

SECTION 3 DRAINAGE AND STORM SEWERS

1.0 GENERAL REQUIREMENTS. This section covers general construction requirements of drainage systems, storm sewers and appurtenances as described herein. The outline is generally as follows:

- General Requirements
 - Pipe Selection
 - Materials
 - Order of Construction
 - Test Holes
 - Sewer Grades
 - Surface Drainage Structures
 - Temporary Sewer and Drain Connections
 - Cleanup
- Storm Sewer Pipe Installation
 - Pipe Materials
 - Construction Methods
 - Method of Measurement
 - Basis of Payment
- Reinforced Concrete Pipe
 - Materials
 - Construction Methods
 - Method of Measurement
 - Basis of Payment
- Polyvinyl Chloride Pipe
 - Materials
 - Construction Methods
 - Method of Measurement
 - Basis of Payment
- High Density Polyethylene Pipe
 - Materials
 - Construction Methods
 - Method of Measurement
 - Basis of Payment
- Reinforced Fiberglass Pipe
 - Materials
 - Construction Methods
 - Method of Measurement
 - Basis of Payment
- Sliplining
 - Materials
 - Construction Methods
 - Acceptance of Sliplining
 - Method of Measurement
 - Basis of Payment
- Precast Reinforced Concrete Sewer Manholes
 - Materials
 - Manhole Rings and Covers
 - Construction Methods
 - Basis of Payment
 - Testing
- Point Repair
 - Materials
 - Construction Methods
 - Method of Measurement
 - Basis of Payment
- Television Inspection

1.1 STORMWATER ENGINEERING FUNCTIONAL SPECTRUM. Drainage and stormwater engineering covers a broad spectrum of channel classes, types, and regulatory requirements. These are depicted in the following table.

Channel Classes, Types, and Pipes				
Line Class	A	B	C	D
Type	Watershed	Basin	Subbasin	Local
Areal	Rural	Suburban	Urban	Parcels and Lots
Scale	Sections	Subdivisions	Blocks	Lots
Channel Structure	Bridges, Boxes	Boxes, Creeks	Creeks, Pipes	Pipes, Swales
Spectrum	Rivers, Creeks	Stormwater	Stormwater	Drainage
Levels	State, county	Municipal	Municipal	Private
Function	County, regional, and state systems	Commercial and residential developments	Neighborhoods, commercial developments	Individual facilities and residences
Floodplain	Yes	Yes	No	No
Diameter	>120"	>36" to 120"	>15" to 36"	15"
Cross-section Q				

The focus of this Section is the specification of materials and construction procedures for improvements in municipal creeks, channels, and pipes serving lots, blocks and subdivisions within the city limits. Normally these works include Line Classes B, C, and D and the specifications apply to works in City rights-of-way or privately-funded infrastructure to be dedicated to the City.

1.2 PIPE SELECTION AND STANDARD APPLICATIONS. The type of pipe to be employed in new construction and repair projects is based upon the location, soil conditions, depth of excavation, location within or across rights of way, maintainability, anticipated difficulties of future repairs, site accessibility, initial costs, life-cycle costs, pipe design, and pipe materials.

1.2.1 General Pipe Selection Table. In general, pipe selection shall routinely conform to the following table

Storm Sewer Pipe Type and Application Table						
APPLICATION	PIPE TYPE					
[LOCATION/SITUATION]	RCP	PVC	HDPE	RFP	DIP	CGM
Existing Right of Way Structures						
Residential Street Crossing	O	O				
Residential Street Parallel in ROW	X	X	X			
Urban Street Crossing	X	X				
Urban Street ROW	X	X				
Suburban Street Crossing	X	X				
Suburban Street ROW	X	X	X			
Multilane Crossing	X	OB	B	B	B	
Multilane ROW	O	OB	B	B	B	
Rural 2-Lane Crossing	X	OB				
Rural 2-Lane ROW	X	X				
Rural Driveway	X	X				X

Slipline Residential		X	X	X		
Slipline Multilane Crossing		X	X	X	X	
New Right of Way Structures						
City Street Crossing	X					
City Street Parallel in ROW	X	X				
Private Commercial	X	X	X	X		
Private Commercial Parallel in ROW	X	X				
Private to City ROW	X	X	X	X		
Elective Boring		X	X	X		
New Rural Crossing	X	X			X	
Rural Driveway Asphalt or Concrete	X	X	X			X
RCP	=	Reinforced Concrete Pipe				
PVC	=	Polyvinyl Chloride Pipe				
HDPE	=	High Density Polyethylene Pipe				
RFP	=	Reinforced Fiberglass Pipe				
DIP	=	Ductile Iron Pipe				
CGM	=	Corrugated Metal Pipe				
X	=	Acceptable				
O	=	Open Cut				
B	=	Boring				

1.2.2 Exceptions. General and specific exceptions to the General Pipe Selection Table shall be considered and granted or rejected based on sound engineering criteria. Such criteria include, principally, performance and strength, maintainability and repairability by City Street Division crews, constructability, and cost. Approvals of all materials and their specific application shall be rendered by the Engineer Department during the preliminary design reviews of public and private projects.

1.1 MATERIALS. Construction materials shall not be delivered to the site of the work more than 5 days in advance of their anticipated use nor shall the quantity of pipe or other materials on hand at the site of the work at any time be in excess of the amount required to complete 300 feet of sewer unless with special permission of the Engineer. Unless otherwise specified, all concrete used in construction of sewers and their appurtenances shall have a minimum 28-day compressive strength of 4,000 psi. All steel reinforcement used shall be Grade 60 with a minimum yield strength of 60,000 psi. All trenches not under pavement shall be compacted to 90% standard proctor; all trenches and excavation under pavement shall be compacted to 95% standard proctor density.

1.2 ORDER OF CONSTRUCTION. The Contractor shall start at enough different locations to complete the entire contract within the time limit specified. The construction of all sewers shall begin at the low point in the line in every case working toward the high point. When the construction involves the building of main or submain sewers having one or more lateral or tributary, the construction of tributary lines shall not be started until the main or submain sewer has been completed to the point where the tributaries or laterals discharge into it, except as may be approved by the Engineer. Approval by the Engineer for an exception to procedure shall not relieve the Contractor of the responsibility for establishing and achieving the required grades and specified connection points.

1.2.1 Sewer appurtenances shall be constructed as soon as the sewer that they serve is constructed to their locations. The postponing of the construction of appurtenances until the sewer line has been completed, or the building of appurtenances in advance of the construction of the sewer line, will not be permitted.

1.2.2 The construction of sewers 18-inches in diameter and smaller for more than 600 feet, and sewers 21-inches in diameter and larger for more than 300 feet in advance of appurtenances which are incomplete or the construction of which has not been started will not be permitted.

1.2.3 Unless otherwise directed by the Engineer, the Contractor shall leave no more than 900 feet between backfilling operations and the complete restoration of paving, paving repairs, fencing, sodding, etc.

1.3 TEST HOLES. Test hole information, when shown on the plans or included in the specifications, shall only represent subsurface characteristics to the extent indicated, and only for the point location of the test hole. Each bidder shall make his own interpretation of the character and condition of the materials that will be encountered between test hole locations. Each prospective Bidder may, at his own expense, make additional surveys and investigations as he may deem necessary to determine conditions which will affect performance of the work.

1.4 SEWER GRADES. The grade line shown on the plans is the elevation of the invert or flow line of the sewer. The sewer grade shall be established by use of laser beam, or other methods approved by the Engineer. When laser beams are used to establish line and grade, they shall first be calibrated in accordance with the equipment manufacturers recommended procedures. The Contractor shall establish horizontal and vertical controls (offset stakes) with a transit or theodolite or any other equipment approved by the Engineer. The Contractor may then proceed to establish line and grade using the laser equipment. In conjunction with the laser beam, the Contractor may also be required to provide temporary benchmarks at intervals as specified by the Engineer.

1.5 MAINTENANCE OF STORMWATER FLOWS. The construction of new and the repair of old storm sewers is often, if not usually, at low points to which natural or existing drainage courses lead. Accordingly, the storm sewer works must continue to operate during rain events.

1.5.1 Temporary Work Stoppage. When construction is stopped at the end of each day's work or for any other cause, the excavation, banks and trenches shall be formed or shaped to limit soil erosion. When work is stopped temporarily, the exposed end of the pipe or pipes shall remain open however the Contractor shall place hay bales, rip rap or silt fencing to prevent mud, trash or debris from entering the pipe. Upon reoccupation of the site and resuming work, these temporary measures shall be removed and the excavation re-shaped and cleaned before proceeding.

1.5.2 Stormwater Pollution Prevention. The contractor shall be responsible for the prevention of stormwater pollution prevention. Such pollution includes soil erosion into pipes, ditches, channels, streams and creeks as well as materials or liquids brought to the site for use in the construction work (such as fuels, lubricants, adhesives, solvents or sealants). The contractor shall implement the stormwater pollution prevention plans shown on the plans and daily update such measures as necessary to maintain their effectiveness; or develop and implement his own plan to the satisfaction of the Engineer.

1.6 SURFACE DRAINAGE STRUCTURES. When not called for on the plans or specified as separate bid item, all surface drainage structures, streets, pavements, curbs and gutters, and

appurtenances affected by the construction or repairs shall be removed and replaced in a condition equal to or better than the original installation when required. No additional compensation shall be made for this work, except for permitted pavement removal and replacement, if and unless called-out on the plans. Otherwise, the cost of such shall be included in site restoration..

1.8 CLEANUP. After installation of each section of storm sewer line, the Contractor shall remove all spoils resulting from work, debris, construction materials and equipment from the site of work and then grade and smooth over surfaces on both sides of the line, and leave the right-of-way in a clean, neat, and serviceable condition prior to sodding.

2.0 STORM SEWER PIPE INSTALLATION. This section covers installation of pipes in open-cuts, in conformity with the lines, grades, and dimensions and as provided in applicable sections of these specifications.

2.1 PIPE MATERIALS

2.1.1 PIPE. Acceptable pipe materials and fittings shall meet the requirements of the appropriate sections listed below:

Pipe Type	Pipe Material	Paragraph
Rigid	Reinforced Concrete Pipe (RCP)	
	Ductile-Iron Pipe (DIP)	
Flexible	High Density Polyethylene (HDPE) Pipe	
	Polyvinyl Chloride (PVC) Pipe	
	Reinforced Fiberglass Pipe (RFP)	

2.1.2 EMBEDMENT AND BACKFILL MATERIAL. Embedment and backfill material shall meet the requirements of the Standard Drawings. Prior to delivery, the Contractor shall submit laboratory tests for materials to be used for embedment and backfill. The Engineer prior to placement shall approve materials. Where required, the Contractor shall submit invoices for the purpose of complying with the minimum quantities necessary to complete installation pursuant to the appropriate standard details and the minimum dimensions specified.

2.2 CONSTRUCTION METHODS

2.2.1 Shipping, Handling and Storage. Pipe shall be transported from the plant, where it is manufactured, to the job site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the job site, it shall be carefully inspected for any damage that may have occurred in transit. The pipe shall be handled at all times with care using padded slings or hooks. The pipe shall not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe shall be rejected. All pipe and accessories shall be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe shall be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

2.2.1 Bedding and Haunching.

- Rigid Pipes. All rigid pipes shall be embedded in accordance with ASCE Manual No. 60, "Gravity Sanitary Sewer Design and Construction", Class "B" Bedding and in

accordance with the dimensions and lines shown on the "Standard Detail for Installation of Rigid Pipes" and meeting the requirements of relevant paragraphs of these specifications.

- Flexible Pipes. All flexible pipes shall be embedded in accordance with ASTM D2321, "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe", and in accordance with the dimensions and lines shown on the "Standard Detail for Installation of Flexible Pipes" and meeting the requirements of relevant paragraphs of these specifications.

2.2.2 Procedures. Watertight joints, first grade material and accurate construction shall be required. Furthermore, utmost care shall be exercised in laying pipe to line and grade, constructing inverts in manholes, transitions, couplings, junction boxes, manhole connections and etc.

- Pipe Foundation. No sewer shall be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable soil, or rock, trench bottom shall be stabilized as and when directed by the Engineer.
- Laying Requirements. All pipes, specials, fittings and other appurtenances shall be examined carefully for damage and other defects before installation. The City retains the right to reject damaged and defective materials. The pipe ends shall be free of all lumps, blisters and they shall be wiped clean of foreign materials such as dirt and sand before installation. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill, using laser beams or other methods approved by the Engineer. Bell holes for bell-and-spigot pipe, if used, shall be excavated at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of pipe. Bell holes shall not be excavated more than 10 joints ahead of pipe laying. Filling and ramming earth or other material beneath the pipe to raise it to grade shall not be permitted.
- Pipe Placement. The Contractor shall use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances shall be lowered carefully into the trench with suitable equipment, to prevent damage to the sewer main materials. In rock trenches, plywood shields or other approved means shall be used to prevent the cradled pipe from swinging against the sides of the trench.
- Joints. All joint preparation and joining operations shall comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section. For reinforced concrete pipe the position of the rubber gasket shall be checked with a feeler after each joint is completed. Additionally, when laying reinforced concrete pipe, the maximum joint opening shall not exceed 3/8-inch. Rubber gaskets shall be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces shall be coated with the lubricant furnished with the pipe.
- Finish. Any damage to the pipe, from any cause during installation of the pipeline shall be cause for replacement, as directed by the Engineer, and at the expense of the Contractor. After a section of pipe is properly installed and approved for backfill, the trench shall be backfilled and compacted to the required density but in no case less than 90% Standard Proctor Density.

2.3 METHOD OF MEASUREMENT. Payment for "Storm Sewer Pipe" shall be made at the unit price bid per lineal foot of pipe installed for each size. The price established shall be full compensation for all materials including pipe, material, labor, tools, equipment and incidentals necessary to complete this item of work. Payment shall not include the cost of trench excavation and backfill nor foundation material. Measurement for "Sewer Pipe" shall be by the foot laid through manholes, junction boxes and other small structures.

2.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

STORM SEWER PIPE (SIZE)	LF
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Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications. Embedment material shall be paid for under separate line pay item.

3.0 REINFORCED CONCRETE PIPE (RCP). This section covers bar-cage reinforced concrete pipe and fittings with O-ring rubber gasketed joints intended to be used for conveyance of stormwater. Pipes shall be supplied in nominal diameters of 18-inches and larger.

3.1 MATERIALS.

3.1.1 Submittals. Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted. The drawings and data shall include, but shall not be limited, to the following for each size of pipe.

- Data on reinforcement
- Details of joints
- Details of fittings and specials
- Test reports
- Laying schedule
- Certification for pipe and protective lining
- Certification and sample of Elastomeric O-ring gasket

All material furnished under certification shall be tagged, stenciled, stamped or otherwise marked with a lot number, heat number, order number, or other appropriate identification which can be readily recognized and checked against the certification. The Contractor shall submit 4 copies of all submittals requested in this specification.

3.1.2 Pipe. All pipe and fittings shall be manufactured in accordance with the following ASTM Standards or as modified herein. Except for special design pipe, all concrete sewer pipe, fittings and accessories comply with

- ASTM C76, "Standard Specification "Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe"; or
- ASTM C655 "Standard Specifications for "Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe".

Standard concrete sewer pipe shall be tongue-and-groove jointed pipe, conforming to ASTM C76, Wall Type B. Bell-and-spigot pipe is not prohibited, neither is it standard.

3.1.3 Materials. Unless otherwise specified, all materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM C76 or as modified herein.

- Fine Aggregate. Fine aggregate shall conform to the requirements of ASTM C33, and shall be clean natural sand. Artificial or manufactured sand will not be acceptable.
- Cement. Cement shall conform to the requirements of ASTM C150 containing not more than 5% percent tricalcium aluminate.
- Gaskets. Gaskets shall conform to requirements of ASTM C361, Section 6.9.1, except minimum tensile strength shall be 1,500 psi, Shore A, hardness shall be 40. Polymer used in the manufacture of gaskets shall be synthetic rubber. Natural rubber will not be acceptable.
- Rubber Joint Filler. Rubber joint filler shall be synthetic.

3.1.3 Minimum Pipe Design. Reinforced Concrete Pipes are designed using procedures outlined in Concrete Pipe Design Manual published by American Concrete Pipe Association. The minimum pipe designs provided herein are for AASHTO HS-20 truck highway live loading and Cooper Axle E-80 Railroad live loading conditions.

3.1.4 Joints. Joints shall be formed concrete bell and spigot types, conforming to Section 8 of ASTM C361 except as modified herein. Gaskets shall have a circular cross section and shall be confined in a groove in the pipe spigot. Pipe with collars in lieu of integral bells will not be acceptable. Each concrete pipe joint shall be designed to withstand, without cracking, the gasket compression plus a differential load across the joint equal to 4,000 psf of internal diameter. Pipe sections connecting to manholes shall have a joint in each line within 4 feet of the inside face of each manhole or other structure.

3.1.5 Reinforcement. Circumferential reinforcement shall be full-circle type. Elliptical or part-circle reinforcement shall not be acceptable unless otherwise specified by the Engineer. The total area of longitudinal steel shall be not less than 0.2% of the concrete cross sectional area of the pipe. Longitudinal steel shall be spaced uniformly around the pipe and shall consist of at least 8 continuous or lap-spliced wires or bars in each cage. The minimum concrete cover over circumferential reinforcement, except under the spigot groove of pipe with concrete spigots, shall be not less than 3/4-inch for pipes less than 60-inches or 1-inch for 60-inch and larger pipes.

3.1.6 Fittings. All bends, tees, closure pieces, wall fittings, and other fittings which are indicated on the drawings or required to complete the work shall be furnished. Except as modified or otherwise provided herein, the design and manufacture of fittings shall be governed by the same requirements as the connecting piping.

- At the option of the Contractor, bends for concrete sewer pipe shall be fabricated from segments of a steel cylinder with concrete or mortar lining and reinforced concrete exterior covering, or from segments of concrete pipe miter cut while the pipe is still green. The deflection angle between adjacent segments shall not exceed 30 degrees. Steel cylinders for bends shall be at least USS 10 gauge and shall be lined with concrete or mortar at least

3/4-inch thick. Bends fabricated from steel cylinders shall be designed for the same three-edge bearing loads as the adjacent piping. Bends fabricated from miter cut segments of green concrete pipe shall have the concrete removed from around the reinforcing steel as necessary, the steel shall be welded, and the concrete shall be replaced.

- After installation, the entire bend shall be encased in concrete. Concrete encasement shall be at least 8-inches thick all around and shall extend the full length of the bend. Bell type wall fittings shall be provided at the locations indicated on the drawings.
- Wall fittings shall be of the required length and shall have bells to match the joints on the concrete pipe. Fabricated outlet branches shall be provided as indicated on the drawings. Closure pieces shall be cut in the field after pipe, fittings and specials, as indicated on the drawings, have been installed.
- The alignment indicated on the drawings shall be maintained by deflecting joints and by adding fittings if necessary. The length between structures and P.I. locations shall be adjusted in the field as required. Closure pieces shall be field cut from full length pieces of pipe. At the option of the Contractor, field cuts may be made with a masonry saw or may be chiseled and neatly trimmed. Field cut ends shall be encased in reinforced collars at least 8-inches thick and extending 18-inches on each side of the field cuts.

3.3 METHOD OF MEASUREMENT. Reinforced concrete pipe will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

3.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price:

REINFORCED CONCRETE PIPE (SIZE)	LF
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Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

4.0 POLYVINYL CHLORIDE (PVC) PIPE. This section covers the use and installation of Polyvinyl Chloride (PVC) storm sewer pipe and fittings.

4.1 MATERIALS

4.1.1 Submittals. Provide submittal detailing chemical and physical features of the pipe which conform to the Materials Section requirements.

4.1.2 Pipe. PVC storm sewer and drain pipe and fittings shall be manufactured and tested in accordance with ASTM F949. The structural design of the pipe shall conform to AASHTO "Buried Structures and Tunnel Liners".

- Manufactured from 12454 cell class material per ASTM D1784 with a minimum pipe stiffness of 46 psi when tested in accordance with ASTM D2412. Supply in diameters to 36-inches.
- Use Contech Brand A2000 PVC pipe or approved equal.

4.2 CONSTRUCTION METHODS

4.2.1 Shipping, Handling and Storage. Pipe shall be transported from the plant, where it is manufactured, to the job site employing special methods of packaging to prevent damage to the pipe. After the pipe is received at the job site, it shall be carefully inspected for any damage that may have occurred in transit. The pipe shall be handled at all times with care using padded slings or hooks. The pipe shall not be dropped, skidded or rolled against pipe already on the ground. If any damage occurs to pipe, the pipe shall be rejected. All pipe and accessories shall be stored on flat, level ground with no rocks or other objects under the pipe. Gaskets for push-on joints and pipe shall be stored in cool location out of direct sunlight in accordance with the manufacturer's recommendations.

4.2.2 Bedding and Haunching. PVC shall be embedded in accordance with ASCE Manual No. 60, "Gravity Sanitary Sewer Design and Construction", Class "B" Bedding and in accordance with the dimensions and lines shown on the "Standard Detail for Installation of Rigid Pipes".

4.2.3 Procedures. Watertight joints, first grade material and accurate construction shall be required. Furthermore, utmost care shall be exercised in laying pipe to line and grade, constructing inverts in manholes, transitions, couplings, junction boxes, manhole connections and etc. Installation shall comply with AASHTO Thermoplastic Specifications and ASTM D2321.

- Pipe Foundation. No sewer shall be laid unless the foundation is in a condition satisfactory to the Engineer. Where trenches are excavated in soft, unsuitable soil, or rock, trench bottom shall be stabilized as and when directed by the Engineer. Stabilization shall include over-excavation and placement of aggregate base or over-excavation and backfill with concrete.
- Laying Requirements. All pipes, specials, fittings and other appurtenances shall be examined carefully for damage and other defects before installation. The City retains the right to reject damaged and defective materials. The pipe ends shall be free of all lumps, blisters and they shall be wiped clean of foreign materials such as dirt and sand before installation. Pipe laying shall proceed upgrade, starting at the lower end of the grade using laser beams or other methods approved by the Engineer. Filling and ramming earth or other material beneath the pipe to raise it to grade shall not be permitted.
- Pipe Placement. The Contractor shall use every precaution at all times during construction of the pipeline. All pipe, specials, fittings, and other appurtenances shall be lowered carefully into the trench with suitable equipment, to prevent damage to the sewer main materials. In rock trenches, plywood shields or other approved means shall be used to prevent the cradled pipe from swinging against the sides of the trench.
- Joints. Joints shall be integral bell-gasketed joints. All joint preparation and joining operations shall comply with the instructions and recommendations of the pipe manufacturer and meet the joint requirements in the appropriate material section.
- Finish. Any damage to the pipe, from any cause during installation of the pipeline shall be cause for replacement, as directed by the Engineer, and at the expense of the Contractor. After a section of pipe is properly installed and approved for backfill, the trench shall be backfilled and compacted to the required density but in no case less than 90% Standard Proctor Density.

4.3 METHOD OF MEASUREMENT. Will be measured by the linear foot in place. Payment shall be by the linear foot in place.

4.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

POLYVINYL CHLORIDE (PVC) PIPE (SIZE)

LF

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

5.0 HIGH DENSITY POLYETHYLENE (HDPE) PIPE. This section covers High Density Polyethylene (HDPE) pipe and fittings.

5.1 MATERIALS

5.1.1 Submittals. Provide submittal detailing chemical and physical features of the pipe which conform to the Materials Section requirements.

5.1.2 General Pipe Features. The HDPE pipe shall be made of high density plastic compound meeting the requirements of Type III, Class C, Category 5, Grade P34 as defined in ASTM D1248 and with an established hydrostatic design basis (HDB) of not less than 1,600 psi as determined in accordance with ASTM Test Method D2837.

5.1.3 Solid Wall Pipe (HDPE). All solid wall HDPE pipes may be used for open-cut and sliplining installations, in sizes ranging from 6-inches to 60-inches in diameter. All solid wall HDPE pipe and fittings shall be manufactured in accordance with ASTM F714.

- Sections of polyethylene pipe shall be assembled and joined on the job site. Jointing shall be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions. The butt-fusion method for pipe jointing shall be carried out in the field by operators with prior experience in fusing polyethylene pipe with similar equipment using proper jigs and tools per standard procedures outlined by the pipe manufacturer.
- These joints shall have a smooth, uniform, double rolled back bead made while applying the proper melt, pressure, and alignment. It shall be the sole responsibility of the Contractor to provide an acceptable water-tight butt-fusion joint. For all open-cut installations, HDPE pipe shall have a minimum pipe stiffness of 46 psi as determined in accordance with ASTM D2412.

5.1.4 Profile Pipe (HDPE). All open or closed profile wall HDPE pipe and fittings may be manufactured in accordance with ASTM F894. Pipes shall be supplied in sizes from 18-inches to 120-inches in diameter. Regardless of size, open profile wall pipes will be allowed only on sections of pipe when there are no apparent intersecting pipes.

- For all installations specified, HDPE pipe and fittings shall have a minimum pipe stiffness of 46 psi as determined in accordance with ASTM D2412. Pipe joining system shall be gasketed type and consist of integrally formed bell and spigot, one which is designed to accommodate a gasket, which when assembled forms a watertight seal by the radial

compression. Joints shall provide a watertight seal and meet the requirements of ASTM D3212.

- Gaskets shall meet the requirements of ASTM F477 and be molded into a circular form or extruded to the proper section, then spliced into circular form, and shall be made of a properly cured high grade elastomeric compound. The basic polymer shall be neoprene, synthetic elastomer, or a blend of both. The gasket shall be designed with an adequate compressive force, so as to effect a positive seal under all combinations of joint tolerances. Natural rubber gaskets will not be acceptable. The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe. Type and application of the lubricant shall be in accordance with the manufacturer's recommendations.

5.2 CONSTRUCTION METHODS

5.2.1 Sliplining. Pipes used for sliplining installations shall meet the following requirements:

- For existing pipes with a nominal inside diameter (ID) less than or equal to 33-inches, the outside diameter (OD) of the sliplining pipe shall not be more than 3-inches smaller than the nominal ID of the existing pipe. For existing pipes with a nominal ID greater than 33-inches, the OD of the sliplining pipe shall not be more than 6-inches smaller than the nominal ID of the existing pipe.
- The minimum outside diameter (OD) of HDPE liner pipe shall be as below:

Sewer Line Nominal Inside Diameter (inches)	Minimum O.D. of Liner (inches)
8	7.125
10	8.625
12	10.750
15	12.750
18	16
21	18
24	22
27	24
30	28
33	30
36	32
42	36
48	42
54	48

5.3 METHOD OF MEASUREMENT. Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

5.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

HIGH DENSITY POLYETHYLENE (HDPE) PIPE (SIZE) LF

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

6.0 REINFORCED FIBERGLASS PIPE (RFP). This section covers reinforced fiberglass pipe and fittings. RFP shall normally be used in larger diameter sliplining applications.

6.1 MATERIALS

6.1.1 Submittals. Submittals shall be furnished which provide the chemical and physical features of the pipe as manufactured.

6.1.2 General Pipe Features. All FRP pipes, joints and fittings shall be manufactured in accordance with the requirements of ASTM D3262 or as modified herein. Pipes shall be supplied in sizes 12-inches and larger. Pipes shall be centrifugally cast, fiberglass-reinforced polyester resin as manufactured by Hobas USA, Inc. or approved equal. Prior to manufacturing, the pipe supplier shall provide the Engineer with test reports of independent test laboratory certifying that the pipe has been tested in accordance with, and exceeds all minimum requirements of ASTM D2992, ASTM D3262 and ASTM D3681. The pipe stiffness shall be a minimum of 46 psi when measured in accordance with ASTM D2412 for all installations except jacking. Other pipe stiffnesses may be used when called for on the plans or as directed by the Engineer.

6.1.3 Reinforced Fiberglass Pipe Features. The manufacturer shall use only approved polyester or epoxy resin systems for which he can provide a proven history of performance for the intended application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product. The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade of E-glass filaments with binder and sizing compatible with impregnating resins. Sand may be used as fillers providing that sand shall be a minimum 98% silica with a maximum moisture content of 0.2 percent. Resin additives, such as pigments, dyes, and other coloring agents, if used, shall in no way be detrimental to the performance of the product nor shall they impair visual inspection of the finished product. Although the pipes specified here a contemplated for use in a storm sewer application, the internal liner resin shall be suitable for service as sanitary sewer pipe, and shall be inert to exposure to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Provide the certified test results from an independent laboratory that the pipe exceeds the requirements of ASTM D3681.

6.2 CONSTRUCTION METHODS. Pipe outside diameters shall be in accordance with AWWA Standards C151 and C950 and as shown below. The minimum wall thickness(es) shown are for a minimum pipe stiffness of 46 psi.

Nom. Pipe Dia. (inches)	Pipe OD (inches)	Min. Wall Thickness (inches)
12	13.20	0.30
14	15.30	0.34
16	17.40	0.38
18	19.50	0.42
20	21.60	0.46

24	25.80	0.54
30	32.00	0.66
36	38.30	0.78
42	44.50	0.90
48	50.80	1.02
54	57.10	1.14
60	62.90	1.26
66	69.20	1.38
72	75.40	1.50
78	81.60	1.62
84	87.00	1.74
90	94.30	1.86
96	100.60	1.98
102	108.00	2.13

6.2.1 Pipe shall be supplied in nominal lengths of 10 feet or 20 feet for jacking, and 20 feet for all other installations. For sliplining installations, where radius curves in the existing pipe or limitations in the entry pit dimensions restrict the pipe to shorter lengths, nominal sections of 10 feet shall be used. Actual laying length shall be the nominal plus or minus 2-inches. Except for special order lengths, all pipes shall be furnished in the nominal lengths specified herein. All pipe ends shall be square to the pipe axis plus or minus 1/4-inch. For jacking Installations the minimum pipe wall thickness measured at the bottom of the spigot gasket groove where the wall cross-section has been reduced, is determined from the maximum allowable jacking load and shall not be less than as shown in the table below:

Nom. Pipe Dia. (inches)	Pipe O.D. (inches)	Min. Wall Thickness (inches)
12	13	0
14	15	0
16	17	0
18	19	0
20	21	0
24	25	0
30	32	0
36	38	0
42	44	1
48	50	1
54	57	1
60	62	1
66	69	1
72	75	1
78	81	1
84	87	1
90	94	1
96	100.60	1

6.2.2 Pipes used for sliplining installations shall meet the following general requirements. For existing pipes with a nominal inside diameter (ID) less than or equal to 33-inches, the outside diameter (OD) of the sliplining pipe shall not be more than 3-inches smaller than the nominal ID of the existing pipe. For existing pipes with a nominal ID greater than 33-inches, the OD of the sliplining pipe shall not be more than 6-inches smaller than the nominal ID of the existing pipe. In addition, sliplining pipes shall meet the following requirements:

Sewer Line Nominal Inside Diameter (inches)	RFP Liner O.D. (inches)	Wall Thickness (inches)
1	13.20	0.30
1	15.30	0.34
2	19.50	0.42
2	21.60	0.46
2	25.80	0.54
3	27.00	0.60
3	30.00	0.66
3	32.00	0.66
4	38.30	0.78
4	44.50	0.90
5	50.80	1.02
6	57.10	1.14
6	62.90	1.26
7	69.90	1.38
7	75.40	1.50
8	81.60	1.62
9	87.00	1.74
9	94.30	1.86
102	100.60	1.98

6.2.3 Joints. Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets for all installations except jacking and sliplining installations. The joints shall meet the performance requirements of ASTM D4161.

- For sliplining situations, unless otherwise specified, the pipe shall be field connected with low-profile fiberglass bell and spigot joints. The joints shall meet the performance requirements of ASTM D4161.
- For jacking installations, unless otherwise specified, the pipe shall be field connected with sleeve couplings or bell and spigot joints that utilize elastomeric sealing gaskets as the sole means to maintain joint water tightness. The joint shall have the same outside diameter (OD) as the pipe, so when the pipes are assembled, the joints are flush with the outside surface.

6.2.4 Gaskets and Lubricants. Gaskets and lubricants shall be provided and installed according to the manufacturer's recommendations.

6.2.5 Fittings. Where applicable, flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall, when installed, be capable of withstanding all operation conditions. Acceptable configurations include contact molded or mitered fiberglass properly protected standard ductile iron, fusion bonded epoxy coated steel and stainless steel constructions. The tolerance of the angle of an elbow and the angle between the main and leg of a wye or tee shall be plus or minus 2 degrees. The tolerance on the laying length of a fitting shall be plus or minus (\pm) two (2") inches.

6.3 METHOD OF MEASUREMENT. Will be measured by the linear foot in place. Payment shall be by the linear foot in place, but not to exceed quantity shown on the plans or called for in the special provisions.

6.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

REINFORCED FIBERGLASS PIPE (RFP) (SIZE)	LF
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Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

7.0 SLIPLINING. This section covers rehabilitation of deteriorated sewer lines by trenchless method of sliding a liner pipe of smaller diameter into an existing circular pipeline, then if required, re-establishing service connections to the new liner pipe.

7.1 MATERIALS

7.1.1 Submittals. The Contractor shall submit source of materials for the specified liner pipe, or proposed liner pipe when alternate materials are specified. No liner pipe shall be shipped to job site until all submittals have been reviewed and approved by the Engineer. Submittals shall include:

- Construction and Laying Schedule. The Contractor shall submit an area map of the project designating the beginning and ending points as well as complete pipe laying and time schedule and detail drawings. The map shall also indicate the access points, length, and pipes to be installed. Unless surveyed plans accompany project specifications, all elevations shall be determined and included in the Schedule. This shall include verification of all elevations on as-built drawings when such information is provided. No pipe, special sections and fittings shall be manufactured until all submittals have been reviewed and approved by the Engineer. The drawings and data shall include but not be limited to the following for each size and class of pipe.
- Details of the proposed pipe, properties, strengths, etc. of pipe.
- Details of joints.
- Certification of Material Compliance. A letter from the manufacturer stating that all material satisfies claims made by the manufacturer and meets the requirements specified. Reports of the plant test including liner thickness, flexural strength, and flexural modulus shall be submitted.

- Insertion or Access Pits. The location and number of insertion or access pits shall be planned by the Contractor and submitted in writing for approval by the Engineer prior to excavation. The pits shall be located such that their total number shall be minimized, and the footage of liner pipe installed in a single pull shall be maximized. Locations of damaged pipe shall be used for insertion pits as directed by the Engineer when practicable.
- Sealing Compound and Grout. The Contractor shall submit proposed sealing compounds to be used for sealing liner pipe at the manholes and type of grout and grouting equipment to be used.
- Jacking Loads. The Contractor shall submit a complete record of all jacking loads for the insertion of the pipe liner. This information shall be submitted to the Engineer for review after each insertion operation.
- Copies. The Contractor shall submit 6 copies of all submittals requested in these specifications.

7.1.2 Liner Pipe Materials. Acceptable liner pipe materials are as follows and shall meet the requirements of the appropriate sections indicated below:

Pipe Material	Paragraph
Reinforced Fiberglass Pipe (RFP)	
High Density Polyethylene (HDPE) Pipe	
Polyvinyl Chloride (PVC) Pipe	

7.2 CONSTRUCTION METHODS

7.2.1 Cleaning or Clearing Storm Sewer Lines. Sewer lines to be sliplined shall be cleaned to the maximum extent practicable to ensure structural integrity. Such cleaning shall include flushing, jetting, pressure flushing, and point excavation as needed.

7.2.2 Sewer Flow Control. Contractor shall provide bypass sewer flow control.

7.2.3 Point Repairs. Point repairs shall be accomplished in accordance with other parts of these specifications when cleaning or clearing by conventional methods are unsuccessful. Segments between two consecutive manholes that require more than 5 point repairs for successful rehabilitation may be deleted, by the Engineer, from the specified work. At the discretion of the Engineer, these segments may be replaced by conventional excavation.

7.2.4 Inspection or Access Pit Excavation and Backfill. Before excavation is begun, it shall be the responsibility of the Contractor to check with the various utility companies and determine the location of the utilities in the vicinity of the work area. The Contractor at no cost to the City shall arrange temporary construction easements and/or right-of-way areas. All excavations shall be properly sheeted and shored in accordance with relevant specifications to ensure trench safety and prevent damage to adjacent structures. Any damage resulting from improperly shored excavations shall be corrected to the satisfaction of the Engineer with no compensation due to the Contractor. All open excavations shall be kept secure at all times by the use of barricades with appropriate lights and signs, construction tape, covering with steel plates, etc., or as directed by the Engineer.

7.2.5 Miscellany. The cost for diversion pumping required around an insertion pit, from a manhole upstream to a manhole downstream, shall be per applicable item of these specifications. Excavations initially begun as Point Repairs that, for convenience, are later used as Insertion Pits, shall be treated as incidental to sliplining. If the point repair excavation is used as an insertion pit, the Contractor shall not be required to replace the carrier pipe.

7.2.6 Liner Pipe Insertion. The insertion and installation of the liner pipe shall be in accordance with appropriate ASTM Standard Specifications and the Manufacturer's Recommendations.

- The liner pipe shall be aligned in contact with the invert of the existing sewer. If more than 1/3 of the top profile of the existing sewer line is not intact and cavities exist above the pipe, the condition of the sewer line shall be considered unsuitable and the sliplining operation shall not be performed.
- The Contractor shall maintain sewage flow at all times. This may be accomplished by allowing flows to pass through the liner pipe. By-pass pumping may also be allowed.
- Liner pipe shall not be installed prior to the Engineer's approval. The liner pipe shall be jacked, pushed or pulled, in case of a butt-welded polyethylene liner pipe (with no exceptions), into the existing pipe. An aqueous solution of Bentonite may be used to minimize the jacking load. For each section to be lined, insertion shall be one continuous operation until the planned termination point is reached. Precautionary measures shall be taken to prevent or minimize scarring the liner or breaking the joints. It shall be necessary to use a nose-cone to guide the pipe end past minor obstructions and prevent entry of debris and to put guards over the edges of the existing pipe at the inlet end to prevent their gouging the pipe during the insertion procedure. Once the insertion is initiated, it shall continue to completion without interruption.
- Total jacking loads shall not exceed the manufacturer's recommendations. The Contractor shall provide a suitable means of measuring jacking loads, and shall monitor the load as the liner pipe is being installed. If at any time the load appears to rise non-uniformly, indicating possible obstruction of the pipe, jacking operations shall be terminated and the obstruction or other impediment removed before continuing.
- Permanent bends to accommodate line or grade changes shall be limited to radii equivalent to a longitudinal strain recommended by the pipe manufacturer. At no time shall this minimum allowable radius of curvature be exceeded.
- The Engineer shall approve equipment employed in the sliplining process. A hydraulic or cable operated winching pipe pushing device may be used. The machine operator must closely and continuously monitor and control the jacking load in uniformity and magnitude. A jacking ring or device shall be used to distribute the jacking load evenly over the entire surface perimeter of the pipe end. The Contractor shall also utilize a device that holds stable a nearly inserted joint preventing damage to it while the following joint is shoved home. All joint operations shall be made in full view of the inspector. The maximum pulling length recommended by the manufacturer shall not be exceeded.
- After insertion, the pipe shall be allowed to normalize for the number of hours suggested by the pipe manufacturer to the temperature of the ground as well as recover any imposed strain before cutting the pipe to length between manholes.

7.2.7 Liner Pipe Sealing. The annular space between the liner and the existing pipe must be sealed at each manhole with a chemical seal and non-shrink grout. Oakum soaked in Scotchseal 6500, 3-M Elastomeric Compound (CR-202), or approved equal, shall be placed in a band to form an effective watertight gasket in the annular space between the liner and the existing pipes in the manholes. The width of the band shall be a minimum of 12-inches or half the diameter of the pipe, whichever is greater. It shall be finished off with a non-shrink grout placed around the annular space from inside the manhole and shall not be less than 6-inches wide. The Engineer shall approve the chosen method, including chemicals and materials. The Contractor shall cut the liner so that it extends 4-inches into the manhole. The Contractor shall make a smooth, vertical cut and slope the area over the top of the exposed liner using non-shrink grout. The Contractor shall also use cementitious grout to form a smooth transition with a reshaped invert and a raised manhole bench such that neither the sharp edges of the liner pipe, nor the concrete bench, nor the channeled invert shall exist to catch debris and create a stoppage. The invert of the manhole shall also be reworked (smoothed and built-up) to match the flow line of the new liner. The liner pipe shall be allowed to normalize to ambient temperatures as well as recover from any imposed strain, in accordance with the manufacturer's recommendation before being cut to fit between manholes and proceeding with reshaping and/or smoothing the manhole invert.

7.2.8 Liner Pipe Grouting. The annular space between the liner pipe and the existing pipe shall be sealed with a grout having good flow characteristics, minimum shrinkage, and permanence of support such as Haliburton's LG-3 or an approved cementitious grouting system. A minimum 28-day compressive strength of the grout shall be 750 psi. The safe grouting pressure shall conform to the type and the requirements of the pipe used. The maximum grouting pressure shall be in accordance with the liner pipe manufacturer's recommendations. The sealing compound shall be suitable for underwater application and have elastomeric properties. The annular space shall be completely filled, but particular attention must be paid to those areas just downstream of manholes to avoid air traps, transition couplings, and changes in pipe type or diameter. Equipment for placement of grout shall be used so as to prevent segregation of the grout components and to cause the grout to flow around the liner and completely fill the voids in the annular space. The Contractor shall have operable vibrators on the job to aid the flow of the grout. The Contractor shall have operable pumps on the job site to remove water from the vertical shafts or pits as it is displaced by grout to prevent an excessive hydrostatic head on the liner. Pumping pressures during the grouting process must not exceed the collapse pressure of the liner pipe.

7.3 ACCEPTANCE OF SLIPLINING. Final acceptance of sliplining shall be based on, but not be limited to, review of post-television inspection, leakage testing, and conformance with all provisions of these specifications as determined by the Engineer. The installed liner pipe shall be watertight, smooth, and free from wrinkles, defects, and improper connections or couplings. Should any of these defects occur, the line shall be excavated, repaired and/or replaced, and complete restoration shall be made to the satisfaction of the Engineer at no additional cost to the City.

7.4 METHOD OF MEASUREMENT. "Sliplining" shall be measured along the pipe, through manholes, junction boxes, and other small structures. Payment for "Sliplining" shall be made at the unit price bid per lineal foot of line, for each size installed and shall include liner pipe, grout for pipe sizes fifteen (15) inches and smaller, and buildup, shaping and reworking the manhole invert, and sealing the annular space, equipment, labor, tools, and incidentals necessary to complete this item of work.

7.5 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

SLIPLINING (SIZE)	LF
GROUTING (SIZE > 15-INCH)	CY
GROUTING (SIZE < 15-INCH)	Incidental to sliplining

The cost of grouting shall be incidental to sliplining for pipes 15-inches and smaller in size. For larger pipes, "Grouting" shall be paid for at the unit price bid per cubic yard. The prices established for sliplining and grouting shall be full compensation for all materials including liner pipe, grout, placement of grout, labor, tools, equipment and incidentals necessary to complete this item of work.

8.0 PRECAST REINFORCED CONCRETE SEWER MANHOLES. This section covers construction of precast reinforced concrete storm sewer manholes.

8.1 MATERIALS. This specification covers construction of precast reinforced concrete manhole base sections, riser sections (walls) and appurtenances in accordance with ASTM C-478 Standard Specification for "Precast Reinforced Concrete Manhole Sections" and as modified herein. When requested by the Engineer, the Contractor shall submit the following, but not limited to, for review and approval.

- Concrete cylinder compressive test results as per ASTM C478.
- Amount and detail layout of steel reinforcement as per ASTM C478.
- Certification for the specified protective coating.
- Affidavit of compliance with these specifications.

8.1.1 Components. Components of manholes shall be as follows:

- Precast Risers and Grade Rings. Precast risers and grade rings shall be cylindrical type.
- Precast Tops. Precast tops shall be eccentric cone
- Precast Base Sections. Base section types shall be Base riser section and separate base slab with Mastic sealer or a Base riser section with integral floor and preformed socket to accept a rubber ring.

8.1.2 Sizes. The standard internal diameter of a manhole shall be 4 feet. Non-standard internal diameters of 5, 6, or 7 feet may be constructed when specified or called for on the plans. The manholes shall be constructed pursuant to the appropriate "Standard Details for Precast Reinforced Concrete Manholes", and/or as specified in ASTM C478. The minimum wall thickness shall be as specified in the following table or not less than 1/12 of the internal diameter of the largest cone or riser section or 5-inches, whichever is greater.

Manhole Internal Diameter (feet)	Minimum Wall Thickness (inches)
4	5
5	5
6	6
7	7
8	8

8.1.3 Materials and Design. All materials for construction of storm sewer manholes and junction boxes shall be in accordance with Section 6 of ASTM C478. Concrete properties, reinforcement type and grade, joints, manufacturing and physical requirements shall be in accordance with Sections 7 to 10 of ASTM C478.

- Base slabs or floors shall have a minimum thickness of 8-inches.
- Steps and ladders shall not be included in manholes whose depth is less than 6 feet unless otherwise directed by the Engineer. If called for, they shall conform to Section 13 of ASTM C478.
- All lifting holes shall be repaired with a mixture of cement and sand grout firmly packed.
- Protective Coating. If and only when directed by the Engineer for a specific application, all inside surfaces (walls, bottom, and etc.) of pre-cast concrete manholes may be shop coated with a total dry film thickness of not less than 8 mils of TNEMEC Series 69 Hi-Build Epoxoline II, or approved equal.

8.1.4 Testing. When directed by the Engineer, a set of 3 each 3-inch cylinders shall be cut from randomly selected manholes. Testing shall be performed to verify compliance with the requirements of these specifications. Basis of acceptance for testing shall be in accordance with the appropriate ASTM requirements. Acceptance of manhole structure shall be based on the conformance and performance of materials required in ASTM C478, and the Engineer's inspection of the installed product. The assessment shall include, but not be limited to, the Engineer's random plant inspections during production, the quantity and the placement of reinforcement, surface fractures, honeycombs and roughness, and the test results of compressive strength performed on cores and cured cylinders in accordance with Section 7 of ASTM C497.

8.2 MANHOLE RINGS AND COVERS. Cast iron rings, tops, covers, gratings and all cast iron fittings shall be sound, true to form and thickness and neatly finished and shall fit together in a satisfactory manner. Castings shall be clean, uniform and whole, and without blow or sand holes, dorisit, hardspots, shrinkage, distortion or any other surface defects which would impair serviceability. Casting surfaces shall be smooth and well cleaned by shot-blasting or other approved cleaning method. Plugging or filling of holes or other defects shall not be permitted. Parting fins and pouring gates shall be removed. Sharp edges resulting from fabrication shall be dulled by any acceptable method to ensure safety in handling. Casting shall conform to the requirements of the Standard Specifications for Grey Iron Fittings ASTM A48, Class "30B" for rings and "35B" for covers and the appropriate "Standard Details for Manhole Ring and Cover".

8.2.1 All rings and covers shall be accurately and carefully placed. All rings shall be bedded in a substantial layer of mortar, or a flexible ring seal, shall have a full bearing, and shall be set to the exact grade. Unless otherwise shown, the top of covers shall be flush with, or slightly above, the surrounding surface. When each cover is placed in any position on the ring, the side play shall not exceed 1/8-inch in any direction. Wording and markings on covers shall be in accordance with the Standard Details.

8.2.2 Manhole covers may be manufactured in accordance with the appropriate "Standard Detail for Vented or Non- Vented Manhole Cover". Unless otherwise specified or directed by the Engineer, non-vented manhole covers shall not be used in the streets. When called for on the plans or specified, the underside of all manhole covers shall be given 1 coat of asphalt varnish after visual inspection and approval on the job site.

8.3 CONSTRUCTION METHODS. Manholes shall be constructed in a dry excavation. A crushed rock foundation mat shall be constructed under the manhole. The mat shall be a minimum of 8-inches thick. Following placement, the excavation shall be backfilled with crusher run.

8.3.1 Manhole to Pipe Connection at Inverts. Manhole to pipe connections shall be made pursuant to manufacturer's recommendations and "Standard Details for Concrete Manhole Pipe Connection". In addition, flexible gasket pipe seals shall be required where each pipe enters the wall of manholes. Where possible, the opening for each connecting sewer pipe shall be circular and match the diameter of the pipe. For manholes built over existing lines or for special conditions, horseshoe-shaped openings shall be accepted. Flexible gaskets shall be A-Lok, or an approved equal. The Engineer prior to construction shall approve the method and materials used for grouting any remaining annular space.

8.3.2 Above Invert Manhole to Pipe Connection. Above invert manhole to pipe connection shall be constructed in accordance with the "Standard Detail for Above Invert Manhole to Pipe Connection".

8.3.3 Finishing Manhole to Grade. The manhole ring and cover shall be adjusted to grade with concrete grade rings.

8.3.4 Manhole Inserts. When called for on the plans or specified, manhole inserts shall consist of a new disk, gasket and relief valves etc., meeting the requirements of these specifications, and shall be manufactured by Southwestern Packing and Seals or approved equal. The watertight inserts shall fit the walls and rings. Damaged or missing inserts identified prior to the final inspection shall be replaced at no cost to the City.

8.3.5 Outside Waterproofing. When called for on the plans or specified, waterproofing shall be applied to the outside of manholes. The waterproofing material shall be TNEMEC Series 66 Hi-Build Epoxoline or approved equal. The coating shall have a minimum dry thickness of 4 mils.

8.3.6 Extra Depth Manhole Wall. Where required to construct manholes beyond a depth of 6 feet, manhole walls shall be constructed to the depth called for on the plans or as directed by the Engineer. The construction requirements for Extra Depth Manhole Wall are the same as for standard manholes.

8.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

(SIZE) STORM SEWER MANHOLE (0 TO 6 FEET)	EA
(SIZE) EXTRA DEPTH MANHOLE WALL	VF

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

9.0 CLEANING STORM SEWER LINES. To be published.

10.0 POINT REPAIR. This section covers replacement of short segments of sections of the existing storm sewer pipe, normally 50 feet or less in length, as specified or directed by the Engineer. The point repair is made by excavation to repair a line or remove an obstruction such as dropped joints or crushed or collapsed pipe, which cannot be readily-removed or repaired. A point repair consists of the following tasks or work elements:

- Mobilization to and clearing of the Site and site clean-up and restoration
- Excavation, removal and disposal of damaged or defective line
- Placement of new pipe, with embedment and backfill

10.1 MATERIALS. Acceptable pipe materials and fittings shall be determined based on the pipe diameter, existing material and location.

10.2 CONSTRUCTION METHODS. All point repairs require prior approval of the Engineer. The length and extent of any point repair shall be determined by the Engineer. Selection and providing of pipe, methods of pipe installation, excavation, embedment and backfill, and site clean-up shall be in accordance with the appropriate sections of the specifications.

10.3 METHOD OF MEASUREMENT. Payment for "Point Repair" shall be made at the unit price bid per for each point repair work element. [These point repair work elements are based on the premise that the repair of an existing line is different from the construction of a new line.]

- Point Repair. Includes mobilization to the site, clearing of the site, site clean-up and restoration.
- Point Repair Excavation and Backfill. Includes excavating, removal and disposal of damaged or defective line, and backfill. Excavation and backfill shall be computed based on the length, width and depth of the point repair.
- Point Repair Pipe. Placement of new pipe of the required diameter followed by and including connections and related work.

The prices for each point repair work element established shall include all material, equipment and labor costs for excavation, pipe, replacement, embedment and backfill, sodding, cleanup, and incidentals necessary to complete a point repair. Paving and fencing, if required, shall be replaced and paid for directly in accordance with the appropriate section. Removal of obstructions by internal means shall be considered incidental to work.

10.4 BASIS OF PAYMENT. The items measured as provided above will be paid for at the contract unit price bid:

POINT REPAIR	EA
POINT REPAIR EXCAVATION AND BACKFILL	CY
POINT REPAIR PIPE (SIZE) (TYPE)	LF

Such payment shall be compensation in full for furnishing all materials, labor, equipment, tools and incidentals, and for performing the work in accordance with these specifications.

11.0 TELEVISION INSPECTION. This section covers closed-circuit television (CCTV) inspection of existing sewer lines and rehabilitated and newly constructed sewer lines. The work shall consist of furnishing all labor, materials, accessories, equipment, tools, transportation, services and technical competence for performing all operations required to professionally execute the internal inspection of sewers in strict accordance with these specifications. Information concerning depths of flow, manhole depths, air quality in the sewers, accessibility of manholes, traffic conditions, and other safety considerations are to be the sole responsibility of the

Contractor to obtain and to incorporate the necessary provisions into the overall contract price to complete the specified work under the conditions existing in the sewers to be inspected. For large-diameter sewer inspections, the Contractor may be required to submit sample video recordings from recently completed projects demonstrating the picture quality obtained with each available inspection system for pipe diameters 27-inches and larger. All television testing shall be performed in accordance with guidelines published by the National Association of Sewer Service Companies (NASSCO) and as modified or specified in these specifications.