

## SECTION 4 – STORM COLLECTION

### GENERAL REQUIREMENTS

The hydraulic design of storm collection facilities shall comply with the Ohio Department of Transportation, Location and Design Manual, Volume II – Drainage Design, latest edition and the requirements as follows.

Hydrologic Calculations shall be submitted to the City showing the following information;

Minimum requirements for drawings and engineering calculations for all drainage systems shall comply with the following:

1. A map showing the existing topography of the development area and adjacent land within a minimum of three hundred (300) feet of its boundary. The topographic map shall use a contour interval appropriate to portray clearly the surface conformation and drainage pattern of the area and of the water shed.
2. A vicinity map at a scale of not less than two thousand (2,000) feet to the inch showing the development area in relation to existing roads, the water shed, and nearest existing thoroughfares, streams, wetlands, and other water areas.
3. The drainage area, not project area, for each pipe or drainage structure shall be outlined, with contours and have the acreage shown. To show the entire drainage area, additional sheets may be required. If additional sheets are needed, existing aerial mapping or USGS mapping with contours clearly depicting the watershed shall be sufficient.
4. Location of any adjacent existing drainage structures. This information shall be based on field investigations and mapping.
5. The acreage of all tributary drainage areas and their sum.
6. Runoff calculations shall be generated using the Rational Method. Times of concentration shall be used to identify ~~r~~-intensity rainfall intensity. The time of concentration, intensity, and runoff coefficients used in the Rational Method, used to estimate the amount of runoff, shall be clearly identified in the drainage calculations. The Flow Path used to calculate the time of concentration shall be shown on the drainage map.

7. Discharge in cubic feet per second (cfs), velocities in feet per second (fps) and any additional data needed to establish that the drainage system will convey the flow.
8. The plan and profile of all drainage courses over all sections being affected.
9. Cross sections along the drainage course at one hundred (100) foot intervals or as directed by the City based on existing or proposed grading.
10. Size and types of all drainage improvements including the detailed standard drawings of each.
11. Computation of downstream structures capacity (i.e. downstream pipes, ponds, ditches, streams, etc.) may also be required as directed by the City.

**COMPUTATION OF STORM WATER RUNOFF**

Given the type of drainage structure to be designed, the rate of runoff shall be computed using the storm frequencies given below:

<u>Structure</u>	<u>Storm Frequency (Years)</u>
Storm Sewers*	10
Open Ditches	<del>1025</del>
Culverts	<del>2550</del>
Bridges**	<del>2550</del>

\*The Hydraulic Grade Line (HGL) for storm sewers shall not exceed the crown of the pipe and the HGL for open ditches shall be held at 12" below the top of ditch.

\_\_\_\_\_The design frequency to be considered for an individual structure, culvert or pipe, may be altered by the City Engineer where the health and safety of the residents would be endangered by the hazards of flood waters or increased flows.

Concrete work shall be as specified in ODOT Item 602.

All work shall conform with the General Requirements in Section 1 for seeding, restoration, landscaping, etc.

**I. MATERIALS**

4.1. PIPE AND FITTINGS

A. Requirements - Pipe, fittings, and appurtenances shall conform to the latest edition of the referenced Standards.

Main line Sewers, pipes, culverts, etc. shall be a minimum size of 12-inch diameter. All sewers and pipes 15-inch and smaller shall be PVC SDR35, per ASTM D3034 or polypropylene meeting ASTM F2764 unless otherwise directed by the City Engineer. All sewers and pipes greater than 15-inch shall be concrete meeting ASTM C76 Class IV unless otherwise directed by the City Engineer. Polypropylene pipe may only be used outside the public roadway's pavement, and above the roadway's angle of repose (above a 45 degree line extending from the edge of pavement or curb downwards).

All drive culverts with two (2) foot or less cover above the top of the culvert shall be either concrete pipe, meeting ASTM C76 Class IV, or concrete encased PVC SDR 35 or polypropylene pipe. The concrete encasement shall be class MS, poured the entire length of the culvert, from the spring line of the pipe to the bottom of the proposed driveway approach. A visqueen barrier shall be provided between the concrete encasement and bottom of the approach. All drive culverts with greater than two (2) feet of cover shall be of pipe material as specified for sewers and pipes.

All drive culverts greater than 15-inch shall have installed, as a minimum, half-height head walls. Full headwalls may be required upon review by the City. All drive culverts 15-inch or smaller are not required to have headwalls.

The manufacturer shall furnish an affidavit indicating that the pipe, fittings and appurtenances have been manufactured and tested in accordance with the requirements of the applicable referenced Standards. A copy of the affidavit, indicating the project on which the material is to be used, shall be submitted as a shop drawing to the City prior to construction.

All pipes, fittings and appurtenances shall be appropriately marked for purposes of identification. The materials and methods of manufacture, and the completed pipes, fittings and appurtenances shall be subject to inspection and rejection at all times. The City has the right to make inspections.

For new public storm sewers that transition from the right-of-way to an easement on private property, the storm sewer material used within the right-of-way will be used within the downstream section on private property.

B. PVC Plastic Pipe and Fittings - PVC plastic pipe and fittings shall have a minimum pipe stiffness of 46 psi at 5% deflection when tested in accordance with ASTM D2412, and, as applicable for the sizes involved, shall meet the requirements of ASTM D3034, ASTM F679 or ASTM D2729. The pipe shall be of the elastomeric gasket joint (integral bell) type. Joints shall provide a watertight seal and shall be

made in accordance with the pipe manufacturer's instructions. Joints shall be of the push-on type meeting the requirements of ASTM D3212, and, in addition, the bell shall be designed to retain the gasket to prevent pull-out during the making of the joint.

PVC plastic fittings for use with ASTM D3034 pipe eight (8) inch in size and smaller shall meet the requirements of ASTM D3034 with a minimum wall thickness of SDR 35 as defined in section 7.4.1, and shall be molded in one piece with elastomeric joints and minimum socket depths as specified in sections 6.2 and 7.3.2. PVC material shall have a cell classification of 12454-B or C as defined in ASTM D1784. Gaskets shall have minimum cross sectional area of 0.20 sq. in. and shall meet the requirements of ASTM F477.

PVC plastic fittings for use with ASTM D3034 pipe ten (10) inch in size and larger, and for use with all sizes of PVC plastic pipes other than ASTM D3034 shall be molded or fabricated in accordance with, and have joints meeting the requirements of the ASTM Standard as specified for the pipe.

At the end of all fittings, premanufactured tee's, etc., of all pipe installations, the final fitting at the "plug" shall be SDR 35 compatible. Non-compatible joints to existing sewers shall be made using banded neoprene couplings as manufactured by Fernco, Inc., or City approved equal.

The pipe shall be installed in accordance with ASTM D2321, and with the requirements of these specifications. Any requirements in these specifications which may be in conflict or inconsistent with the requirements of ASTM D2321 shall be void to the extent of such conflict or inconsistency, except in all cases material for pipe embedment shall be as subsequently specified in Item 4.12. PVC plastic pipe shall be tested for deflection as subsequently specified in Division III.

C. Concrete Pipe and Fittings - Concrete pipe and fittings shall be of the spigot and socket or tongue and groove pattern meeting the requirements of ASTM C76 and shall be Class IV or V. Pipes shall be of the greatest lengths commercially available. Circular pipes having elliptical reinforcing shall have the word "Top" or "Bottom" clearly stenciled on the inside of the pipe at the correct place to indicate the proper position when laid. Joints shall be of the rubber gasket type meeting the requirements of ASTM C443. The gasket shall be confined in a groove and shall be installed in accordance with the manufacturer's instructions.

For concrete pipes installed in open trench, the maximum allowable trench width at the top of the pipe for the various sizes and classes of pipe shall be as follows:

CONCRETE PIPE TRENCH WIDTH (As measured at top of pipe)		
Pipe Diameter (inches)	ASTM C76-CLASS	
	IV	V
12	2'-9"	3'-0"
15	3'-0"	3'-3"
18	3'-3"	3'-6"
21	3'-6"	3'-9"
24	4'-0"	4'-3"
27	4'-6"	4'-9"
30	4'-9"	5'-0"
33	5'-3"	5'-6"
36	5'-9"	6'-0"
42	6'-3"	6'-6"
48	6'-9"	7'-0"
54	7'-6"	8'-0"
60	8'-0"	8'-6"
66	9'-0"	9'-6"
72	9'-6"	10'-0"

D. Polypropylene Pipe and Fittings - Pipe shall be joined using a bell & spigot joint meeting the requirements of ASTM F2764. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris and protected from the elements. A joint lubricant available from the manufacturer, or as approved by the City, shall be used on the gasket and bell during assembly. 12-inch through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.

Fittings shall conform to ASTM F2764. Bell and spigot connections shall utilize a welded or integral bell and valley or inline gaskets meeting the watertight joint performance requirements of ASTM D3212.

The pipe shall be installed in accordance with ASTM D2321, and with the requirements of these specifications. Any requirements in these specifications which may be in conflict or inconsistent with the requirements of ASTM D2321 shall be void to the extent of such conflict or inconsistency, except in all cases material for pipe embedment shall be as subsequently specified in Section 4.15.

E. Replacement of Existing Sewers and Drains - The Contractor shall report to the City all existing sewers and drains exposed during trenching or other operations. Replacements shall be made in accordance with all applicable requirements of these specifications for new construction and in accordance with all applicable requirements ODOT Item 611 using pipe with premium joints unless otherwise specified, as approved by the City. In the event of conflict, the requirements of these specifications shall take precedence.

Pipe for storm sewers shall be approved for such use. Replacements 12 feet or less in length of perforated pipe or open joint tile (such as underdrains) shall be made by using PVC plastic pipe meeting the requirements of ASTM D3034, SDR35, or F679 based on diameter, as specified in Paragraph 4.1.A. In any event, all such replacements in cultivated fields shall be with the specified perforated pipe. Drain discharges removed at ditches or other watercourses shall be replaced with one standard length of reinforced concrete pipe, or as otherwise approved by the City. Joints between existing and replacement pipes, when of differing materials or with otherwise non-compatible joints, shall be made using banded neoprene couplings as manufactured by Fernco, Inc.

Existing sewers and drains shall be replaced so as to withstand future settlement by bridging with timber supports a minimum of six (6) inches square. Bridging shall extend into undisturbed earth a minimum of 12 inches each side of the trench, and the pipe, tile, etc., banded or tied using stainless steel banding to the bridging for its full length. Where timber bridging cannot be supported by a firm foundation, the Contractor shall provide vertical support for the timber bridging, including any lateral bracing necessary to provide a firm and substantial support. Supports and bracing shall be of native hardwood.

F. Storm Sewer Laterals – All structures, yard drains, and downspout drains shall that connect to the public storm sewer system within the public right-of-way or in a storm/drainage easement shall be a minimum of six (6) inch diameter, PVC SDR 35 or as specified in Paragraph 4.1.A.

#### 4.2. PIPELINE MARKERS

Provide pipeline markers for sewer installation in railroad or Turnpike right-of-ways or in easements other than maintained residential yards or as required by the City.

In railroad or Turnpike right-of-ways, furnish and install prominent durable, weatherproof signs located over the centerline of the pipe at each right-of-way line, and along the pipeline in the right-of-way for longitudinal occupancy. Signs shall show the name and address of the Owner, contents of the pipe, pipe depth below grade at the sign and an emergency telephone number in the event of pipe rupture. The signs shall be acceptable to the railroad company or Ohio Turnpike Commission.

In easements other than railroad or Turnpike right-of-way, furnish and install prominent, durable weatherproof signs located over the centerline at each end of the easement and along the pipeline in the easement. Signs shall have the word STORM permanently imprinted on them and shall be Carsonite Utility Markers as manufactured by Carsonite Composites, or as approved; and shall comply with APWA/ULCC color coding for utility locating.

Signs shall be located at each right-of-way line, at beginning of easements, at each manhole location and at 500-foot intervals along the pipeline outside the public right-of-way, or such shorter interval to allow sight distance between two consecutive marker signs.

#### 4.3. STEEL ENCASUREMENT PIPE

Where shown, the pipe shall be installed within welded steel encasement pipe. The encasement pipe shall meet the requirements of ASTM A139, Grade B, and shall be bituminous coated on the outside. Any coating applied in the field shall be applied a minimum of 48 hours prior to installation. The encasement pipe diameter shall be four inches larger than the diameter of the pipe bell, rounded up to the next nominal pipe size. The minimum wall thickness of the encasement pipe shall be 0.375-inches and is based on steel pipe having a minimum tensile strength of 60,000 psi and a minimum yield strength of 35,000 psi. The wall thickness shall be adjusted as necessary for other grades of pipe. All joints shall be fully welded on the circumference.

The encasement pipe shall be installed by boring and jacking and in such a manner so as to allow the pipe to be laid at the grade shown. This shall include both horizontal and vertical control methods as approved by the City Engineer. Control methods shall permit location of and realignment of the cutting heads at all times during installation. Boring and jacking operations shall be continuous. The pipe shall be blocked in place within the encasement pipe to prevent shifting or flotation. The ends of the encasement pipe shall be blocked up in such a way as to prevent the entrance of foreign material, but allowing leakage to pass in the event of same within the encasement pipe. See Figure 4.5.1.

Blocking shall be accomplished using wood blocks or approved casing chocks. Wood blocking shall be as shown on the drawings. Wood blocks shall be of hardwood lumber. Banding straps for holding the wood blocks in place shall be of stainless steel. Casing chocks shall be of polyethylene or stainless steel with a liner and UHMW polymer plastic runners, shall be as manufactured by Power Seal Pipeline Products Corporation, Cascade Waterworks Manufacturing Company, Advance Products & Systems, Inc., or equal, and shall be installed in accordance with the manufacturer's instructions. Blocking shall be notched to secure banding to blocking without slippage. Two sets of blocks or chocks shall be used per pipe segment. See Figure 4.5.2.

The annular space between the encasement pipe and the carrier pipe shall be filled with either sand, blown in, or grout.

The Owner will secure all necessary permits for boring pipe, but the Contractor shall pay the cost of all necessary inspection, insurance, etc. No work shall begin until a permit, if required, has been issued. The City shall either secure upfront the cost of all necessary inspections, insurances, etc., or shall withhold monies due to Contractor for same until satisfactory proof is received from Contractor that all costs have been paid. The Contractor shall be responsible for meeting the requirements of the governing authority, which may include approval of equipment to be used, for installation of the encasement pipe and for providing same with the required notification prior to the start of such work. The City shall not be responsible for any additional cost to the Contractor as the result of the Contractor's failure to meet any of the governing authorities requirements.

Steel encasement pipe in and across railroad right-of-ways shall meet the requirements of the railroad company. Steel encasement pipe in and across Turnpike right-of-ways shall meet the requirements of the Ohio Turnpike Commission.



#### 4.4. BRIDGES/BOX CULVERTS

A bridge is any structure greater than or equal to ten (10) feet in length, including supports, erected over a depression or an obstruction, as water, highway or railway, and having a passageway for moving traffic, pedestrians or other moving loads. Bridge and box culverts shall be sized according to the ODOT [Locatoin & Design Manual and Bridge Design Manual](#), latest editions. Box culvert material and construction shall be in compliance with the ODOT Item 706.05, latest edition. Bridges shall meet AASHTO Standard Specifications for Highway Bridges, latest edition.

#### 4.5. CATCH BASINS

A. Bases and Walls - Bases and walls for Catch Basins shall be precast and shall either be 2'-0" x 2'-0" (ODOT 2-2-A or B) or 3'-0" x 3'-0" (ODOT 2-3) in size, as designated on the drawings or as required to properly accommodate the pipe sizes required for the installation. The structures shall meet H-20 loadings if located within any pavement. Spacing shall be no greater than 300 feet apart. Inverts shall be poured to the spring line of pipe. Catch basins greater than four (4) feet deep should be a minimum of 3' x 3' with polypropylene steps.

B. Frames and Grates - Frames and grates for Catch Basins shall be EJ (formerly East Jordan Iron Works) 5250 frame with 5110, Type M3 sinusoidal grate or City approved equal. Frames and grates with a curb shall be EJ 7035 (single); 7036 (double) with a Type M6 Vane Grate and Type T6 backs, or equal. Grate openings shall allow passage of 25-year storm event volumes.

#### 4.6. MANHOLES

A. Description - Manholes shall be constructed of precast reinforced concrete sections and appurtenances meeting the requirements of ASTM C478, except as modified by these specifications and the details on the drawings, and shall be complete with required pipe sewer stubs. Manholes shall have a minimum 48-inch I.D. or larger as recommended by the manufacturer. An affidavit from the manufacturer shall be provided stating that the manhole is appropriately sized for the sizes and angles of incoming pipes.

The City may require anti-floatation pads for manholes, upon review of the required soil borings.

B. Bases - Bases shall be constructed in two pours or monolithically with bottom reinforcement tied to side reinforcement to form an integral structure. Walls shall have a minimum thickness of 1/12 the base I.D. plus 1 inch. See Figure 4.6.1.

Bases shall incorporate provisions for making a flexible joint between the pipe and the manhole for all pipe connections. Flexible joints shall be Kor-N-Seal as manufactured by National Pollution Control Systems, Inc; A-LOK as manufactured by A-LOK Products Corporation, or City approved equal. Flexible joints shall be shock absorbent and shear resistant; shall be designed to prevent any direct contact between the pipe and manhole; and shall provide a tight, infiltration proof sewer connection with the pipe deflected up to 10 degrees in any direction. Should incorporation of the flexible joints require a base I.D. greater than required for the wall sections, the Contractor shall furnish and install the larger base and an approved precast reinforced concrete transition section to go from the larger base to the wall sections.

Joints between bases and wall sections shall be as subsequently specified for the walls.

If not integrally cast with the base, after installation of the pipes provide an ODOT Class F concrete invert through the manhole. The invert shall have a depth through the manhole equal to one half of the diameter of the sewer pipe and shall slope upward toward the manhole walls approximately three (3) inches. Concrete shall be trowelled smooth, and shall be placed so as not to interfere with the flexibility of the joint.

Bases shall be set plumb and at the proper elevation on a cushion of compacted ODOT #57 crushed limestone as approved by the City

C. Walls and Tops - Walls shall be vertical riser sections having a minimum wall thickness of  $1/12$  the base I.D. plus one (1) inch. The top section shall be an eccentric cone narrowing down to an I.D. of not less than 24 inches and an O.D. of not less than that of the subsequently specified grade rings. No pipes shall enter the cone section. See Figure 4.6.2 for standard and shallow manhole details and Figure 4.6.3 for transition manhole details. Manholes too shallow to accommodate a cone section shall have a reinforced flat slab top. Flat slab tops shall be designed to withstand H-20 traffic loading and design calculations shall be submitted to the City. See Figure 4.6.4.

Adjoining riser sections shall be firmly keyed together by means of tongue and groove joints with rubber gaskets meeting the requirements of ASTM C443. In addition, preformed plastic gasket material shall be provided on the outside shoulder of all joints. Installation of the gasket material shall not interfere with the proper sealing of the rubber gasket. The preformed gasket material shall meet the requirements of Federal Specification SS-S-210A and shall be as manufactured by Hamilton-Kent Manufacturing Company; K.T. Snyder Company, Inc.; or equal.

Each manhole frame shall be set at the proper elevation by use of precast concrete grade rings. The rings shall be provided for a minimum height of four (4) inches and shall not exceed 12 inches in height. Rings, unless otherwise subsequently specified, shall have an I.D. equal to the access opening in the manhole top section, and an O.D. not less than the O.D. of the manhole frame. The rings shall each be set in a full bed of mortar composed of 1 part, by volume, Portland cement and 2 parts clean, hard sand. The interior of the grade rings shall be mortared to provide a smooth common surface from frame to top. See Figure 4.6.5.

When the manhole frame is to be anchored to the manhole top, as subsequently specified in Item 4.7, the top section and grade rings shall have four 1-inch diameter holes located to match the holes in the casting and shall be of such dimensions as to provide a minimum two (2) inch concrete cover for the one (1) inch diameter holes. Holes in the top section shall extend at least six (6) inches into the concrete. Holes shall not be made in the field.

D. Steps - Steps shall be provided in all manholes. Steps shall meet the requirements of ASTM C478 and shall be of reinforced polypropylene. Installation of manholes, when in pavement, shall be such that steps are in the center of a traffic lane or between lanes where possible, and, when outside pavement, shall be such that steps are located away from the pavement edge unless the manhole is within a ditch line, in which case they shall be located at the high side of the ditch slope.

Reinforced polypropylene steps shall consist of a 1/2 inch steel reinforcing rod encapsulated in a copolymer polypropylene plastic and shall incorporate a notched tread ridge and retainer lugs on each side of the tread ridge. The steel rod shall be continuous through the entire length of legs and tread. Steps of the press fit type driven into the concrete wall shall have a pullout resistance of not less than 1,500 pounds per leg, as evidenced by test data. Steps must be provided for any structure greater than four (4) feet deep.

E. Pipe Sewer Stubs - Where noted, pipe sewer stubs shall be provided at manholes for future sewer connections. The stubs shall be of the same type of pipe as being provided on the Project for the respective sizes of pipe, shall be a minimum of two (2) feet in length outside the manhole wall, and shall terminate with a full pipe bell. Installation shall be as specified in Division II. The end of each stub shall be provided with a pipe stopper (plug) specifically designed for use with the pipe. Plugs shall be for permanent or temporary use, shall be watertight, and shall be removable without damaging the pipe.

#### 4.7. FRAMES AND COVERS

All frames and covers shall be heavy duty gray iron castings conforming to ASTM A48. Both the underside of the cover and the upper surface of the ledge upon which it rests shall be machined so as to prevent rocking on its supporting surface. All castings shall be cleaned and coated with asphalt paint prior to installation and, after installation, the tops of frames and covers shall be given an additional coat of asphalt paint.

The frames shall have a clear opening of not less than 24 inches in diameter and a height of not less than 7 inches. Covers shall have strengthening ribs on the underside, and shall have the words "City of Hudson Storm Sewer" cast into the top. No frame and cover unit shall weigh less than 375 pounds.

Standard frames and covers shall be East Jordan Iron Works 1040 with Type A solid cover, or equal.

Frames shall have four equally spaced anchor bolt holes in the base flange and shall be anchored to the manhole top. Anchors shall be four 3/4 inch diameter all-thread rods, and each shall be complete with washer and nut for holding the frame down. Anchors shall be of a length to extend through the grade rings and to the bottom of the hole in the manhole top, and allow for at least the length of one nut to protrude through the nut when tightened. The anchors shall be set with the entire annular space around the rods filled with epoxy from the top of the rings to the bottom of the hole in the manhole top. The epoxy shall be 100%, 2-part, with a minimum compressive strength of 5,000 psi, and shall be Rawl/Sika Foil-Fast Injection Gel System by The Rawl/Plug Company, Inc., or equal. After the epoxy has cured, the frame shall be bolted in place.

The manhole frames shall be firmly set on top of the adjusting rings with a full leveling bed of 1:1 cement mortar. Where manholes are located in paved areas, the surface of the cover shall be made flush with the pavement surface. In unpaved streets and alley areas, the cover shall be set not to exceed one (1) inch above the ground surface. On right-of-way and in ditches cover elevation shall be as approved by the City.

After a manhole frame is installed in its final position, it shall be encased in Class C concrete. The concrete encasement shall extend from a horizontal plane four (4) inches below the lowest adjusting ring up to a horizontal plane through the mid-point of the frame. The concrete encasement shall be made circular in plan, using a minimum 48-inch diameter steel casing ring as a form, and shall be centered on the frame.

#### 4.8. STORMWATER CONNECTIONS

Stormwater connections for storm sewers shall be six (6) inches in diameter, unless otherwise shown, and shall be furnished and installed for existing and future houses and businesses. Locations and depths of stormwater connections, where shown on the drawings, are approximate only. Final locations and depths will be established by the City at the time of construction. All downspouts, foundation drains, and yard drains shall be connected to the storm sewer, as approved by the City.

Connections to the main sewer shall include the furnishing and installation of an appropriate wye in the new sewer.

New stormwater connections shall be connected into existing storm sewers where approved by means of positively sealing connections. Connectors shall be of materials such as rubber gaskets, sleeves, etc. with or without stainless steel clamps, bolts, etc. that will not erode over time. Connectors shall be designed specifically for the application intended. Service connections shall be by sewer saddles, style "CB" all stainless steel, as manufactured by Romac Industries, or equal; or by use of Inserta Tees as manufactured by Inserta Fittings Company.

Where stormwater connections are to be installed to the property line, the pipe shall be installed true to line, at a 90° angle from the mainline, if possible, and on at least a 1% grade, but no more than a 3% grade. Except where otherwise specifically required or permitted by the City, stormwater connections shall be installed by open cut excavation, shall have a minimum depth of six (6) feet at the property line and shall be deep enough to serve all basement foundation drains, unless otherwise approved by the City. The requirements for construction shall, in all respects, comply with those specified in this Section for the main sewers.

In general, riser sections will be required between the main line sewer connection and that portion of the service connection installed on at least a 1% grade where depths to the main sewer invert exceed 12 feet. Riser pipe shall be defined as the vertical pipe, plus all pipe and fittings required between the vertical pipe and the connection at the main sewer. The riser shall be fixed in place for its full height by providing thoroughly tamped pipe embedment material. Clean-outs shall be allowed as required and/or approved by City. See Figure 4.10.1.

Where required, stormwater connections shall be installed within steel encasement pipe. Steel encasement pipe shall extend five (5) feet each side of the pavement. Steel encasement pipe shall be as

previously specified in Item 4.3, with the encasement pipe to be sized for at least 2 inches clearance around the pipe bell, but not to exceed 14 inches in size, and the minimum wall thickness shall be 0.188 inch.

Stormwater connections not immediately connected to an existing sewer shall be closed with a stopper. Stoppers shall be specifically designed for use with the pipe, shall be for use as a permanent or temporary plug, shall be watertight, and shall be removable without damaging the pipe. Pipe damaged when installing or removing stoppers shall be replaced at the expense of the Contractor.

The ends of stormwater connections shall not be backfilled until the location is referenced in accordance with Figure 4.10.2. A two (2) inch square oak pole shall be accurately placed over the termini of all such stormwater connections and shall extend vertically to flush with the surface of the ground so that it can be located.

NO STORMWATER CONNECTIONS SHALL BE TIED INTO THE STORM SEWERS PRIOR TO THE CITY RECEIVING AND APPROVING RECORD DRAWINGS FOR THE STORM SEWER INSTALLATION.

4.9. BEDDING AND BACKFILL

A. Bedding - Pipe embedment shall be crushed limestone #57 for sewers, from four (4) - inches below the pipe barrel to 12-inches above the pipe barrel for PVC pipe and to the springline for RCP pipe. For polypropylene pipe, crushed limestone #57 shall extend four (4) inches below the pipe barrel to six (6) inches above the pipe barrel for 12-inch through 24 diameter sewer, and six (6) below the pipe barrel to six (6) inches above the pipe barrel for 30 inch through 60 inch diameter sewer. See Figure 4.17.1.

Concrete encasement and concrete pipe cradles shall be ODOT Class C concrete.

B. Granular Backfill – The granular backfill shall meet the requirements of ODOT Item 304 crushed limestone.

Trenches within railroad right-of-way, except for longitudinal occupancy, shall be backfilled with crushed stone with a top size of the aggregate to be a maximum of two inches and to have no more than 5% passing the number 200 sieve. The gradation of the material is to be such that a dense stable mass is produced.

C. Control Density Fill (CDF) – Control Density Fill (CDF) shall be ODOT Item 613, Type 1 low strength mortar, except no slag permitted. The design mix used shall be approved by the City, and shall have a design strength of 50 psf.

## II. INSTALLATION

### 4.10. TRENCHES

Except where otherwise specifically required or permitted by the City, sewers shall be laid in open trench, shall be started at the lowest point, and shall have spigot ends pointing in the direction of flow.

Prior to trenching, in lawn areas and in fields used for farming, both as determined by the City, all topsoil shall be removed.

The use of equipment with metal tracks or treads will not be permitted on paved surfaces which will not be removed during trenching operations without some type of pavement protection, such as matting or rubber tracks.

The width of trenches below the level of the top of the pipe shall not exceed the dimensions previously specified for the various types and sizes of pipe, and shall not be less than 12 inches greater in width than the outside diameter of the pipe barrel, unless otherwise directed by the City. Whenever the maximum allowable trench width (below the level of the top of the pipe) is exceeded for any reason, the City reserves the right to direct the Contractor to utilize pipe of greater strength, to modify the type of backfill, to embed the pipe in concrete, or to utilize a combination of these procedures, all at the expense of the Contractor.

Trenches in earth shall be excavated to a depth of not less than one-eighth the outside diameter of the pipe being installed or 4 inches, whichever is greater, below the outside bottom of the pipe barrel and bell when the pipe is laid on its final grade.

Trenches in rock shall be excavated to a depth of one-third the inside diameter of the pipe, but within the limits of 4 inches to 12 inches, below the outside bottom of the pipe barrel and bell when the pipe is laid on its final grade and the pipe shall then be laid on a cushioning layer of bedding material as specified or as approved by the City and provided by and at the expense of the Contractor. Rock excavation shall be in accordance with the requirements subsequently specified in Item 4.~~16~~17.

Prior to open trenches entering the paved limits of a street, alley, driveway, sidewalks or parking area, the pavement shall be neatly cut for its full depth, removed, and disposed of off the Project site. Street and road crossings shall be constructed in accordance with the requirements specified in Section 7 – Roadway.

Trenches shall be kept sufficiently free of water during pipe laying and jointing. When water exists in the trenches at the time of pipe laying, the Contractor shall dewater the trench at his expense.

#### 4.11. PROTECTION OF EXISTING UTILITIES

Existing underground utilities along the route of construction, as shown on the drawings or marked at the time of construction by the utility owner, shall be uncovered by the Contractor and their elevations determined at least 400 feet in advance of pipe installation for sewers. Contractor shall contact OUPS 48 hours prior to any excavation work.

All underground utilities, when encountered, shall be adequately supported, shored up or otherwise protected whenever exposed in the excavation. Timber supports shall be a minimum of 6 inches square. Supports shall extend into undisturbed earth a minimum of 12 inches each side of the trench and the pipe, conduit, etc., banded or tied to the bridging for its full length using stainless steel banding. Where bridging cannot be supported by a firm foundation, the Contractor shall provide vertical support for the bridging, including any lateral bracing necessary to provide a firm and substantial support. Supports and bracing shall be of native hardwood and shall be furnished and installed by the Contractor. See Figure 4.15.1.

The drawings shall indicate the location of existing utilities, in accordance with the best information presently available. The City assumes no responsibility for the accuracy of their location or that all utilities are shown. A listing of utility company contacts shall be included on the drawings.

Prior to performing any excavation, written or oral notification shall be give to all utilities within the area to be excavated not less than two working days nor more than ten working days in advance of the work. For City utilities, notification must be in writing. The notice shall include:

- a) the name of the project, if applicable
- b) the name, address, and telephone number of the person filing the notice;
- c) the name, address, and telephone number of the person doing the excavation;
- d) the anticipated starting date of the excavation;
- e) the anticipated duration of the excavation;
- f) the types of excavation to be conducted;
- g) the location of the proposed excavation;
- h) any anticipated interruptions to service; and
- i) whether or not explosives will be used.



The excavation work shall be so planned as to avoid damage to and minimize the interference with existing underground utilities in the area. Adequate clearance between the cutting edge of the excavation equipment and the underground utility shall be maintained to avoid damage to the utility.

Above ground (aerial) utilities, including power, telephone and cable television, shall remain in service at all times. Any anticipated disruption of service shall be with the full knowledge of the utility company and required advance notice to the affected users by the Contractor. Removal of guy wires and holding of poles shall be done as required to complete the work, shall be as agreed upon by the utility company and the Contractor, and shall be at the expense of the Contractor.

Arbitrary disruption of underground and aerial utility services will not be permitted.

#### 4.12. TRENCH PROTECTION

Where necessary to prevent caving of the trench and other excavation, and for protection of workmen and nearby structures, trench protection shall be provided per OSHA standards by and at the expense of the Contractor. Trench protection shall be by trench box, wood sheeting and bracing or such other methods as determined by the Contractor. If wood sheeting or bracing is used, the design of the sheeting or bracing shall be sealed by an Ohio registered professional engineer and submitted to the City prior to installation. Contractor shall have a competent person on-site to determine the appropriate method for the conditions.

Wood sheeting and bracing shall be of sound lumber suitable for the purpose intended and shall be so arranged as to support the trench walls and existing structures and utilities. Sheeting left in place shall be cut off not less than 18 inches below ground surface.

Sheeting and bracing not noted to be left in place may be removed at the discretion and responsibility of the Contractor after backfill has been placed and compacted to a level at least two (2) feet above the top of the pipe. In no case shall sheeting be pulled in increments exceeding three (3) to four (4) feet in order to avoid the danger of breaking the pipe due to the weight of the backfill. Upon removal of sheeting and bracing, voids left due to such removal shall immediately be filled and the backfill recompacted.

Where it is necessary to drive sheeting below the centerline of the pipe, it shall be driven below the bottom of the pipe as determined by the City, and that sheeting below a point two feet above the top of the pipe shall be left in place.

#### 4.13. PIPE EMBEDMENT

The bedding material shall be shaped to conform to the bottom quadrant of the pipe barrel. The City reserves the privilege of altering the type of bedding material and regulating the exact grading of the bedding material depending upon the water characteristics of the trench. At least the minimum of bedding shall be provided under pipe bells.

After the pipe is laid, the bedding material shall be shovel placed and tamped to fill all voids. The bedding material shall be placed in six (6) inch layers, loose measurement, and compacted by hand or mechanical tamping to secure a good compaction. All embedment material shall be carefully placed and tamped so as not to damage or displace the joints or pipe, and no material shall be dropped directly on the pipe. The material shall be compacted to not less than 98% of maximum density as determined in accordance with ASTM D1557 (Modified Proctor).

An exception shall be made where concrete encasement is noted on the drawings. Concrete encasement shall be square in cross section, shall have a minimum thickness of six (6) inches at pipe bells, and shall be of the length as shown on plan/profile drawings or as required. See Figure 4.17.1.

This shall include the materials and construction of concrete pipe cradles to support the new pipes where they cross over existing pipes in the locations noted on the drawings. Damage to existing pipes resulting from the Contractor's operations shall be repaired or replacements made to the satisfaction of the City by and at the expense of the Contractor. See Figure 4.17.2.

If the material found at the specified depths of excavation below the elevation of the outside bottom of the pipe barrel is not suitable to provide adequate foundation for the pipe, a further depth shall be excavated and filled with granular bedding material approved by the City.

#### 4.14. PIPE LAYING

Pipes shall be laid with their full lengths true to line and grade with the aid of batterboards, grade pole and grade string, or other method approved by the City, and shall rest on the bedding material provided. Pipe slope shall be as designed and approved by the City of Hudson.

When batterboards are used, not less than three, set at 25-foot intervals, shall be installed and maintained in proper position at all times as a check on the accuracy of the grade line.

When laser beam equipment is used, it shall be checked a minimum of twice daily, once in the A.M. and once in the P.M., in the presence of the City to verify that the equipment is maintaining the established

line and grade. In addition, when temperature and other atmospheric conditions prevent the laser beam from maintaining grade, the Contractor shall provide additional ventilation through the pipeline by the use of blowers as recommended by the equipment manufacturer or as directed by the City.

Regardless of the method used, the City shall be immediately notified of any misalignment of the pipe when laid in accordance with established cuts or elevations.

Pipes and manholes shall be installed at a minimum ten (10) foot horizontal distance from water mains, and pipes laid at a minimum 18 inches vertical distance from water mains at their crossing, both as measured between the outside of the pipe walls. At crossings, one full length of pipe shall be installed so both joints will be as far from the main as possible. If necessary, existing water mains shall be relocated under proposed sewers. See Figure 4.18.1.

#### 4.15. BACKFILLING

Backfill shall include the material placed above the pipe embedment material previously specified. No heavy or large quantities of backfill material shall be placed over the pipe until backfilling has progressed to a depth of at least three (3) feet over the top of the pipe barrel. All backfill material shall be carefully placed so as not to damage the joints or displace the pipe. Backfilling shall immediately follow trenching and pipe laying operations to reduce the possibility of damage to pavements and utilities.

Trenches within existing and proposed stoned streets, alleys, driveways, stoned parking areas and concrete or brick sidewalks shall be backfilled with granular material. The material shall be placed and compacted to not less than 100% of maximum density as determined in accordance with ASTM D1557 (Modified Proctor). Contractor shall provide a Certified Proctor test result from limestone supplier with the shop drawings, prior to stone being delivered to the Project site.

Where sewers are installed along and across existing and proposed paved or stoned streets, alleys, driveways and parking areas, the specified compacted granular material shall also be provided for backfilling any portion of the trenches falling within that area below a line drawn at 45 degrees to the horizontal from the surface at the edge of the pavement or back of curb and above the horizontal plane of the pipe embedment material. See Figure 4.19.1.

For trenches within existing or proposed paved streets, alleys, driveways and paved parking areas a controlled density fill (C.D.F.) shall be provided or backfill as approved by the City. The mix shall be placed in a usable fluid form and in uniform vertical lifts. Design, finishing and protection of the

material shall be recommended by the manufacturer for the application. Quality control test procedures of the manufacturer shall include ASTM C138 - Test for Unit Weight, and ASTM C39 - Test for Compressive Strength. No compaction is required for C.D.F.

Trenches within railroad right-of-way, except for longitudinal occupancy, shall be backfilled with crushed stone. Trenches where sewers are installed longitudinal to the railroad tracks shall be backfilled per railroad requirements, latest revisions. The backfill material shall be placed in loose six (6) inch lifts and compacted to at least 95% of its maximum density with a moisture content that is not more than 1% greater than or 2% less than the optimum moisture as determined in accordance with current ASTM Designation D - 1557 (Modified Proctor). When the backfill material is within three feet of the subgrade elevation (the interface of the ballast and the subsoil), a compaction of at least 98% will be required. Compaction test results confirming compliance must be provided to railroad company's Engineer by the Contractor.

The City may require Contractor to check compaction of the backfill at a location and depth determined by the City, at any time, at no cost to City. Where trenches are backfilled with granular material, the Contractor shall remove excess excavated material. Any excess excavated spoil shall be removed to an approved dump site.

In all paved streets and highways, immediately upon completion of other backfilling operations and prior to the end of work for that day, a temporary pavement as specified in Section 7 - Roadway shall be provided and shall remain in place and be properly maintained until such time as the permanent pavements are placed. For a project with more than one road crossing permanent pavements shall be placed within two weeks after completion of tests and acceptance of each section of the storm sewer. For a single road crossing or utility repair, permanent pavements shall be placed within 48 hours after acceptance of the crossing or repair.

For backfilling the remainder of the trenches, as much of the excavated material as possible shall be replaced until backfilling has progressed to a depth of at least 3 feet over the top of the pipe barrel. The material shall be finely divided free of stones three (3) inches or greater in any dimension, no boulders, organic materials or other harmful debris shall be used. The material shall be placed in six (6) inch layers, loose measurement, and compacted by mechanical tamping.

Also, immediately upon completion of other backfilling operations and prior to the end of work for that day, a temporary sidewalk shall be provided, and shall remain in place and be properly maintained until such time as the permanent sidewalk is placed. The temporary sidewalk shall consist of a minimum of 1-1/2 inches of the specified compacted granular backfill material placed to the same width as the original sidewalk, and shall be furnished, placed and maintained by and at the expense of the Contractor. The temporary sidewalk shall be reshaped and regraded prior to the installation of permanent sidewalk.

After backfilling, along weed or unsodded areas the material shall be graded to conform to the original ground profile. In lawn areas and in fields used for farming, all topsoil removed and stockpiled prior to trenching shall be replaced and graded to conform to the original ground profile. In lawns and other areas where grass exists, as determined by the Owner or the City, the area shall be graded and made ready for seeding as specified in Section 1. In lawn areas, if the existing replaced topsoil does not provide the required four (4) inch minimum depth as specified in Section 1, the Contractor shall provide additional topsoil at his expense.

The Contractor shall be required to regrade and reshape all road shoulders and all ditches or swales from existing high points to existing drainage structures or other outlets along the proposed improvement. The Contractor and the City shall mutually agree and establish all ditch grades to be restored prior to construction. Ditches, which are reshaped, shall have reasonable side slopes. Vertical or steep slopes will not be permitted.

#### 4.16. CONNECTIONS TO STRUCTURES AND PIPES

When required, new and existing sewers shall be connected to structures through stubs, wall castings, wall sleeves, etc. provided for same or a cored opening shall be made at the proper elevation in the wall of the structure, the pipe inserted and the opening around the pipe neatly and permanently closed with a non-shrinking and non-corrosive grout. No straight-line saw cutting and/or hammering of openings will be allowed. Grout shall be, Five Star Grout as manufactured by Five Star Products, Inc.; Sealtight 588-10K Grout as manufactured by W.R. Meadows, Inc.; Set Grout as manufactured by Master Builders; or equal. All connections shall be watertight. Where necessary, the bottoms of existing structures shall be reshaped to give a smooth flow in all directions.

Connections to unlike types and sizes of pipe shall be accomplished using the proper adapter and/or connector as manufactured by Fernco, Inc.

#### 4.17. ROCK EXCAVATION

A. General - The term "rock excavation" shall include the removal of such material as cannot be broken and removed by ordinary excavating equipment. The definition of ordinary excavating equipment does not include rippers or power operated jack hammers. Disintegrated, weathered, rotten and loose rock particles capable of removal by ordinary methods are not included within the scope of rock excavation.

B. Excavation - Excavation shall be carried to a sufficient depth to provide for a cushioning layer of bedding material as previously specified in Item 4.12. Width of trench shall be not more than previously specified for the respective type of pipe.

Excavation for structures shall extend to a plane four (4) inches below the underside of the concrete foundations and be confined to limits two feet beyond the outside of such foundations.

C. Disposal of Rock - Except under special permission from the Engineer, rock removed by excavation shall not be used for backfill, but shall be disposed of by the Contractor off the Project site. Necessary bedding and backfill for trenches and other excavations in rock excavation shall be approved by the City.

D. Method - Where rock is encountered which cannot be removed by ordinary excavating methods, rock excavation, unless otherwise specified, may be accomplished by the use of explosives, with the approval of the City Manager and subject to compliance with all Federal, State and Local laws and the following requirements:

- 1) All required permits shall be secured by the Contractor well in advance of such operations.
- 2) The transporting, handling and firing of explosives shall be performed by someone thoroughly familiar, experienced and, if applicable, licensed in this type of work, preferably a representative of the manufacturer of the explosives to be used.
- 3) Prior to removing rock in any area, the type of explosives to be used, the number, depth and loading of holes to be detonated at any one time; and

any special precautions to be observed shall be determined at a conference between representatives of the Owner, the City, the Contractor, the Contractors Insurance Company and the person directly responsible for detonation. The procedure thereafter followed in that area shall conform to the decisions reached; subject to any modifications which may be required because of unsatisfactory or unsafe results or the procedure agreed upon.

- 4) Suitable timber mats or other coverings shall be provided to confine all materials lifted by blasting within the limits of the excavation.
- 5) All public and private utility companies having facilities in the vicinity shall be notified by the Contractor of the location and time of contemplated detonation in sufficient time to allow them to protect their facilities. Likewise, where operations are to be carried on in any location where traffic on streets or highways may be affected, proper notice shall be given the local Police Department.
- 6) For purpose of protecting the general public, the Contractor and the Owner, the utmost cooperation will be required between the Contractor and all other interested parties. All safety precautions shall be strictly enforced.
- 7) Should permit limitations or the nearness of existing structures and utilities prohibit the use of explosives, rock excavation shall be performed by an approved alternate method.
- 8) Seismographic monitoring, pre-blasting and post-blasting inspections shall be performed on those structures nearby to avoid fraudulent damage claims.

E. Damage to Existing Facilities - The Contractor shall be responsible for all damage to existing structures, piping, sewers, drains, cables, conduits, equipment and appurtenances resulting from his rock excavation operations, and shall repair same to the satisfaction of the Owner and the City.

### III. TESTING

#### 4.18. TESTING FOR DEFLECTION (STORM SEWERS)

All storm sewers of PVC plastic pipe or polypropylene pipe shall be tested for a maximum deflection of 5% of the pipe average inside diameter not less than 30 days after final full backfill, has been placed, as determined by the City.

Such tests shall be conducted with a representative of the Engineer present. All pipes exceeding a deflection of 5% of the average inside diameter shall be repaired or replaced and then retested until satisfactory test results are obtained. The Contractor shall pay all costs for the tests.

The tests shall be conducted using electronic equipment specifically designed for measuring and recording deflection in flexible pipe or by the use of an approved deflection probe, having a diameter equal to 95% of the average inside diameter of the pipe being tested, pulled through the sewer line. If the deflection probe is used, test shall be performed without mechanical pulling devices, and a proving ring, having an I.D. equal to the O.D. of the probe, shall be available at the time the probe is used to verify that the probe has the proper diameter by inserting the probe into the ring.

The deflection probe shall be as available from Wortco, Inc.; Burke Concrete Accessories, Inc.; or equal, and shall be designed specifically for testing the deflection of the type and size of pipe subject to test. The probe shall incorporate an odd number (no less than 9) of 1/2" x 3/16" bar stock runners equally spaced on edge around and welded to the circumference of two minimum 1/4 inch thick circular steel plates. The diameter of the probe for the type and nominal size of the pipe to be tested shall be equal to 95% of the average inside diameter of the respective pipe as specifically given or determined by the Engineer from information given in the appropriate ASTM Standard for the pipe.

The distance between plates, out-to-out, shall not be less than two (2) inches smaller than the nominal diameter of the pipe to be tested. The runners shall extend approximately 1-1/2 inches beyond each plate, being bent inward for this distance at approximately 30°. A continuous 3/4 inch threaded rod shall be provided through the center of the plates, having a hex nut drawn tight against the inside face of each plate, and extending each side as required for providing a 3/4 inch ferrule loop insert or similar piece for attaching the pulling medium.



#### 4.19. TESTING FOR LEAKAGE (STORM SEWERS)

A. General – The Contractor shall include labor and materials, including any water and all equipment, necessary to complete the leakage tests specified herein. Such tests shall be conducted after testing for deflection is complete, where applicable, and with a representative of the City present, and his judgment shall be final as to the acceptance of all tests. Leakage tests shall be conducted on each pipe section and manhole.

Each section of pipe shall be tested for obstructions prior to visual testing for leakage. Either mandrels, solid cylinders, or balls with diameters of 95% of the pipe diameter may be used to test for obstructions. All obstructions shall be removed.

All visible leakage in sewers and manholes shall be repaired.

All plugs used during leakage tests shall be of a length at least equal to the diameter of the pipe being tested to assure a watertight seal. Pneumatic plugs for air testing shall be able to resist internal test pressures without requiring external blocking.

B. Manholes – Each manhole shall be tested after assembly and after all lift holes have been plugged with an approved non-shrink grout, and, at the option of the Contractor, before or after backfilling is completed.

Testing shall be by drawing a vacuum on the manhole using equipment specifically designed for such testing. All pipes entering the manhole shall be plugged and braced to prevent being drawn into the manhole. A test head with necessary gauges and connections shall be placed at the inside of the top of the cone section and sealed in accordance with the manufacturer's instructions. A vacuum of ten (10) inches of mercury shall then be drawn and the vacuum pump shut off. With valves closed, the time shall be measured for the vacuum to drop to nine (9) inches. The test shall be successful if the time measured meets or exceeds the values indicated in the following table:

<b>MINIMUM TEST TIMES IN SECONDS</b>			
<b><u>MANHOLE DEPTH</u></b>	<b>MANHOLE DIAMETER</b>		
	<b><u>48"</u></b>	<b><u>60"</u></b>	<b><u>72"</u></b>
8'	20	26	33
10'	25	33	41
12'	30	39	49
14'	35	46	57
16'	40	52	65
18'	45	59	73
20'	50	65	81
22'	55	72	89
24'	59	78	97
26'	64	85	105
28'	69	91	113
30'	74	98	121

If the test is unsuccessful, necessary repairs shall be made and retesting shall proceed until a satisfactory test is obtained.

**4.20. TELEVISION INSPECTION (STORM SEWERS)**

Upon completion of leakage testing, sewers shall be televised in the presence of the City. Closed-circuit television inspection shall be performed for all new main line sewers. The City shall have access to view monitor at all times, and shall approve picture quality and definition.

Video equipment for testing shall produce DVD format video discs color video picture and include two audio tracks. A mobile studio for above ground control and adjustment of equipment and viewing the monitor shall be used, and shall accommodate a minimum of four people. The camera shall be designed specifically for such inspections; shall be operative in 100% humidity conditions; shall have lighting suitable to allow a clear picture for entire pipe periphery and, shall have metering device so location of camera at point of observation is known at all times.

During closed-circuit television inspection, location of leakage, damage, obstructions, or other faults discovered and service connections shall be referenced from a structure or terminus and appear on the tape and in the report.

During video inspection, any leakage, damages or other faults discovered shall be corrected to the satisfaction of the City. After completion of repair work or subsequent cleaning of the sewers, the sewers shall be subject to the closed-circuit television inspection again to document the repairs and/or corrective measures taken; and that these corrective measures have achieved the results desired. All subsequent inspections shall be at the Contractor's cost.

The Contractor installing the sewers shall provide one set of DVD format video for each inspection attempt and one copy of the report to the City. The report shall include the results of the video inspection and actions taken to correct leakage, damage and other faults discovered and removal of any obstructions.

4.21. COMPLETION OF TESTS

A. When the tests on the sewer have been successfully completed, the line shall be flushed and cleaned before it is accepted.