

CITY OF ALBANY

Standard Specifications Technical Provisions

Section 18

Sanitary Sewers & Storm Drains

18-1 Trenching

18-1.1 General — For the purpose of shoring or bracing, a trench is defined as an excavation in which the depth is greater than the width of the bottom of the excavation.

Excavations for appurtenant structures, such as but not limited to manholes, transition structures, junction structures, vaults, valve boxes, catch basins, thrust blocks, and boring pits shall, for the purpose of shoring and bracing, be deemed to be in the category of trench excavation.

Excavation shall include the removal of all water and materials of any nature which interfere with the construction work. Removal of groundwater to a level below the structure subgrade will be necessary only when required by the plans or specifications.

Excavation for conduits shall be by open trench unless otherwise specified or shown on the plans. However, should the Contractor elect to tunnel or jack any portion not so specified, they shall first obtain approval from the Engineer. Payment for such work will be made as though the specified methods of construction had been used.

18-1.2 Maximum Length of Open Trench — Except by permission of the Engineer, the maximum length of open trench where prefabricated pipe is used shall be 500 feet (150m) but no more than the amount of pipe installed and backfilled in a single day. The distance is the collective length at any location, including open excavation, pipe laying and appurtenant construction.

Except by permission of the Engineer, the maximum length of open trench in any one location where concrete structures are cast in place will be that which is necessary to permit uninterrupted progress. Construction shall be pursued as follows: excavation, setting of reinforcing steel, placing of floor slab, walls, and

cover slab or arch. Each shall follow the other without any one operation preceding the next nearest operation by more than 200 feet (60m).

Failure by the Contractor to comply with the limitations specified herein may result in an order to halt the work until such time as compliance has been achieved.

18-1.3 Maximum and Minimum Width of Trench — For pipe (except corrugated steel pipe), the minimum and maximum width of trench permitted shall be as indicated on the Plans or Standard Drawings.

For corrugated steel pipe, the trench shall be at least 16 inches (400mm) wider than the diameter of the pipe to be installed.

If the maximum trench width is exceeded, the Contractor shall provide additional bedding, another type of bedding, or a higher strength of pipe, as shown on Plans or approved by the Engineer, at no additional cost to the City.

18-1.4 Access to Trenches — Safe and suitable ladders which project 2 feet (0.6m) above the top of the trench shall be provided for all trenches over 4 feet (1.2m) in depth. One ladder shall be provided for each 50 feet (15.6m) of open trench, or fraction thereof, and be so located that workers in the trench need not move more than 25 feet (7.5m) to a ladder.

18-1.5 Removal and Replacement of Surface Improvements — Bituminous pavement, concrete pavement, curbs, sidewalks or driveways removed in connection with construction shall be removed and replaced in accordance with the other provisions of these Standard Specifications.

18-1.6 Bracing Excavations — The manner of bracing excavations shall be as set forth in the rules, orders, and regulations of the Division of Industrial safety of the State of California.

Prior to commencing the excavation of a trench 5 feet (1.5m) in depth or greater and into which a person will be required to descend, the Contractor shall first obtain a permit to do so from the Division of Industrial Safety.

Should the bracing system utilize steel H-beams or piles or other similar vertical supports, driving of said vertical supports will not be permitted except for the last 4 feet (1.2m). The vertical supports shall be placed in holes drilled to a depth of 4 feet (1.2m) above the proposed bottom of pile, except where this procedure is impracticable. The vertical support may then be driven to the required depth, not to exceed 4 feet (1.2m). During the drilling and driving operations the Contractor shall take care to avoid damage to utilities.

At locations where the drilling of such holes is impracticable because of the existence of rocks, running sand, or other similar conditions, and provided said impracticability is demonstrated to the satisfaction of the Engineer by actual drilling operations by the Contractor, the Engineer may, upon request of the Contractor, approve the use of means other than drilling for the purpose of placing the vertical support. Such other means, however, must be of a nature which will accomplish, as nearly as possible, the purpose of the drilling, namely, the prevention of damage to existing surface or sub surface improvements, both public and private. All costs for this work shall be included in the prices bid for the items involved.

If sheeting is used to support the excavated trench, the sheeting shall be removed by the Contractor, and no such sheeting will be permitted to remain in the trench. When field conditions, the type of sheeting, or methods of construction used by the Contractor are such as to make the removal of sheeting impracticable, the Engineer may permit portions of the sheeting to be cut off to a specified depth and remain in the trench.

18-2 Bedding — Bedding shall be defined as that material supporting, surrounding and extending to between six inches and one foot above the top of the pipe, as shown in the details. Where it becomes necessary to remove boulders or other interfering objects at subgrade for bedding, any void below such subgrade shall be filled with the bedding material designated on the Plans. Where concrete is specified to cover the pipe, the top of the concrete shall be considered as the top of the bedding.

If soft, spongy, unstable, or other similar material is encountered upon which the bedding material or pipe is to be placed, this unsuitable material shall be removed to a minimum depth of 18 inches beneath the bottom of the pipe or as ordered by the Engineer and replaced with bedding material suitably densified. Additional bedding so ordered, over the amount required by the Plans or Specifications, will be paid for as provided in the Bid Schedule. If the necessity for such additional bedding material has been caused by an act or failure to act on the part of the Contractor, or is required for the control of groundwater, the Contractor shall bear the expense of the additional excavation and bedding.

Bedding material for pipe shall first be placed to a depth of 4 inches below the pipe. If the pipe is to be laid in a rock cut, there shall be at least 6 inches of bedding below the pipe. Then the remainder of the bedding shall be placed. Bedding shall be compacted by hand or mechanical tampers prior to backfilling. All bedding material shall be placed carefully to achieve uniform contact with the pipe and a minimum relative compaction of 90 percent, as determined by ASTM D-1557 (AASHTO T-180) laboratory density. Unless the sheeting or shoring is to be cut off and left in place, densification of bedding for pipe shall be accomplished after the sheeting or shoring has been removed from the bedding zone.

In dry trench conditions or where otherwise specified, bedding material for pipe shall be sand, Class II Aggregate Base, native free-draining granular material having a sand equivalent of not less than 30. Where water is encountered, or where trench dewatering is used, Wet Condition Material, meeting the requirements presented in Table 1, shall be used.

TABLE 1	
PIPE BEDDING GRADATION REQUIREMENTS FOR WET TRENCH CONDITION	
Sieve Size	Percent Passing
1½ inches	100
¾ inches	55 to 100
⅜ inches	8 to 50
No. 4	0 to 8
No. 200	0 to 2

Crushed stone or gravel meeting these requirements include No. 3 concrete aggregate, as specified in the Public Works Specifications, and concrete gravel designated ASTM C33, Gradation 67.

Concrete used for bedding shall be one of the classes of concrete specified herein for the indicated time periods before backfill.

Continuity of bedding material shall be interrupted by low permeability groundwater barriers to impede passage of water through the embedment. Barrier material shall be low permeability clay material and shall be compacted to 95 percent of maximum density. Material may be finely divided suitable job excavated material, free from stones, organic matter, and debris. A groundwater barrier of compacted soil shall be placed at or near each manhole or special structure along the sewer line. The groundwater barrier shall be keyed a minimum of 6 inches into undisturbed material on the trench sides and trench bottom and shall extend vertically to the top of the pipe embedment. The barrier shall be 18 inches thick.

18-3 Pipe Materials & Installation (New or Replacement)

18-3.1 General

18-3.1.1 General — Pipe will be inspected in the field before and after laying. If any cause for rejection is discovered in a pipe after it has been laid, it shall be subject to rejection. Any corrective work shall be approved by the Engineer and shall be at no cost to the City.

When connections are to be made to any existing pipe, conduit, or other appurtenances, the actual elevation or position of which cannot be determined without excavation, the Contractor shall excavate for, and expose, the existing improvement before laying any pipe or conduit. The Engineer shall be given the opportunity to inspect the existing pipe or conduit before connection is made.

Pipe shall be laid up-grade with the socket or collar ends of the pipe upgrade unless otherwise authorized by the Engineer.

Pipe shall be laid to Plan line and grade, with uniform bearing under the full length of the barrel of the pipe. Suitable excavation shall be made to receive the socket or collar, which shall not bear upon the sub grade or bedding. Any pipe which is not in true alignment or shows any undue settlement after laying shall be taken up and relaid at the Contractor's expense.

Pipe sections shall be laid and jointed in such a manner that the offset of the inside of the pipe at any joint will be held to a minimum at the invert. The maximum offset at the invert of pipe shall be 1 percent of the inside diameter of the pipe or $\frac{3}{8}$ -inch (10mm), whichever is smaller.

In joining socket and spigot pipe, the spigot of each pipe shall be so seated in the socket of the adjacent pipe as to give a minimum of $\frac{3}{8}$ -inch (10mm) annular space all around the pipe in the socket. Unavailable offsets shall be distributed around the circumference of the pipe in such a manner that the minimum offset occurs at the invert.

When pipe is laid in a sheeted trench, all sheeting against which concrete cradle is to be placed shall be faced with at least one thickness of building paper and the sheeting shall be withdrawn without displacing or damaging the cradle.

After the joints have been made, the pipe shall not be disturbed in any manner.

At the close of work each day, or whenever the work ceases for any reason, the end of the pipe shall be securely closed.

18-3.1.2 Marking — Each length of pipe shall be marked by the manufacturer with the trade name, nominal size, D-load, date of manufacture and lot number. The D-load and lot number designations shall be marked on the inside of the pipe.

A lot is defined as 100 lengths of pipe, or a fraction thereof, of one

diameter and D-load manufactured within a 24-hour period.

Each coupling shall be marked with the nominal size and D-load for the pipe with which it shall be used.

- **18-3.1.3 Basis for Acceptance** — The basis for acceptance of lots shall be: D-load strength test, compliance with Specifications, inspection of pipe manufacture, and inspection of completed pipe.

the Engineer may accept a certification indicating compliance with these specifications in lieu of City inspection.

18-3.1.4 Causes for Rejection — The following defects are cause for rejection of individual pipe lengths:

- 1) Any crack, any piece broken from the pipe, or other irregularities.
- 2) Deficiencies or irregularities in wall thickness. Wall thickness shall be at least 95 percent of the manufacturer's specified nominal wall thickness.
- 3) Improper machining of ends of pipe lengths. When plastic couplings are used, pipe ends shall be machined at least 1/16-inch deep (1.5mm) for a minimum of two-thirds of the full circumference. Unmachined portions of the ends shall be sanded smooth to provide a close-fitting joint.

When a pipe contains localized defects but is otherwise acceptable, the pipe will be accepted when the defective portion is cut off and the end or ends satisfactorily remachined.

18-3.2 PVC Plastic Pipe

18-3.2.1 General — This subsection applies to the requirements for unplasticized polyvinyl chloride (PVC) plastic pipe for gravity flow sewers and house connection sewers. Pipe, fittings, couplings and joints shall be in conformance with the requirements of ASTM D 3033 or D 3034, except as modified herein.

The ASTM designation, SDR, and type of joint shall be as shown on the Plans or in the Specifications. When PVC sewer pipe is specified without further qualification, the pipe shall conform to the requirements of ASTM D 3034, SDR 35, and shall have gasketed joints. All pipe, fittings and couplings shall be clearly marked at an interval not to exceed 5 feet

(1.5m) as follows:

- 1) Nominal pipe diameter.
- 2) PVC cell classification.
- 3) Company, plant, shift, ASTM, SDR, and date designation.
- 4) Service designation or legend.

For fittings and couplings, the SDR designation is not required.

18-3.2.2 Cell Classification — Pipe shall be made of PVC plastic having a cell classification of 12454-B, 13364-A, or 13364-B as defined in ASTM D 1784. The fittings shall be made of PVC plastic having a cell classification of 12454-B, 12454-C, or 13343-C. PVC compounds of other cell classifications shall be prequalified.

18-3.2.3 Joining Systems — All pipe shall have a home mark on the spigot end to indicate proper penetration when the joint is made.

the socket and spigot configurations for the fittings and couplings shall be compatible to those used for the pipe.

18-3.2.4 Elastomeric Gasket Joints — Pipe with gasketed joints shall be manufactured with a socket configuration which will prevent improper installation of the gasket and will ensure the gasket remains in place during the joining operation. The gasket shall be manufactured from a synthetic elastomer.

18-3.2.5 Solvent Cement Joints — Pipe with solvent cement joints shall be joined with a PVC cement conforming to ASTM D 2564.

18-3.2.6 Injection Sealed Joints — Pipe with injection sealed joints shall be sealed with a PVC adhesive compound. The compound shall conform to the requirements of ASTM D 2564 and shall have a minimum viscosity of 50,000 centipoise (50Pa.s). The internal diameter of the socket shall be uniform with a locking taper at the base and an outer seal ring attached to the end. The socket shall have an injection port to inject the adhesive and an exhaust port on the opposite side to allow air to escape from the annular space.

18-3.2.7 Test Requirements — General. Pipe, fittings and couplings shall meet the requirements of the section titled “Requirements” of ASTM D 3033 or D 3034. During production of the pipe, the

manufacturer shall perform the specified tests for each pipe marking. A certification by the manufacturer indicating compliance with specification requirements shall be delivered with the pipe. The certification shall include the test result data. The PVC compound shall also meet the chemical resistance requirements.

18-3.2.8 Acceptance — The basis for acceptance shall be the inspection of pipe, fittings and couplings; the tests specified in Subsection 18-3.2.7; and compliance with the specifications. When the pipe is delivered to the work site, the Engineer may require additional testing to determine conformance with the requirements of pipe flattening, impact resistance, pipe stiffness and extrusion quality. Also, pipe which is not installed within 120 days of the latest test shall not be used without prior approval of the Engineer.

18-3.2.9 Selection of Test Pipe — When testing is required by the Engineer, one test pipe shall be selected at random by the Engineer from each 1200 feet (360m) or fraction thereof of each size of pipe delivered to the Work site but no less than one test pipe per lot. A lot shall be defined as pipe having the same identification marking. The length of specimen for each selected pipe shall be a minimum of 8 feet (2.4m).

A pipe lot shall consist of all pipe having the same marking number. The lot test specimen shall have a minimum length of 4 feet (1.2m).

18-3.2.10 Chemical Resistance — The PVC compound for cell classifications not specifically identified herein shall be pre-qualified by the pipe manufacturer by meeting the chemical resistance tests which follow. Compound samples and molded test specimens shall be prepared in accordance with ASTM D 53.

Tensile and Izod impact exposure specimens shall be immersed in the solutions for a period of 112 days. At 4-week intervals, selected specimens shall be removed, washed, surface dried and tested.

Weight change specimens shall be 2 inches (50mm) in diameter and may be molded discs or discs cut from the pipe wall. They shall be conditioned for 7 days at $110^{\circ} \pm 5^{\circ}\text{F}$ ($43^{\circ} \pm 3^{\circ}\text{C}$), cooled in a desiccator for three hours at $75^{\circ} \pm 5^{\circ}\text{F}$ ($24^{\circ} \pm 3^{\circ}\text{C}$), weighed, and then immersed in the solutions specified in Subsection 2.0-2.3.3 of the Standard Specifications for Public Works Construction. At 4-week intervals, selected specimens shall be removed, washed, surface dried and weighed. These same specimens shall then be reconditioned for 7 days at $110^{\circ} \pm 5^{\circ}\text{F}$ ($43^{\circ} \pm 3^{\circ}\text{C}$), cooled in a desiccator for 3 hours at $75^{\circ} \pm 5^{\circ}\text{F}$ ($24^{\circ} \pm 3^{\circ}\text{C}$) and again weighed.

Initial and post-exposure specimens shall meet the following requirements when tested at $75^{\circ} \pm 5^{\circ}$ ($23^{\circ} \pm 2^{\circ}\text{C}$):

Property	ASTM Test Method	Cell Class Min. Values		
		12454	13343	13364
Tensile Strength (Yield), psi (MPa)	D 638	7000 (41)	6000 (41)	6000 (48)
Impact Strength, ft-lbs/in. (J/m)	D 256 Method A	0.65 (80)	1.5 (80)	1.5 (35)
Weight Change, %	D 543	1.5	1.5	1.5

If any specimen fails to meet the requirements at any time during the 112 days exposure period, the material will be subject to rejection.

18-3.2.11 Pipe Acceptance — At the time of manufacture, each lot of pipe and fittings shall be inspected for defects, and tested for impact, stiffness and flattening in accordance with ASTM D 2751.

When testing subsequent to manufacture the impact requirement shall be excluded. For the flattening requirement, the percentage reduction in pipe diameter shall be not less than 15 percent for pipe marked SDR 23.5 or lower, and not less than 25 percent for pipe marked with higher SDR numbers. The stiffness requirement is unchanged.

The Engineer may require certification by the manufacturer that the test results comply with specification requirements.

18-3.2.12 Marking — Pipe shall have a home mark to indicate full penetration of the spigot when the joint is made. Pipe shall be marked at 5-foot (1.5m) intervals or less with a marking number which identifies the manufacturer, SDR, size, machine, date and shift on which the pipe was produced.

18-3.3 Reinforced Concrete Pipe

18-3.3.1 General — These specifications apply to reinforced concrete pipe intended to be used for the construction of storm drains, sewers, and related structures.

The size, type, and D-load of the concrete pipe to be furnished shall be as shown on the Plans, or as specified under the item of work for the project.

Prior to the manufacture of the pipe, three sets of prints of the pipe line layout diagrams, prepared in accordance with good industry practice, shall be furnished to the Engineer. Catch basin connector pipe need not be included in the pipe line layout; in lieu thereof, a list of catch basin connector pipes shall accompany the layout. The connector pipe list shall include size and D-load of pipe, station at which pipe joins mainline, number of sections of pipe, length of sections, type of sections (straight, horizontal bevel, vertical, bevel, etc.). The diagrams and lists submitted will be used by the Agency for reference only, and their use shall in no way relieve the Contractor of its responsibility for correctness. The Engineer may waive the pipeline layout and connector pipe list requirement.

Cast reinforced concrete pipe shall be manufactured by placing the concrete into stationary, vertical, cylindrical metal forms.

Spun reinforce concrete pipe shall be manufactured by introducing the concrete into a rotating, horizontal, cylindrical metal form.

The interior surface of the pipe shall be smooth and well-finished. Joints shall be of such type and design and so constructed as to be adequate for the purpose intended so that when laid, the pipe will form a continuous conduit with a smooth and uniform interior surface.

Sockets and spigots shall be free from any deleterious substance or condition which might prevent a satisfactory mortar bond at the joints.

If the Engineer determines that the forms, end rings or form gaskets used in the manufacture of the pipe are inadequate for the purpose intended, the Contractor shall replace or repair said equipment to the satisfaction of the Engineer.

Pipe stronger than that specified maybe furnished at the Contractor's option, and at its expense, provided such pipe conforms in all other respects to the applicable provisions of these specifications.

The Contractor shall furnish, install and maintain stulls or other devices in the pipe as may be necessary to meet the limitation on cracks as specified herein, throughout pipe handling, transportation, and field installation.

18-3.3.2 Materials — Pipe greater than 24 inches shall be reinforced concrete pipe in accordance with ASTM C 76 Class IV. Cement used in the manufacture of pipe shall be in accordance with ASTM C 150, Type II, low alkali. At least two 3-edge bearing tests shall be made on each size of pipe. No hydrostatic nor absorption tests will be required except as stated hereinafter.

Joints shall be the rubber gasket type with the gaskets in accordance with ASTM C 361. Connections of reinforced concrete pipe to structures shall be with steel manufacturer's bell ring as detailed on the Plans. Plastic or fiberglass bell rings or collars shall not be used. Rubber gaskets shall be of the O-ring type. The spigot shall be formed with a groove for the gasket.

Fittings required as indicated on the Plan shall be constructed to the standards of the pipe manufacturer. Details of fittings shall be submitted for Engineer's acceptance before fabrication.

18-3.3.3 Installation - The ends of the pipe shall be so formed that, when the pipes are laid together and joined, they shall make a continuous and uniform line of pipe with a smooth and regular surface.

This gasket shall be of circular cross section unless otherwise approved by the Engineer. The length and cross sectional diameter of the gasket, the annular space provided for the gasket, and all other joint details shall be such as to produce a watertight joint. The slope of the longitudinal gasket contact surfaces of the joint with respect to the longitudinal axis of the pipe shall not exceed 2 degrees.

Under ordinary laying conditions, the work shall be scheduled so that the socket end of the pipe faces in the direction of laying. Prior to placing the spigot into the socket of the pipe previously laid, the spigot groove, the gasket and the inside of the socket shall be thoroughly cleaned. Then the spigot groove, the gasket and the first 2 inches (50mm) of the inside surface of the socket shall be lubricated with a soft vegetable soap compound.

The gasket after lubrication shall be uniformly stretched when placing it in the spigot groove so that the gasket is distributed evenly around the circumference.

For pipe in which the inside joints are to be pointed, suitable spacers shall be placed against the inside shoulder of the socket to provide the proper space between abutting ends of the pipe.

After the joint is assembled, a thin metal feeler gage shall be inserted between the socket and the spigot and the position of the gasket checked around the complete circumference of the pipe. If the gasket is not in the proper position, the pipe shall be withdrawn, the gasket checked to see that it is not cut or damaged, the pipe relaid, and the gasket position again checked.

Concrete pipe with elliptical reinforcement shall be laid with the minor axis of the reinforcement cage in a vertical position.

In general, horizontal or vertical curves shall be made by using pipe with beveled ends or by slight deflections in the joints of straight pipe. If necessary, short length pipe shall be made for curve of shorter radius than can be made with beveled pipe of usual length. Detailed layouts of curves shall be submitted to the Engineer by the pipe manufacturer for review and acceptance before fabrication of the beveled pipe. Curves may be made by use of angle bands at joints in lieu of beveled ends. Not more than 15 degrees of deflection angle shall be made in any one joint. Each angle joint shall fall upon the curve of the radius as indicated on the Plan.

18-3.4 Reinforced Thermosetting Resin (RTR) and Reinforced Plastic Mortar (RPM) Pipe and Fittings

18-3.4.1 General — This subsection applies to RTR and RPM pipe and fittings.

18-3.4.2 Type of Service — Types of service shall be as follows:

Types of Service	Uses	ASTM Requirements ¹
I	Storm drains Sanitary sewers	ASTM D3517 for pressure and nonpressure
II		ASTM D3262 for nonpressure ASTM D3754 for pressure

1. Pipe shall comply with ASTM requirements except as modified herein.

18-3.4.3 Material Composition — The RTR and RPM material shall conform to Section 213 of the Standard Specifications for Public Works

Construction.

18-3.4.4 Joints for RTR and RPM Pipe and Fittings — Joints shall be socket (bell) and spigot connections with elastomeric gaskets conforming to ASTM F477. Gaskets shall be new.

18-3.4.5 Joint Adapters for RTR and RPM Pipe and Fittings — Where adapters are required, adapters shall be approved by the Engineer. Fittings shall be manufactured from pipe that has been accepted and hydrotested.

18-3.4.6 Pipe Acceptance — Inspection, testing and acceptance shall conform to Subsection 18-3.1. The Engineer may require certification by the manufacturer that the test results comply with specification requirements. Each length of pipe shall be hydrostatically tested to 150 percent of design pressure.

18-3.4.7 Marking — Each length of pipe and each fitting shall be marked with the type, size, pressure class, lot or serial number, the name or mark of the manufacturer and the hydrostatic test pressure. Identification shall be traceable to location, date and shift of manufacture.

18-3.5 Polyethylene (PE) Solid Wall Pipe and Liner

18-3.5.1 General — Polyethylene (PE) plastic solid wall pipe and liner for use in gravity flow sanitary sewers, storm drains and water systems shall comply with ASTM D 2239 and D 3035. Fittings shall comply with ASTM D 2683, D 3797 and D 3261.

18-3.5.2 Material Composition — Pipe and fittings shall be made from PE resins in accordance with ASTM D 1248, and shall consist of a high-density, high-modulus resin which meets or exceeds the requirements listed below, and shall also meet requirements of ASTM D 3350.

Property	Value	ASTM Test
Density (g/cm ³)	0.941 min.	D 1505
Melt Index	0.41 max.	D 1238
Flexural Modulus (psi)	120,000 min.	D 790
Tensile Strength (psi)	3,000 min.	D 638
Environmental Stress Crack Resistance		D 1693
a. Test Condition	C	
b. Test Duration (hrs.)	192	
c. Failure, max. %	20	
Hydrostatic Design Basic (psi) at 73°F (23°C)	1,250 min.	D 2387
Color	2% Carbon Black min.	

The Engineer may at any time direct the manufacturer to obtain compound samples and to prepare compression molded test specimens in accordance with ASTM D 1928. These specimens shall comply with the minimum property values shown above and ASTM D 3350. The materials shall meet the chemical resistance tests in Subsection 18-3.2.10.

18-3.5.3 Pipe or Liner Acceptance Group — At the time of manufacture, each lot of pipe liner, and fittings shall be inspected for defects and tested for impact, stiffness and flattening in accordance with National Sanitation Foundation (NSF) Standard Number 14.

The liner or pipe shall be homogeneous throughout, uniform in color, free of cracks holes, foreign materials, blisters or deleterious faults.

When testing subsequent to manufacture, the impact requirements shall be excluded. For the flattening requirement, the percentage reduction in pipe or liner diameter shall be not less than 15 percent for SDR 21 or lower, and not less than 25 percent for SDR 22 and above. All of the above requirements shall comply with NSF Standard Number 14.

The Engineer may require certification by the manufacturer that the test results comply with specification requirements.

For testing purposes, a production lot shall consist of all pipe or liner having the same marking number. It shall include any and all items produced during any given work shift and must be so identified as opposed to previous or ensuing production.

The test specimen shall have a minimum length of 4 feet (1.2m).

18-3.5.4 Marking Group — Pipe and liner shall be marked at 5-foot (1.5m) intervals or less with a coded number which identifies the manufacturer, SDR, size, material, machine, date and shift on which the pipe and liner were extruded.

At the end of the production shift, during which a production lot has been extruded, the marking code on the pipe and liner shall be changed to indicate that said time intervals have elapsed and that a new production shift has begun.

Fittings shall be marked with the name of the manufacturer or its logo, size and material from which they were molded or fabricated.

18-3.5.5 Dimensions — Unless otherwise indicated, liner for pipe shall be SDR 32.5. Pipe for direct burial shall have an SDR as shown on the Plans.

18-3.6 Vitrified Clay Pipe — Vitrified clay pipe shall be used only when specified on the contract plans for minor repairs to existing vitrified clay pipe sewers.

Except as modified in this subsection, vitrified clay pipe and fittings, including perforated pipe, shall be extra strength manufactured in accordance with ASTM C 700.

All pipe and fittings shall be clearly marked with the name or trademark of the manufacturer's date code. All fabricated bends and/or bevels shall be all standard length straight pipe and shall, in addition to the above, be marked with a manufacturer's date. All fabricated bends and/or bevels shall be manufactured from pipe meeting all requirements of the pipe specifications for the project.

18-4 Pipe Liners (or Pipe Rehabilitation Lines)

18-4.1 General — At the time of manufacture, each lot of pipe, liner, and fittings shall be inspected for defects and tested in accordance with ASTM D 3350.

The liner or pipe shall be homogeneous throughout, uniform in color, free of cracks, holes, foreign materials, blisters or deleterious faults.

The Contractor shall supply certification by the manufacturer that materials used in the manufacture of the pipe and pipe fittings conform to the requirements of these Specifications.

18-4.2 Installer Qualifications — Applicators and welders shall be qualified in

accordance with the Standard Specifications for Public Works Construction.

18-4.3 Preparation of Existing Pipe for Installation of Plastic Liner —

Obstructions such as roots, joint offsets, rocks, or other debris that would prevent passage or damage to the liner pipe sections shall be removed or repaired prior to installing the liner pipe(s).

4.4 Installation — The existing sewer shall be maintained in operation during the relining process. Liner pipes shall be inserted one section at a time through an access pit constructed above the existing sewer. The top of the existing sewer exposed in the pit should be removed down to springline level (halfway). Liner pipes shall be inserted spigot end first with the bell end trailing. The pushing force shall be applied to the pipe walls end inside of the bell. Maximum jacking load shall not exceed the following:

Nominal Diameter (Inches)	Safe Compressive Load (Tons) ¹	
	18 PSI Pipe Stiffness	36 PSI Pipe Stiffness
18	—	17
20	—	19
24	23	31
30	36	52
36	52	66
42	71	95
48	93	130
54	123	171
60	155	212
66	175	240
72	209	292
78	252	351
84	307	422
90	357	485
96	411	560

1. Factor of Safety of 4 is included for longitudinal compressive load.

18-4.5 Reinforced Plastic Mortar Liner Pipe

18-4.5.1 General — Fiberglass Reinforced Plastic Mortar (RPM) Liner pipe for use in lining sanitary sewers shall comply with ASTM D 3262. Unless otherwise indicated, the minimum pipe stiffness shall be 18 psi as measured by testing in accordance with ASTM D 2412.

Pipe Stiffness (psi)	Maximum Hydrostatic Head (ft.) ¹ for UngROUTed Installation ²
18	10
36	21
46	27
72	43
(Any pipe stiffness)	(0.6 x pipe stiffness)

1. Groundwater surface to bottom of liner pipe.

2. Safety factor and grout support factor not included.

18-4.5.2 Material Composition — Pipes, joints, and fittings shall be made from thermosetting resin, glass fiber reinforcements, and silica sand in combinations meeting all requirements of this subsection. Designation per ASTM D 3262 shall be Type 1, Liner 2, Grade 3, and Pipe Stiffness B, C, D, or as indicate din the Specifications. Rubber gaskets shall conform to the requirements of ASTM F 477.

18-4.5.3 Liner Pipe Acceptance — The liner pipe shall be free of cracks, holes, delaminations, foreign inclusions, blisters, or other defects that would, due to their nature, degree, or extent, have a deleterious effect of the pipe performance as determined by the Engineer.

For testing purposes, a production lot shall consist of all liner pipe having the same lot marking number, but shall not exceed a total of 100 pipes per ASTM D 3262. Pipe length, wall thickness, joint dimensions, pipe stiffness, and deflection characteristics shall be verified by testing for each lot per ASTM D 3262 requirements.

18-4.6 Folded PVC Pipe Rehabilitation System

18-4.6.1 General — Folded PVC extrusion material shall be introduced into sanitary sewers and storm drains in order to rehabilitate the existing pipelines system without excavation. This method applies to the rehabilitation of 4-inch through 12-inch diameter pipe in terms of materials and installation. The standard dimension ratio shall be SDR 35 in relation to the nominal pipe diameter.

18-4.6.2 Material Composition — The folded pipe shall be made from unplasticized PVC compounds having a cell classification of 12334-B or 12454-B, as defined in ASTM D 1784. Additives and fillers, including but not limited to stabilizers, anti-oxidants, lubricants, colorants, etc., shall not exceed 10 parts per 100 by weight or PVC resin in the compound.

18-4.6.3 Material and Equipment Acceptance — At the time of manufacture, the extruded material shall be inspected for defects and physical properties in accordance to the ASTM D 1784, or as indicated in the Specifications.

At the time of installation, the material shall be homogeneous, free of defects, cracks, holes, blisters, foreign materials, or other deleterious faults. Pipes with the aforementioned defects will be rejected.

The Contractor shall furnish and maintain, in good condition, all equipment necessary for proper execution and inspection of the work.

18-4.6.4 Marking — Markings shall conform to the requirements of Subsection 18-3.1.2.

18-4.6.5 Chemical Resistance and Physical Testing — The PVC material shall be tested in accordance with Sections 18-3.2.7 and 18-3.2.10. The various requirements shall be met with samples taken from pipe that had experienced the folding and rerounding process.

18-4.6.6 Installation and Field Inspection:

- 1) The existing pipeline shall be cleaned of any obstacles, televised and the condition approved by the Engineer prior to the insertion of the folded pipe.
- 2) A flexible heat containment tube shall be permanently placed inside the existing pipe for the retention of heat necessary to soften the folded pipe. A cable shall be strung through the heat containment tube.
- 3) Steam at 212°F shall be applied to the folded pipe while in the spool trailer for a minimum of 45 minutes prior to insertion into the existing pipe. Once the material has become pliable, the cable shall be attached to the folded pipe. Using a winch at the termination point, the folded pipe shall then be inserted into the existing pipe through an existing manhole or access point. Pulling force shall not exceed 2,000 pounds.
- 4) After the folded PVC pipe is inserted into the existing pipe, it shall be cut off at the starting point and restrained at the terminating point. Steam shall be introduced at the insertion end both inside and outside of the folded pipe until a minimum temperature of 200°F is attained at the

terminating end. This temperature shall be held for a minimum of 20 minutes and shall not exceed 240°F.

- 5) After the material has reached the required temperature, a specifically designed pressure driven rounding device shall be used to progressively round the folded PVC at a maximum rate of 3 feet per second using steam at 5 to 8 psi. The rounding process shall not cause any scraping, tearing, abrasion, movement, or other damage to the liner.
- 6) When the rounding process is complete, the steam shall be converted to air, maintaining an internal pressure of 5 to 10 psi. After the conversion to air pressure, water shall be introduced until the system is completely filled. The air pressure shall then be turned off and a minimum of 8 psi water pressure shall be maintained until the system is cooled to at least 120°F on both ends. At this point, the water pressure shall be relieved and both ends shall be cut off in the manholes.

18-4.7 PVC Manhole and Wet Well Lining Systems

18-4.7.1 General — This subsection describes the installation of the PVC liner by placing the liner strips so that an annular space is created between the PVC liner and the existing manhole/wet well. This annular space is then filled with cementitious grout or other approved materials that will result in a monolithic manhole/wet well within the existing manhole/wet well.

18-4.7.2 Materials

- (a) PVC Liner. The PVC liner shall comply with the applicable requirement in Subsection 18-4.
- (b) Grout. Cementitious grout or other approved materials shall conform to applicable provision of these specifications and as indicated on the Plans.
- (c) Sealant/Adhesive. Sealant/adhesive shall be as indicated on the Plans or in the Specifications.

18-4.7.3 Chemical Resistance — The PVC material and sealant/adhesive shall conform to Sections 18-03.2.7 and 18-3.2.10.

18-4.7.4 Installation and Field Inspection — Surface preparation shall

consist of thorough cleaning to remove all loose material and surface contaminants. Any protrusions on the wall surface which interfere with the installation of the liner shall be removed. The Contractor, when required, shall provide for the flow of sewage around the manhole/wet well designated for lining. Installation shall be accomplished by either manually spirally winding the PVC strip or manually placing the PVC panels and by engaging the complimentary locks (male/female) at the edges of the strips/panels in a manner which creates the annular space, as specified and approved by the Engineer.

18-4.8 End Seals — When required by the Engineer, the beginning and end of the new PVC pipe shall be sealed to the existing pipeline structure in order to prevent water movement between the two systems. The end seal material shall be an approved epoxy material and shall provide a watertight seal.

18-4.9 Service Connections — Existing service connections shall be reinstated through the use of a remote controlled unit or excavation.

18-5 Backfill

18-5.1 General — Backfill shall be considered as starting 1 foot (0.3m) above the pipe or conduit, or at the top of concrete bedding over the pipe or conduit. All materials below this point shall be considered as bedding.

Backfill, or fill, as the case may be, for cast-in-place structures such as, but not limited to, manholes, transition structures, junction structures, vaults, valve boxes and reinforced concrete box conduits, shall start at the subgrade for the structure.

All backfill shall be placed as specified herein.

Except where the pipe must remain exposed for force main leakage tests and subject to the provisions herein, the Contractor shall proceed as soon as possible with backfilling operations. Care shall be exercised so that the conduit will not be damaged or displaced. If the pipe is supported by concrete bedding placed between the trench wall and the pipe, the remainder of any bedding material shall be placed to 1 foot (0.3m) over the top of the conduit. The backfill above the concrete bedding shall not be placed nor sheeting pulled until at least the minimum time after the placement provided by the optional classes of concrete designated in Section 17 for such concrete bedding.

Unless otherwise specified, the periods of time set forth in the following table after which the Contractor may place fill or backfill against or over the top of any cast-in-place structures are predicated on the use of concrete to which no admixture has been added for the purpose of obtaining a high early strength:

OPERATION	LOCATION	
	Against Sides of Structures (Days)	Over Top of Structure (Days)
Placement of Loose Backfill	5	21
Densification of Backfill	7	28

The Engineer may permit the use of admixtures or the use of additional cement in various parts of the structure in accordance with Section 17.

Rocks greater than 6 inches (150mm) in any dimension will not be permitted in backfill placed between 1 foot (0.3m) above the top of any pipe or box and 1 foot (0.3m) below pavement subgrade.

When the trench is wider than 3 feet (0.9m), rocks not exceeding 12 inches (0.3m) in greatest dimension, which originate from the trench, will be permitted in the backfill from 1 foot (0.3m) above the top of any pipe or box to 5 feet (1.5m) below the finished surface.

Rocks greater than 2½ inches (63mm) in any dimension will not be permitted in backfill placed within 1 foot (0.3m) of pavement subgrade.

Where rocks are included in the backfill, they shall be mixed with suitable excavated materials so as to eliminate voids.

Subject to the provisions specified herein, the material obtained from project excavations may be used as backfill provided that all organic material, rubbish, debris, and other objectionable materials are first removed. Broken portland cement concrete and bituminous type pavement obtained from the project excavations will be permitted in the backfill subject to the same limitations as rocks, or provided they are processed to meet all requirements of backfill materials.

Where it becomes necessary to excavate beyond the limits of normal excavation lines in order to remove boulders or other interfering objects, the voids remaining after the removal of the boulders shall be backfilled with suitable material and densified as approved by the Engineer.

The removal of all boulders or other interfering objects and the backfilling of voids left by such removals shall be at the expense of the Contractor and no

direct payment for the cost of such work will be made. The costs of such work shall be included in the prices bid for the various items of work.

Voids left by the removal of sheeting, piles and similar sheeting supports shall be immediately backfilled with clean sand which shall be jetted into place to ensure dense and complete filling of the voids.

After the placing of backfill has been started, the Contractor shall proceed as soon as practicable with densification.

18-5.2 Mechanically Compacted Backfill — Backfill shall be mechanically compacted by means of tamping rollers, sheepsfoot rollers, pneumatic tire roller, vibrating rollers, or other mechanical tampers. All such equipment shall be of a size and type approved by the Engineer. Impact-type pavement breakers (stompers) will not be permitted over clay, asbestos, cement, plastic, cast iron, or nonreinforced concrete pipe.

Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the Contract. The Contractor shall make its own determination in this regard.

Material for mechanically compacted backfill shall be placed in lifts which, prior to compaction, shall not exceed the thickness specified below for the various type of equipment:

- 1) Impact, free-fall, or “stomping” equipment — maximum lift thickness of 3 feet (0.9m).
- 2) Vibratory equipment, including vibratory plate, vibratory smooth-wheel rollers, and vibratory pneumatic-tired rollers — maximum lift thickness of 2 feet (0.6m).
- 3) Rolling equipment, including sheepsfoot (both vibratory and nonvibratory), grid, smooth-wheel (nonvibratory), pneumatic-tired (nonvibratory), and segmented wheels — maximum lift thickness of 1 foot (0.3m).
- 4) Hand-directed mechanical tampers — maximum lift thickness of 4 inches (100mm).

Mechanically compacted backfill shall be placed in horizontal layers of thickness (not exceeding those specified above) compatible to the material being placed and the type of equipment being used. Each layer shall be evenly spread, moistened (or dried, if necessary), and then tamped or rolled until the specified relative

compaction has been attained.

18-5.3 Water Densified Backfill — As used in these specifications, flooding shall mean the inundation of backfill with water, puddled with poles or bars to ensure saturation of the backfill material for its full depth. Jetting shall be accomplished by the use of a jet pipe to which a hose is attached, carrying a continuous supply of water under pressure. Jetting will not be permitted in roadways.

All backfill to be densified by water shall be jetted.

The backfill shall be jetted in accordance with the following requirements:

- 1) The jet pipe shall consist of a minimum 1½-inch (38mm) diameter pipe to which a minimum 2-inch (50mm) diameter hose is attached at the upper end. The jet shall be of sufficient length to project to within 2 feet (0.6m) of the bottom of the lift being densified.
- 2) The Contractor shall jet to within 2 feet (0.6m) of the bottom of the lift and apply water in a manner, quantity and at a rate sufficient to thoroughly saturate the thickness of the lift being densified. The jet pipe shall not be moved until the backfill has collapsed and the water has been forced to the surface.
- 3) The lift of backfill shall not exceed that which can be readily densified by jetting, but in no case shall the undensified lift exceed 15 feet (4.5m).
- 4) Where the nature of the material excavated from the trench is generally unsuitable for densification with water, the Contractor may, at not cost to the Agency, import suitable material for jetting or densify the excavated material by other methods. The backfill shall be allowed to thoroughly drain until the surface of the backfill is in a firm and unyielding condition prior to commencement of any subsequent improvements. The Engineer may require the Contractor, at the contractor's expense, to provide a sump and pump to remove any accumulated water.
- 5) The Contractor shall make its own determination that jetting will not result in damage and any resulting damage shall be repaired at the Contractor's expense.

18-5.4 Compaction Requirements — Except as specified otherwise, trench backfill shall be densified to the following minimum relative compaction:

- 1) 90 percent Relative Compaction:

- a) Between the pipe zone and the upper 3 feet (0.9m), measured from the pavement surface (or finish grade where there is no pavement) within native material.
 - b) Outside the traveled way, shoulders and other paved areas (or areas to receive pavement).
 - c) Under sidewalks.
- 2) 95 percent Relative Compaction:
- a) In the upper 3 feet (0.9m), measured from the pavement surface (or finish grade where there is no pavement), within the existing or future traveled way, shoulders, and other paved areas (or areas to receive pavement).
 - b) Within engineered fill.
 - c) Where lateral support is required for existing or proposed structures.

18-5.5 Imported Backfill — If the Contractor is permitted to import material from a source outside the project limits for use as backfill, said materials shall be clean soil, free from organic material, trash, debris, rubbish, or other objectionable substances.

Whenever the specifications or plans permit the use of imported material for backfill, the Contractor shall deliver, not less than 10 days prior to intended use, a sample of the material to the Engineer. The sample shall have a minimum dry weight of 100 pounds (45 kg) and shall be clearly identified as to source, including street address and community of origin. The Engineer will determine the suitability, the minimum relative compaction to be attained, and the placement method.

Should the imported material not be substantially the same as the approved sample, it shall not be used for backfill and shall be removed from the Work site at the Contractor's expense.

The densification method for imported material authorized by the Engineer will be dependent upon its composition, the composition of the in-place soil at the point of placement, and the relative compaction to be obtained.

Testing of import material shall be at the Contractor's expense.

18-5.6 Transported Backfill — The Contractor may transport or back=haul

material to be used as backfill material from any portion or line of a project to any other portion or line of the same project, or from any project being constructed under one contract to any other project being constructed under that same contract. Such transported material shall be clean soil, free from organic material, trash, debris, rubbish, or other objectionable substances except that broken portland cement concrete or bituminous type paving may be recycled as backfill as specified.

18-5.7 Compaction Tests

Laboratory Maximum Density — The following method shall be used for compaction tests unless otherwise specified;

Compaction tests will be performed in accordance with ASTM D 1557 method “C” modified to use a 4-inch (100mm) diameter mold. If the material contains more than 10 percent of particles which are retained on a 3/4-inch (19mm) sieve, use ASTM D 1557 method “D” modified to use a 40 inch (100mm) diameter mold.

The Engineer may modify ASTM D 1557 at his option to calculate relative compaction based on adjusted laboratory maximum wet density calculated as follows:

$$DA = \frac{100 Dm}{100 \pm Wa}$$

Da Adjusted laboratory maximum wet density
Dm Maximum wet density per ASTM D 1557
± Wa Percent change in moisture content from field moisture to laboratory optimum moisture. Use minus when field moisture content is higher than laboratory optimum moisture content. Use plus when field moisture content is lower than laboratory optimum moisture content.

Field Density — Field density of soil shall be determined by any method, approved by the Engineer, which will accurately and consistently determine the density and moisture content of the soil.

18-5.8 Relative Compaction — The words Relative Compaction (Relative Density) shall mean the ratio of the field dry or wet density to the laboratory maximum dry or adjusted wet density, respectively, expressed as a percentage.

18-5.9 Sand Equivalent Test — This test is intended to serve as a field test to indicate the presence or absence of plastic fine material. The test shall be run in accordance with Calif. Test 217 or ASTM D 2419. When testing material containing asphalt, this test method shall be modified by drying the sample at a

temperature not exceeding 100°F (38°C).

18-5.10 Permeability Test — Permeability tests for granular soils will be performed in accordance with ASTM D 2434, using samples compacted to the specified field density.

18-6 Testing Pipelines

18-6.1 General — All leakage tests shall be completed and approved prior to placing of final asphalt surfacing or concrete surface improvements.

When leakage or infiltration exceeds the amount allowed by the specifications, the Contractor at its expense shall locate the leaks and make the necessary repairs or replacements in accordance with the Specifications to reduce the leakage or infiltration to the specified limits. Any individually detectable leaks shall be repaired, regardless of the results of the tests. Leakage tests shall be made on completed pipelines as follows:

- 1) Storm Drains — Not required unless called for on Plans or in Specifications.
- 2) Gravity Sanitary Sewers [24 inches (600mm) or less in diameter where difference in elevation between inverts of adjacent manholes is 10 feet (3m) or less] — Water exfiltration test or water infiltration test as directed. The Engineer may allow substitution of an air pressure test for the water exfiltration test.
- 3) Gravity Sewers [24 inches (600mm) or less in diameter where difference in elevation between inverts of adjacent manholes if greater than 10 feet (3m) — Air pressure test or water infiltration test as directed.
- 4) Gravity Sewers [greater than 24 inches (600mm) in diameter] — Air pressure test or water infiltration test as directed.
- 5) Pressure Sewers (force mains) — Water pressure test at 120 percent of maximum operating pressure.

18-6.2 Water Exfiltration Test — Each section of 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 4 feet (1.2m) above the invert of the sewer at the center of the upper manhole; or if groundwater is present, 4 feet (1.2m) above the average adjacent groundwater level.

If, in the opinion of the Engineer, excessive groundwater is encountered in the

construction of a section of the sewer, the exfiltration test for leakage shall not be used.

The allowable leakage will be computed by the formulae:

$$\begin{aligned} E &= 0.0001 LD \sqrt{H} \text{ for mortared joints.} \\ E &= 0.00002 LD \sqrt{H} \text{ for all other joints.} \end{aligned}$$

Where:

L is length of sewer and house connections tested, in feet.

E is the allowable leakage in gallons per minute of sewer tested.

D is the difference in elevation between the water surface in the upper manhole and the invert of the pipe at the lower manhole; or if groundwater is present above the invert of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the groundwater at the lower manhole.

The contractor shall, at its expense, furnish all water, materials and labor for making the required test. All tests shall be made in the presence of the Engineer.

18-6.3 Water Infiltration Test — The end of the sewer at the upper structure shall be closed sufficiently to prevent the entrance of water, and pumping of groundwater shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

The infiltration into each individual reach of sewer between adjoining manholes shall not exceed that allowed by the formula in Subsection 18-6.2 where H is the difference in the elevation between the groundwater surface and the invert of the sewer at the downstream manhole.

Unless otherwise specified, infiltration will be measured by the Engineer using measuring devices furnished by the City.

18-6.4 Air Pressure Test — The Contractor shall furnish all materials, equipment and labor for making an air test. Air test equipment shall be approved by the Engineer unless otherwise provided on the plans or in the Specifications.

The Contractor may conduct an initial air test of the sewer mainline after densification of the backfill but prior to installation of the house connection sewers. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the sewer mainline and the upper ends of all lower

lateral sewers. 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. The Contractor has the option of wetting the interior of the pipe prior to the test.

The final leakage test of the sewer mainline and lower lateral sewers, shall be conducted in the presence of the Engineer in the following manner:

Air shall be introduced into the pipeline until 3.09 psi (20kPa) gage pressure has been reached, at which time the flow of air shall be reduced and the internal air pressure shall be maintained between 2.5 and 3.5 psi (17 and 24kPa) gage pressure for at least 2 minutes to allow the air temperature to come to equilibrium with the temperature of the pipe walls. Pressure in the pipeline shall be constantly monitored by a gage and hose arrangement separate from hose used to introduce air into the line. Pressure in the pipeline shall not be allowed to exceed 5 psi (34kPa) gage pressure.

After the temperature has stabilized and no air leaks at the plugs have been found, the air pressure shall be permitted to drop and, when the internal pressure has reached 2.5 psi (17kPa) gage pressure, a stopwatch or sweep-second-hand watch shall be used to determine the time lapse required for the air pressure to drop to 1.5 psi (10kPa) gage pressure.

If the time lapse (in seconds) required for the air pressure to decrease from 2.5 to 1.5 psi (17 to 10kPa) gage pressure exceeds that shown in the following table, the pipe shall be presumed to be within acceptance limits for leakage.

If the time lapse is less than that shown in the table, the Contractor shall make the necessary corrections to reduce the leakage to acceptance limits.

- | | |
|---|---|
| T | time in seconds for pressure to drop from 2.5 to 1.5 psi (17 to 10kPa) gage pressure. |
| D | inside diameter of pipe in inches (mm). |

LOW PRESSURE AIR TEST FOR SEWERS

Time (T) in Seconds

Main Line				4" (100mm) House Connection					Main Line				6" (150mm) House Connection						
Dia.		Length		House Connection Length					Dia.		Length		House Connection Length						
In.	(mm)	ft.	(m)	0 ft. (0m)	100 ft. (30m)	200 ft. (60m)	300 ft. (90m)	400 ft. (120m)	In.	(mm)	ft.	(m)	0 ft. (0m)	100 ft. (30m)	200 ft. (60m)	300 ft. (90m)	400 ft. (120m)		
8	(200)	0	(0)	0	20	40	50	70	8	(200)	0	(0)	0	40	80	100	110	110	
		50	(15)	40	50	70	90	80			50	(15)	40	70	110	110	110	110	110
		100	(30)	70	90	100	100	90			100	(30)	70	110	120	110	110	110	110
		150	(45)	110	120	110	100	100			100	(45)	110	120	120	120	120	120	120
		200	(60)	140	120	110	110	100			100	(60)	140	130	120	120	120	120	120
		300	(90)	140	130	120	110	110			110	(90)	140	130	120	120	120	120	120
		400	(120)	140	130	120	120	110			110	(120)	140	130	130	120	120	120	120
10	(250)	50	(15)	50	70	90	100	90	10	(250)	50	(15)	50	90	120	120	120	110	
		100	(30)	110	130	120	110	110			100	(30)	110	140	130	130	130	130	
		200	(60)	170	150	140	130	120			200	(60)	170	150	140	140	140	140	
		300	(90)	170	160	150	140	130			300	(90)	170	160	150	140	140	140	
		400	(120)	170	160	150	150	140			400	(120)	170	160	150	150	150	150	
12	(300)	50	(15)	80	100	110	110	110	12	(300)	50	(15)	80	120	140	130	120	12	
		100	(30)	160	170	150	140	130			100	(30)	160	170	150	140	140	14	
		200	(60)	200	180	170	160	150			200	(60)	200	180	170	160	160	15	
		300	(90)	200	190	180	170	160			300	(90)	200	190	180	170	170	16	
		400	(120)	200	190	180	180	170			400	(120)	200	190	180	180	180	17	
15	(375)	50	(15)	120	140	160	140	130	15	(375)	50	(15)	120	160	160	150	14		
		100	(30)	250	220	190	170	160			100	(30)	250	210	190	170	16		
		200	(60)	260	230	220	200	190			200	(60)	260	230	210	200	19		
		300	(90)	260	240	230	220	210			300	(90)	260	240	220	210	20		
		400	(120)	260	240	230	220	220			400	(120)	260	240	230	220	21		
18	(450)	50	(15)	180	200	190	170	150	18	(450)	50	(15)	180	220	190	170	16		
		100	(30)	310	260	230	210	190			100	(30)	310	260	220	200	19		
		200	(60)	310	280	260	250	230			200	(60)	310	280	260	240	22		
		300	(90)	310	290	280	260	250			300	(90)	310	290	270	260	24		
		400	(120)	310	290	280	270	260			400	(120)	310	290	280	270	26		
21	(525)	50	(15)	240	260	230	200	180	21	(525)	50	(15)	240	260	220	200	18		
		100	(30)	360	310	280	250	230			100	(30)	360	300	260	240	22		
		200	(60)	360	330	310	290	280			200	(60)	360	330	300	280	26		
		300	(90)	360	340	320	310	300			300	(90)	360	330	320	300	29		
		400	(120)	360	340	330	320	310			400	(120)	360	340	330	310	30		
24	(600)	50	(15)	320	320	270	240	210	24	(600)	50	(15)	320	310	260	220	20		
		100	(30)	410	360	320	290	270			100	(30)	410	350	310	280	26		
		200	(60)	410	380	360	340	320			200	(60)	410	370	350	320	310		
		300	(90)	410	390	370	360	350			300	(90)	410	380	360	350	330		
		400	(120)	410	390	380	370	360			400	(120)	410	390	370	360	350		
27	(675)	50	(15)	400	370	310	280	250	27	(675)	50	(15)	400	350	290	260	230		
		100	(30)	460	410	370	340	310			100	(30)	460	390	350	320	290		
		200	(60)	460	430	410	390	370			200	(60)	460	420	390	370	350		
		300	(90)	460	440	420	410	390			300	(90)	460	430	410	390	380		
		400	(120)	460	450	430	420	410			400	(120)	460	440	420	410	390		
30	(750)	50	(15)	490	420	360	310	280	30	(750)	50	(15)	480	390	330	290	260		
		100	(30)	510	460	420	380	360			100	(30)	510	440	390	360	330		
		200	(60)	510	480	460	440	420			200	(60)	510	470	440	420	390		
		300	(90)	510	490	470	460	440			300	(90)	510	480	460	440	420		
		400	(120)	510	500	480	470	460			400	(120)	510	490	470	460	440		
33	(825)	50	(15)	560	460	400	350	320	33	(825)	50	(15)	560	440	370	320	290		
		100	(30)	560	510	460	430	400			100	(30)	560	490	440	400	370		
		200	(60)	560	530	510	490	460			200	(60)	560	520	490	460	440		
		300	(90)	560	540	520	510	490			300	(90)	560	530	510	490	470		
		400	(120)	560	550	530	520	510			400	(120)	560	540	520	510	490		
36	(900)	50	(15)	610	510	440	390	360	36	(900)	50	(15)	610	480	410	360	320		
		100	(30)	610	560	510	480	440			100	(30)	610	540	480	440	410		
		200	(60)	610	580	560	530	510			200	(60)	610	570	540	510	480		
		300	(90)	610	600	580	560	540			300	(90)	610	590	560	540	520		
		400	(120)	610	600	580	570	560			400	(120)	610	590	570	560	540		
39	(975)	50	(15)	660	560	490	440	390	39	(975)	50	(15)	660	530	460	410	350		
		100	(30)	660	610	560	520	490			100	(30)	660	590	530	480	450		
		200	(60)	660	630	610	580	560			200	(60)	660	620	590	560	530		
		300	(90)	660	640	620	610	590			300	(90)	660	640	610	590	570		
		400	(120)	660	650	630	620	610			400	(120)	660	640	620	610	590		
42	(1050)	50	(15)	710	610	540	480	430	42	(1050)	50	(15)	710	580	490	430	390		
		100	(30)	710	660	610	570	540			100	(30)	710	640	580	530	490		
		200	(60)	710	680	660	630	610			200	(60)	710	670	640	610	580		
		300	(90)	710	690	680	660	640			300	(90)	710	690	660	640	620		
		400	(120)	710	700	680	670	660			400	(120)	710	690	670	650	640		

18-6.5 Water Pressure Test — Preparatory to testing, the section of the pipeline to be tested shall be filled with water and placed under a slight pressure for at least 48 hours. The pipeline shall then be brought up to the test pressure specified and maintained on the section under test for a period of not less than 4 hours.

Accurate means shall be provided for measuring the quantity of water required to maintain full pressure on the line for the test period, which volume shall not exceed:

$$L = \frac{CN D\sqrt{P}}{1850}$$

Where:

- L = Maximum allowable leakage in gallons per hour for section of pipeline tested.
- N = Number of joints in length tests.
- D = Diameter of pipe in inches.
- P = Test pressure in psi.
- C = 1.0 for reinforced concrete pressure pipe with rubber joints, cylinder type.
- C = 3.0 for reinforced concrete pressure pipe with rubber joints, non-cylinder type.
- C = 0.50 for cast iron pipe with mechanical or rubber gasket joints and asbestos-cement pipe.
- C = 1.0 for other type of cast iron joints (caulked) and other types of pipe.

No leakage is allowed for welded steel pipe with welded joints.

18-6.6 Mandrel Test of ABS and PVC Pipe — Following the placement and densification of backfill and prior to the placing of final pavement, all mainline pipe shall be cleaned and then mandrelled to measure for obstructions (deflections, joint offsets and lateral pipe intrusions). A rigid mandrel, with a circular cross section having a diameter of at least 95 percent of the specified average inside diameter, shall be pulled through the pipe by hand. The minimum length of the circular portion of the mandrel shall be equal to the nominal diameter of the pipe.

All material, equipment and labor to perform the test shall be provided by the Contractor at no cost to the City.

18-6.7 Field Inspection for RTR and RPM Pipe Deflections — Installed pipe shall be inspected during construction to ensure that vertical deflections do not exceed

5 percent of the nominal ID. After the pipe had been joined and backfilled, inspection shall be as follows:

The first section of the pipeline that has been installed shall be inspected to ensure that the Contractor's installation procedures result in acceptable vertical deflections. Additional sections shall be inspected to ensure that the specified maximum deflection is not exceeded. If excessive deflections are encountered, the affected pipes shall be re-installed properly. For pipelines with ID's less than 24 inches (600mm), a mandrel shall be used to check deflections. For pipelines 24 inches (600mm) or greater, a method approved by the Engineer shall be used to test vertical deflections, provided the accuracy of the test procedure is $\pm 1/16$ of an inch (2mm).

18-7 Manholes, Cleanouts and Appurtenances

18-7.1 General — These specifications apply to manholes, cleanouts and appurtenance materials.

The quality of all materials, the process of manufacture, and the finished sections shall be subject to inspection and approval by the Engineer. Such inspection may be made at the place of manufacture, or on the job site after delivery, or at both places, and the materials shall be subject to rejection at any time on account of failure to meet any of the Specification requirements, even though samples may have been accepted as satisfactory at the place of manufacture. Materials rejected after delivery to the job site shall be marked for identification and shall be removed from the job site at once. All materials which have been damaged after delivery, and prior to project acceptance by the Agency, shall be rejected, even if installed. The Engineer's judgement shall be final on the condition of the material. Contractor may attempt to make acceptable repairs on installed material(s), if the Engineer so agrees; however, Engineer's judgment on the acceptability of the repairs will be final, and if not satisfactory, the material shall be removed and replaced with satisfactory material entirely at the Contractor's expense. The Engineer may accept a certification indicating compliance with the specifications in lieu of inspection.

18-7.2 Manholes

18-7.2.1 Precast Manhole Sections — Precast manhole sections, where not otherwise modified in the Plans, shall conform to ASTM C478 and meet the following requirements:

- 1) The wall thickness shall not be less than 5 inches for 48-inch diameter barrel sections and 6 inches for 60-inch diameter barrel sections

- 2) All sections shall be fully cured and shall not be shipped nor subjected to loading until the design compressive strength has been reached.
- 3) Precast base sections shall have the base slab integral with the sidewalls. Precast base sections shall be used only if the invert plan and alignment of the sewer connections in the base exactly match the field measured angles between the connecting sewers.

18-7.2.2 Manhole Bases — Materials used in cast-in-place concrete manhole bases shall be in accordance with the applicable requirements of Section 17. At the option of the Contractor and with the approval of the Engineer, precast base sections with integral floor conforming to ATM C 478 may be used.

18-7.2.3 Manhole Extensions — Concrete grade rings for extensions shall be a maximum of 6 inches thick.

In general, manhole extensions will be used on all manholes in roads or streets or in other locations where a subsequent change in existing grade may be likely. Extensions will be limited to a maximum height of 12 inches.

18-7.2.4 Jointing Manhole Sections — Male and female joints of manhole sections shall be sealed with either a round rubber “O”-ring gasket or a preformed flexible joint sealant. The “O”-ring shall conform to ASTM C-443. The preforming flexible joint sealant shall conform with Federal Specification SS-S-00210, and be Kent Seal No. 2 as manufactured by Hamilton-Kent, Ram-Nek as manufactured by K.T. Snyder Company, or equal. The size of the preformed joint sealant shall be as recommended by the manufacturer of the precast manhole sections.

18-7.2.5 Placing Precast Manhole Sections — Precast manhole sections shall be carefully inspected prior to installation. Sections with chips or cracks in the tongue shall not be used. Ends of precast manhole sections shall be cleared of foreign materials.

The precast sections shall be installed in a manner that will result in a watertight joint. Rubber “O”-Ring gaskets or preformed flexible joint sealant shall be installed in strict conformance with the manufacturer’s recommendations. Only pipe primer furnished by the gasket manufacturer will be approved. IF leaks appear in the manholes, the inside joint shall be caulked with non-shrink epoxy mortar to the satisfaction of the Engineer.

18-7.2.6 Manhole Channels — Manhole channels shall be constructed as shown on the Plans and with smooth transitions to ensure an unobstructed flow through manhole. All sharp edges or rough sections which tend to obstruct flow shall be removed. Where a full section of pipe is laid through a manhole, a neatly cut half pipe shall be laid to form the channel. The exposed edge of the pipe shall be completely covered with mortar. All mortar surfaces shall be troweled smooth. Breaking out the top half section after installation is not acceptable.

18-7.2.7 Flexible Joints — Flexible joints shall be provided not more than two feet form manhole walls. Pipes entering manholes shall be laid on firmly compacted base rock or bedding material as specified.

18-7.2.8 Covers — Castings shall conform to ASTM A 48, Class 35. The bearing surfaces of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. The frames and covers shall be asphalt coated. Frames and covers shall be installed on top of manholes to positively prevent all infiltration of surface or groundwater into manholes. Frames shall be set in a bed of mortar with the mortar carried over the flange of the ring as shown on the Plans. Set frames so tops of covers are flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed. Provide a concrete manhole collar as shown on the Plans. Manhole covers shall be stamped with “Storm Drain” or “Sewer” as appropriate.

18-7.2.9 Manhole Over Existing Sewers — Manholes shall be constructed over existing operating sewer lines at locations shown. Excavation shall be as specified hereinbefore.

Flow through existing sewer lines shall be maintained at all times and shall be controlled. New concrete and mortar work shall be protected for a period of one day after concrete has been placed.

The new base shall be constructed under and around the existing sewer as specified herein.

The top half of the existing pipe shall be neatly removed within the new manhole, the edges covered with mortar, and troweled smooth.

18-7.2.10 Connection to Existing Manholes — Sewers shall be connected to existing manholes. Provide all diversion facilities and perform all work necessary to maintain sewage flow in existing sewers during connection to the manhole such that overflows or backup into house laterals do not occur. Break through existing manhole bases and grout as necessary to provide smooth flow into and through existing manholes. The connection

procedure shall be as follows:

- 1) Break through an opening approximately 6 inches in diameter greater than the outside diameter of the pipe.
- 2) Roughen the surface of the pipe to be encased in the wall by sandblasting or other means. Plastic pipes shall be provided with a waterstop gasket.
- 3) Coat the surface of the existing wall edge and the area of the pipe to be encased with an epoxy bonding agent such as Sikadur Hi-Mod Epoxy Adhesive, as manufactured by the Sika Chemical Corporation, Concessive 1001-LPL, as manufactured by Adhesive Engineering Co., or equal. The grout must be placed while the bonding agent is still tacky.
- 4) Fill the space between the pipe and the existing wall with a non-shrink, non-metallic grout as manufactured by Master Builders, U.S. Grout Corp. (5 Star), or equal. The grout shall have 0.00 percent shrinkage when tested according to the requirements of ASTM C-827 and Fed. Spec. CRD-C 621.
- 5) The pipe shall be shored in place so that there is not possibility of movement during and after the grouting operation. The shoring shall not be removed until the grout has attained a compressive strength of 3,000 psi or higher.

18-7.2.11 Vacuum Testing — All project manholes shall be vacuum tested. Vacuum test procedures and requirements shall be as follows:

- 1) After completion of the manhole barrels but prior to backfilling and grade ring installation, all openings in the manhole are sealed with plugs and a rubber ring “donut” type plug inserted inside the opening of the cone.
- 2) A small vacuum pump is attached to a hose connected to the plug and 4 psi of vacuum applied.
- 3) The vacuum is permitted to stabilize at 3.5 psi for one minute, then the test is begun.
- 4) The manhole must maintain vacuum such that no greater than 0.5 psi of vacuum is lost during the specified test period.
- 5) The specified test period is as follows:

Manhole Depth (Ft.)	Test Period (Min.)
0-5	4.5
5-10	5.5
10-15	6.0
Greater than 15	6.5

- 6) Manholes that fail the test shall be patched as required and re-tested.
- 7) A vacuum regulator shall be provided on the vacuum pump such that no greater than 10 psi can be applied to the manhole during the test. All manholes that do not meet the leakage test, or are unsatisfactory from visual inspection shall be repaired to the satisfaction of the Engineer.

18-7.2.12 Hydrostatic Testing — At the option of the Contractor and with the approval of the Engineer, hydrostatic testing may be substituted for vacuum testing. The test shall consist of plugging all inlets and outlets and filling the manhole near the top with water. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above the invert. All manholes that do not meet the leakage test, or are unsatisfactory from visual inspection, shall be repaired to the satisfaction of the Engineer.

18-7.3 Sewer Cleanouts

18-7.3.1 General — Cleanout construction shall be as shown on the Plans. The cleanout shall be the same material as the mainline sewer.

18-7.3.2 Pipe and Fittings — Pipe fittings, including material for drop connections at the manhole, shall be the type and dimensions as shown on the Plans or as specified in the Special Provisions for the Project.

18-7.3.3 Cleanout Frames and Covers — Cleanouts shall be as shown on the plans or the Standard Details and shall be the same type of material as approved for use in main sewer or house connection sewer construction. Castings shall conform to ASTM A48, Class 30B. The bearing surfaces of the frames and covers shall be machined and the cover shall seat firmly into the frame without rocking. The frames and covers shall be asphalt coated.

18-8 Sewer Lateral Rehabilitation

18-8.1 General — Construction shall conform to the following subsections and modifications of the Public Works Specifications:

Active lower lateral sewers, as indicated on the contract drawings, shall be replaced, sliplined, or otherwise rehabilitated. Lateral work shall include installation of a two-way cleanout between the sidewalk and the curb.

18-8.2 Abandoned House Connection Sewers — The Contractor shall be responsible for determining if a house connection sewer is abandoned. An abandoned house connection sewer shall be defined as a house connection sewer that does not connect to a house sewer (upper lateral). Abandoned house connection sewers shall be disconnected from the sewer main and the sewer main connection fitting shall be replaced with a straight piece of pipe similar to the existing sewer and approved fittings to make a watertight and airtight replacement. The abandoned house connection sewer shall be removed completely at least 2 feet from the sewer main and the removed pipe shall be disposed of by the Contractor. The remaining house connection sewer shall be plugged with the Class C grout.

18-8.3 Initial Lateral Inspection — The initial work of the lateral rehabilitation program shall include televising the entire building lateral (upper and lower) and pulling a sizing pig through the lateral. The results of the initial work shall be provided to the Engineer who will determine if the lateral will be:

- 1) Replaced.
- 2) Sliplined.
- 3) Combination of replacement and sliplining.
- 4) No rehabilitation required. As a minimum, two-way cleanouts near the property line will be installed if not present.

The Engineer reserves all rights and will make the final determination of the rehabilitation method of the lateral. Payment for lateral rehabilitation shall be based on the unit prices provided for lateral inspection, lateral replacement, lateral sliplining, and installation of two-way cleanouts and standard cleanouts.

18-8.4 Television Inspection

18-8.4.1 General — Video recordings shall be made of the television inspections and one copy each shall be submitted to the Engineer. One copy of the printed inspection log shall also be submitted to the Engineer.

Television equipment shall include a color television camera, television monitor, cables, power source, lights and other equipment. The television camera shall be specifically designed and constructed for operation in

connection with sewer inspection. The camera shall be operative in 100 percent humidity conditions. Lighting for the camera shall minimize reflective glare. Lighting and camera quality shall be suitable to provide a clear, in-focus picture of the entire inside periphery of the sewer pipe for all conditions encountered during the work. Focal distance shall be adjustable through a range of from 6 inches to infinity. The remote reading footage counter shall be accurate to two-tenths of a foot over the length of the particular section being inspected and shall be mounted over the television monitor. The camera, television monitor and other components of the video system shall be capable of producing a minimum 350 line resolution color video picture. The camera shall be mounted on skids suitably sized for each pipe diameter to be investigated.

18-8.4.2 Installation — The camera shall be moved through the line in either direction at a uniform rate, stopping when necessary to ensure proper documentation of the sewer's condition but in no case shall the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation, the television camera will not pass through the entire manhole section, the Contractor shall reset up his equipment in a manner so that the inspection can be performed from the new manhole. If, again, the camera fails to pass through the entire section, the Contractor shall, with Engineer's approval, remove the obstruction by excavation and proceed with the television inspection. The Engineer shall determine based on the method of rehabilitation identified for the sewer reach, how and if the exposed line shall be fixed.

18-8.4.3 Documentation of the Television Results

- 1) Television inspection logs shall be typed or printed location reports acceptable to the Engineer. One copy shall be maintained on-site by the Contractor throughout the project. Printed location reports shall clearly show the location, in relation to adjacent manholes, of each source of infiltration discovered. In addition, other data of significance including the locations of buildings, suspected sump pump flows and house service connections, joints, unusual conditions, roots, storm sewer connections, collapsed sections, presence of scale and corrosion and other discernible features shall be recorded and a copy of such records shall be submitted to both the agency and the Engineer. Voice recordings on the videotapes shall make brief and informative comments on the sewer conditions.

- 2) The measurement of distance to defects is critical in confirming the locations of areas to be excavated shown on the Plans. The Contractor shall use the following procedure in performing the television inspections:
 - a. A marker or flag shall be attached to the top of the camera yoke.
 - b. The measurements recorded in the log shall be zeroed in alignment with the marker rather than the camera itself, as is the usual practice.

- 3) Color videotape recordings of the internal sewer inspection shall be made by the Contractor. One copy of the videotape in a format approved by the City shall be submitted. The tab to prevent accidental erasure shall be removed from the cassette before submittal.

Videotape recording playback shall be the same speed that it was recorded. Slow motion or stop motion playback features may be supplied at the option of the Contractor. Title to the tape will remain with the Agency. The Contractor shall have all videotapes and necessary playback equipment readily accessible for on-site review by the Engineer during the project.

Tapes shall include the following information:

- a. Data view:

- Report No.
- Date of TV inspection
- Upstream and downstream manhole numbers
- Current distance along reach (tape counter footage)
- Printed labels on tape container and tape cartridge with location information, date, format information, and other descriptive information

- b. Audio:

- Date of TV inspection
- Verbal confirmation of upstream and downstream manhole numbers
- Verbal description and location of each defect
- Verbal description and location of each service connection

18-8.4.5 Payment — Payment for preconstruction video-inspection of reaches which have been previously video-inspected is included in the unit cost for the rehabilitation method performed. Payment for preconstruction video-inspection of reaches not previously televised will be based on the unit bid price per linear foot of sewer. Payment for post-construction video-inspection of reaches is included in the unit cost for the rehabilitation method performed.

18-8.5 Determination of Suitability of Sliplining — A sizing pig shall be pulled through the existing sewer to ensure that there are no obstructions. The minimum size of pipe for sliplining shall be three inch inside diameter.

The sizing pig shall comprise a pulling head made of steel, attached to a piece of pipe of the same size and material as the liner. A flexible pulling head is not acceptable. A cable shall be attached to the tail of the pig to allow withdrawal if necessary.

If the size pig is scored to a depth equal to or greater than 10 percent of the liner thickness, insertion of the liner shall not be permitted.

18-8.6 Lateral Replacement

Lateral Materials — Lateral materials shall be Polyvinyl Chloride Pipe (PVC) SDR 21 in accordance with ASTM D2241; or Polyethylene Pipe (PE) SDR 21 in accordance with Section 18.3.6 of the Standard Specifications or Vitrified Clay Pipe (VCP), extra strength, bell and spigot rubber gasket joint, in accordance with ASTM C700.

Laterals shall be 4 inch minimum diameter or shall match the size of the existing lateral, whichever is larger.

After replacement, the laterals shall be reconnected to the main sewer line and connected to new cleanouts. Connections to new cleanouts shall be made with mechanical joints or as otherwise directed by the Engineer

Construction of laterals shall conform to Section 18 of the Standard Specifications. Maximum deflection with one fitting shall not exceed 22-1/2 degrees. Long-radius bends shall be used for changes in direction except as otherwise allowed by the Engineer.

The Engineer shall determine the line and grade of replacement laterals. Replacement laterals shall be constructed with a minimum number of changes in grade and direction as possible, regardless of the alignment of the existing lateral. Unless otherwise directed, Contractor shall lay the pipe on a uniform grade between the sewer main and the upstream end of the lateral. Minimum slope

shall be 1/4 inch per foot unless otherwise permitted by the Engineer.

18-8.7 Sliplining

18-8.7.1 General — The installation of the polyethylene solid wall sewer pipe liner shall conform to this Standard Specification and to ASTM Specifications F585, D2657, and D2321.

18-8.7.2 Liner Handling — The liner shall be handled with care to minimize the possibility of it being cut, kinked, gouged or otherwise damaged. Damage will be assessed in accordance with ASTM F585. Ropes, fabric, rollers, or rubber-protected slings and straps may be used when handling the liner. The use of cables, chains or hooks will not be permitted. Liner shall be stored on level ground or surface, free of sharp objects which could cause damage. The liner shall be pulled on rollers, or otherwise protected from damage during the pulling operation. Sections of the liner damaged, cut, or gouged shall be repaired by cutting out the section of pipe containing the damaged areas and then rejoining the liner sections as specified herein.

18-8.7.3 Liner Installation — The Contractor shall insert the liner into the pipe in accordance with ASTM F585, the manufacturer's recommendations, and the shop drawings. A thermal crayon shall be used for providing a fail-safe mechanism for the thermometer to assure proper fusion temperature.

18-8.7.4 Joining Systems

- a. **Butt Fusion.** Sections of the liner shall be joined into continuous lengths on the job site at ground level above the trench. Joining shall be accomplished by butt fusion performed in accordance with the liner manufacturer's recommendations and pertinent sections of ASTM D2657.

Butt fusion shall be accomplished by aligning the sections to be joined in a fixture, softening the ends by heat and then joining them together under controlled pressure. All fusion must be done by personnel trained by the pipe supplier and using tools recommended by the pipe supplier and approved by the Engineer. Joints between pipe sections shall be smooth and internal fusion beads in no case shall be greater than 0.10 inch.

Two joints, selected at random by the Engineer shall be tested in compliance with ASTM D638 to assure that the tensile strength of

the joints equals or exceeds that of the material joined. The specimens to be tested shall be obtained by cutting the liner pipe at least 12 inches on each side of the field-made joint. The ends may then be rejoined and work may proceed.

- b. **Mechanical Joints.** Where the polyethylene liner is reconnected to the sewer main stubout and to the cleanout, and where the liner must be joined in the trench as approved by the Engineer, the polyethylene pipe shall be joined together with a stainless steel full encirclement clamp.

Clamps shall be 316 stainless steel with a rubber sleeve and shall be of adequate length to protect against pull out. Minimum lengths of clamps are listed below.

Approximate Outside Diameter of the Liner Pipe (inches)	Minimum Length of Clamp (inches)
3.5	7.5
4.5	10
5.5	10

18-8.7.5 Insertion of Liner Pipe — The top of the lateral shall be exposed to the springline for the full length of the access pit prior to the removal of the crown portion. All sharp edges shall be removed from the exposed pipe opening.

18-8.7.6 Stress and Strain Relief of Polyethylene Liner Pipe — Stress and strain relief shall be provided for as part of lateral sliplining.

18-8.7.7 Sealing Entire Annular Space Between Liner and Pipe Wall — The Contractor shall grout the entire annular space between the liner and pipe wall with Class “E” mortar specified in Subsection 201-5 of the Public Works Specifications. The grout shall have a water/solids ratio of 0.35 to 0.40. The workability shall be measured by the Corps of Engineers test method C 611; and shall satisfy a range of 10 to 30 seconds.

Grouting procedure shall conform to Subsection 306-3.8 of the Public Works Specifications. The grout shall be supplied to the pump continuously and shall be placed in such a manner that it will not place any undue stresses on the polyethylene liner.

The Contractor shall utilize special procedures including pressure relief

valves on the grout pumping apparatus, as necessary, to ensure that the liner does not rise off the existing sewer invert nor is deflected out-of-round during placement and curing of the grout. The use of water to fill the liner prior to grouting is an acceptable method to prevent flotation. If the liner is not filled with water, the grout pressure at the point of injection shall not exceed 7 psi.

Grouting shall be considered complete when the quantity of grout pumped is between 90 and 120 percent of the annular space volume.

18-8.7.8 Cleanout Installation — All upper laterals that are rehabilitated and all lower laterals that are replaced shall have two-way cleanouts as shown on the Plans. Existing cleanouts shall be removed and shall be replaced with new cleanouts.

Temporary reconnection or pumping shall be done as necessary to maintain service during rehabilitation of laterals. Cleanouts shall not be installed until laterals have been rehabilitated.

If the lateral is sliplined, the clean out shall be either PVC pipe or polyethylene liner pipe as approved by the Engineer. All cleanout plumbing shall have an inside diameter within 15 percent of the liner inside diameter. Transition from house plumbing to the cleanout fitting shall be made with a ductile iron or polyethylene fabricated reducer.

Cleanouts shall be constructed as shown in the Standard Details. If the lateral is replaced, the cleanout shall be the same dimension and material as the replacement sewer pipe. All joints shall be made watertight and airtight. The Contractor shall submit to the Engineer shop drawings of all materials used in constructing cleanouts.

18-9 Control of Existing Flows

18-9.1 Sewer Flow Control — Flow in the existing sewers shall not be restricted or dammed for any period of time without the approval of the Public Works Director. All manhole connections shall be constructed while sewage is flowing in the existing pipe. All rerouting and/or bypass pumping of existing flows necessary to make the required modifications shall be made at the Contractor's expense. The Contractor must advise the Engineer of plans for diverting sewage flow and obtain Engineer's approval before starting. Engineer's approval shall not relieve Contractor of the responsibility for maintaining adequate capacity for flow at all times and adequately protecting new and existing work.

Bypassing of untreated wastewaters to surface water or drainage courses will not be permitted. All wastewater facilities will remain in continuous and full

operation during construction.

Where temporary pumps are required to bypass any sewage across traffic lanes, the discharge lines crossing the traffic lanes shall be buried a minimum of 4 inches below the pavement surface and backfilled with temporary asphalt concrete surfacing.

18-10 Trench Resurfacing

18-10.1 Temporary Resurfacing — Unless permanent pavement is placed immediately, temporary bituminous resurfacing 2 inches (50mm) thick shall be placed and maintained at locations determined by the Engineer wherever excavation is made through pavement, sidewalk or driveways. In sidewalk areas the temporary bituminous resurfacing shall be at least 1 inch (25mm) thick; in all other areas it shall be at least 2 inches (50mm) thick. At major intersections and other critical locations, a greater thickness may be ordered. Temporary resurfacing shall be placed as soon as the condition of the backfill is suitable to receive it and shall remain in place until the condition of the backfill is suitable for permanent resurfacing.

The bituminous mixture used for temporary trench resurfacing shall conform to Class D, Fine, Type #, Asphalt Concrete, and of bitumen conforming to grade SC-800 liquid asphalt.

The mixture may be furnished from stockpiles or directly from the plan mixer and may be laid cold, at the option of the Contractor. The resurfacing shall be placed, rolled, maintained, and removed and disposed of by the Contractor.

18-10.2 Permanent Resurfacing — Unless otherwise shown on the Plan or in the Specifications, all surface improvements damaged or removed as a result of the Contractor's operations shall be reconstructed by the Contractor to the same dimensions, except for pavement thickness, and with the same type materials used in the original work. Trench resurfacing shall be 1 inch (25mm) greater in thickness than existing pavement, or 3 inches, whichever is greater.

18-11 Measurement & Payment — Pipe and conduit shall be measured along the longitudinal axis between the ends as laid and shall include the actual pipe in place and shall not include the inside dimensions of structures. House connection sewers shall be measured from the inside face of the "Y" of the main to the inside face of conduit or structure to which connection is being made.

The price per linear foot (m) for pipe and conduit in place shall be considered full compensation for all wyes, tees, bends, monolithic catch basins, and special appurtenances as shown on the Plans; the removal of interfering portions of existing sewers, storm drains, and improvements; the closing or removing of abandoned conduit

and structures; the excavations of the trench; the control of ground and surface waters; the preparation of subgrade; placing and joining pipe; backfilling the trench; permanent resurfacing; and all other work (excluding temporary resurfacing) necessary to install the pipe or conduit, complete in place.

Payment for structures such as manholes, clean outs, junction structures, lamp holes, and catch basins shall be made at the price bid for each structure and shall be full payment for each structure complete in place, including excavation, backfill, constructing inverts, furnishing and installing castings, restoration of the street surface and all other work, excluding temporary resurfacing, necessary to complete the Work.