressure air into the sealed line.

There shall be a 3-1/2 inch or larger diameter, 30.0 psig gauge mounted on the control panel for reading of the internal pressure in the line being tested. Calibrations from the 0-10 psig range shall be in tenths of pounds and the 0-10 psig portion shall cover 90% of the complete dial range.

Low pressure air shall be introduced into the sealed line until the internal air pressure reaches 4 psig greater than the average back pressure of any ground water that may be over the pipe. At least two (2) minutes shall be allowed for the air pressure to stabilize. After the stabilization period (3.5 psig minimum pressure in the pipe), the third hose shall be disconnected from the control panel.

The portion of line being tested shall be accepted if the portion under test does not lose air at a rate greater than 0.003 cubic feet per minute per square foot of internal pipe surface or 2.0 cubic feet per minute minimum when tested at an average 3.0 psig greater than any back pressure exerted by ground water that may be over the pipe at the time of the test.

For PVC pipe the pipe and joints shall also be considered acceptable when the time required in minutes for pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any ground water that may be over the pipe) shall not be less than the time shown for the given diameters in the following tables:

<u>Pipe Diameter in Inches</u>	<u>Minutes</u>
4	2.0
6	3.0
8	4.0
10	5.0
12	5.5
15	7.5
18	8.5

* For all concrete pipe use ASTM C924 or C969.

If the installation fails to meet this requirement, the Contractor shall determine at his own expense the source of leakage. He shall repair or replace all defective materials and/or workmanship.

9.11.6 INFILTRATION TEST In addition to the exfiltration test, the City may require the newly laid sewer system shall also comply with the following infiltration requirements. Infiltration tests shall be conducted by placing an approved calibrated V-notch weir in the line just above the next lower manhole and plugging the line just above

the next higher manhole. Sufficient time shall be allowed for the water level behind the weir to stabilize before reading. Dislodge any foreign material obstructing the weir before reading. Take successive readings until consistent results are obtained.

Whenever the rate of infiltration is found to exceed the maximum, conduct electronic or photographic visual inspection of the interior of the pipeline. Make repairs and continue to test the conduit until it is within specified limits prior to proceeding with further construction. Make repairs at all manholes to exclude all infiltration occurring, whether or not they are within specified limits.

The maximum allowable infiltration for any section of the system shall be as follows, subject to the limitations described hereafter: $I = 150$ gallons/mile/inch-diameter/day

Upon completion of all sectionalized testing, the total project infiltration of the newly constructed system shall be measured and recorded. This value shall be limited to 125 gallons/mile/inch-diameter/day. Make repairs and continue to test for total project infiltration until it is within this specified limit.

9.11.7 VIDEO INSPECTION All sanitary sewer lines and laterals shall be video inspected and approved by the city engineer before inspection. All videos must be submitted to the city.